A mixed-methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviours among clinicians in Qatar.

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A mixed-methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviours among clinicians in Qatar

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Abstract

The detection of antimicrobial resistance (AMR) and awareness of the magnitude of associated threats to global public health as well as the world economy have long been recognised, with many countries implementing antimicrobial stewardship (AMS) programmes. Although these programmes can be effective, AMS interventions often fail to consider the determinants (contextual influences) of antimicrobial prescribing behaviour which vary within and across countries, practice settings and health professions. In addition, little attention has been paid to the use of theory to inform the design and choice of such interventions.

The State of Qatar is an advanced country with exceptional economic and social progress. The 2030 vision statement by the Qatari government aims at a 'comprehensive world-class healthcare system', designed to meet the needs of the State's fast-growing population. In line with this, AMS programmes had been implemented across Qatar's public healthcare providers by 2015. There, however, remains a significant increase in AMR coupled with inappropriate antimicrobial prescribing.

The overarching aim of this programme of research was to identify, quantify and explore clinicians' behavioural determinants of antimicrobial prescribing in Qatar. It involved three phases, each based upon the findings of the earlier phase, informed by theory and guided by the United Kingdom (UK) Medical Research Council (MRC) framework for developing and evaluating complex interventions.

The first phase (Phase 1) was a PROSPERO registered systematic review on the use of theory in the development and evaluation of behaviour change interventions designed to improve clinicians' antimicrobial prescribing. Ten studies were identified, most were suboptimal in the use of theory and the application of the UK MRC framework. In addition to the lack of studies, none was carried out in the Middle East or targeted pharmacists indicating a clear gap in the literature.

In the second phase (Phase 2), a cross-sectional survey of clinicians in Qatar was conducted to identify the potential determinants of antimicrobial prescribing behaviour, using the Theoretical Domains Framework (TDF). Principal Component Analysis of 535 responses identified three components: 'Guidelines compliance',

'Influences on practice' and 'Self-efficacy'. Respondents generally scored highly for 'Guidelines compliance' and 'Self-efficacy', but less highly for the 'Influences on practice' component with particular focus on the TDF domains: 'Environmental context and resources', and 'Social influences'. Comparison of component scores showed that doctors, the more qualified and those with greater experience were more likely to be positive in their responses ($P<0.05$).

In the final phase (Phase 3), online, video semi-structured interviews with 16 clinicians explored in depth the determinants of antimicrobial prescribing behaviour in Qatar, using the TDF. A number of themes, linked to ten TDF domains, were identified as determinants of antimicrobial prescribing and these determinants were interrelated. 'Goals', 'Intentions' and 'Beliefs of consequences' were key determinants which acted as facilitators while 'Environmental context and resources', 'Social influences', 'Knowledge', 'Social/professional role and identity', and 'Memory, attention and decision processes' were the main barriers highlighted.

This programme of research has generated original, robust and rigorous findings which it is hoped will support the development of future BCIs focusing on the proposed evidence-based behaviour change techniques. These will have the potential to improve clinicians' antimicrobial prescribing and reduce the major health challenge of AMR.

Keywords: antimicrobial stewardship; prescribing; behaviour change; theory; barriers, facilitators; Middle East; Qatar; systematic review; mixed methods.

Acknowledgments

Alhamdulillah, I thank Allah for the countless favours and bounties He has blessed me and my family with. Thanks for guiding me throughout this PhD journey, giving me the strength to keep going and for making me who I am today.

Over the past few years, I have been helped and supported by many people.

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I am thankful for the funding received from the Medical Research Center at Hamad Medical Corporation in Qatar (Grant number MRC-01-19-219). Many thanks also to all clinicians in Qatar who gave up their time to participate in my research during a period that was incredibly difficult for them due to the COVID-19 pandemic. They were welcoming, generous and honest and I feel very fortunate to have gained an insight into the work they do.

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Dedication

I dedicate this thesis in memory of my father, Monir Talkhan (1959- 2016), who died from liver cancer (Hepatocellular Carcinoma, HCC) in Hamad General Hospital, Hamad Medical Corporation, Qatar one year before I graduated with my BSc (Pharmacy). My father was chronically infected with hepatitis C virus which is one of the main risk factors for HCC development. In addition to several health issues, he had been suffering from a bacterial infection (Central Line-Associated Bloodstream Infection) in the months leading up to his death. I cannot forget what a consultant in infectious diseases told me when I was asking about my father's medications, 'he has been infected with bacteria that are resistant to multiple antibiotics and this is challenging!'

Antimicrobial resistance took my father and it has taken countless other fathers, mothers, brothers, daughters and even babies. Therefore, for the past few years, I have been working hard to fight resistance by taking a more in-depth look at clinicians' antimicrobial prescribing behaviours. It was my father who, through his sickness, inspired me to research this area.

My father was a great family man and I miss him every single day. He was an incredible husband, an incredible father, an incredible grandfather and an incredible teacher. He taught me the importance of education and supported my dream of becoming a pharmacist, even when he was battling for life and going through pain. His words of encouragement and push for tenacity have always rung in my ears throughout my PhD study. It is sad that he is gone, but I know he is not in pain anymore.

I love my father very much and nothing is going to bring him back. However, if by raising the awareness of my experience, I can help prevent even one unnecessary death, it would be a fitting tribute to a person who meant the world to me. I wish my father was here and I am sure he would have been very proud of me.

Outputs

This programme of research has resulted in the following outputs to date:

Published peer reviewed papers

1. Talkhan H et al. The application and use of theory in the development and evaluation of behaviour change interventions designed to improve clinicians' antimicrobial prescribing: a systematic review protocol. *PROSPERO*. 2018; CRD42018098586.
2. Talkhan H et al. The use of theory in the development and evaluation of behaviour change interventions to improve antimicrobial prescribing: a systematic review. *Journal of Antimicrobial Chemotherapy.* 2020; 75(9): 2394-2410.
3. Talkhan H et al. Investigating clinicians' determinants of antimicrobial prescribing behaviour using the Theoretical Domains Framework. *Journal of Hospital Infection.* 2022; 122: 72-83.

Peer reviewed conference abstracts

1. Talkhan H et al. The application and use of theory in the development and evaluation of behaviour change interventions designed to improve clinicians' antimicrobial prescribing: a systematic review protocol. (Poster presentation at the School of Pharmacy and Life Sciences Postgraduate Research Day, Robert Gordon University, Aberdeen, UK, May 2018).
2. Talkhan H et al. The application and use of theory in the development and evaluation of behaviour change interventions designed to improve clinicians' antimicrobial prescribing: a systematic review protocol. (Poster presentation at the Postgraduate Certificate Research Methods Module GSM008 Course, Robert Gordon University, Aberdeen, UK, August 2018). *Awarded First Prize for best research poster.
3. Talkhan H et al. Theoretical approaches in the development and evaluation of behaviour change interventions that improve clinicians' antimicrobial prescribing: a systematic review. (Poster presentation at the 9th Pharmaceutical Care Conference, Muscat, Oman, February 2019).
4. Talkhan H et al. Theoretical approaches in the development and evaluation of behaviour change interventions that improve clinicians' antimicrobial

prescribing: a systematic review. (Poster presentation at the 5th Qatar International Pharmacy Conference, Doha, Qatar, February 2019).

5. Talkhan H et al. Theoretical approaches in the development and evaluation of behaviour change interventions that improve clinicians' antimicrobial prescribing: a systematic review. *International Journal of Pharmacy Practice.* 2019; 27(2). (Oral presentation at the 2019 Health Services Research and Pharmacy Practice Conference, Birmingham, UK, April 2019).
6. Talkhan H et al. Theoretical approaches in the development and evaluation of behaviour change interventions that improve clinicians' antimicrobial prescribing: a systematic review. *Antimicrobial Resistance and Infection Control*. 2019; 8(1). (Poster presentation at the 5th International Conference on Prevention and Infection Control, Geneva, Switzerland, September 2019).
7. Talkhan H et al. Theoretical approaches in the development and evaluation of behaviour change interventions that improve clinicians' antimicrobial prescribing: a systematic review. *Access Microbiology*. 2019; 2(2). (Poster presentation at the 2019 Federation of Infection Societies Conference, Edinburgh, UK, November 2019).
8. Talkhan H et al. Using the Theoretical Domains Framework to investigate clinicians' behavioural determinants of antimicrobial prescribing in Qatar. *International Journal of Pharmacy Practice.* 2021; 29(1): i20-i22. (Poster presentation at the 2021 Health Services Research and Pharmacy Practice Conference, Reading, UK, April 2021).
9. Talkhan H et al. Exploring determinants of antimicrobial prescribing behaviour: a qualitative study using the Theoretical Domains Framework. *International Journal of Pharmacy Practice.* 2022; 30(1): i6-i7. (Oral presentation at the 2022 Health Services Research and Pharmacy Practice Conference, Bath, UK, April 2022). *Awarded Day Lewis Scholarship as one of the highest scoring student abstracts and First Prize for best oral presentation.

Further published output is planned for Chapter 5.

Abbreviations

AMR	Antimicrobial Resistance
AMS	Antimicrobial Stewardship
BCIs	Behaviour Change Interventions
BCTs	Behaviour Change Techniques
BCTTv1	Behaviour Change Technique Taxonomy version 1
CDC	Centers for Disease Control and Prevention
CDSR	Cochrane Database of Systematic Reviews
CINAHL	Cumulative Index of Nursing and Allied Health Literature
CITI	Collaborative Institutional Training Initiative
CONSORT	Consolidated Standards of Reporting Trials
COREQ	Consolidated Criteria for Reporting Qualitative Research
CPD	Continuing Professional Development
CRD	Centre for Reviews and Dissemination
DARE	Database of Abstracts of Reviews of Effectiveness
DS	Derek Stewart
EHS	Electronic Health System
GP	General Practitioner
HMC	Hamad Medical Corporation
HT	Hend Talkhan
ID	Infectious Diseases
IDSA	Infectious Diseases Society of America
IPA	International Pharmaceutical Abstracts
IQR	Interquartile Range
IV	Intravenous
JBI	Joanna Briggs Institute
MDR	Multidrug Resistance
MEDLINE	Medical Literature Analysis and Retrieval System
MeSH	Medical Subject Headings
MoPH	Ministry of Public Health
MRC	Medical Research Council
N/A	Not Applicable
NMP	Non-Medical Prescriber
OLT	Operant Learning Theory

PCA	Principal Component Analysis
PHCC	Primary Health Care Corporation
PhD	Doctor of Philosophy
PIDS	Pediatric Infectious Diseases Society
PO	Oral
PRISMA	Preferred Reporting Items of Systematic reviews and Meta-Analyses
PRISMA-P	Preferred Reporting Items for Systematic review and Meta-Analysis Protocols
PROSPERO	International Prospective Register of Systematic Reviews
QU	Qatar University
RCT	Randomised Controlled Trial
RCUK	Research Councils UK
RGU	Robert Gordon University
SC	Scott Cunningham
SCT	Social Cognitive Theory
SHEA	Society for Healthcare Epidemiology of America
SPSS	Statistical Package for the Social Sciences
TCS	Theory Coding Scheme
TDF	Theoretical Domains Framework
TM	Trudi McIntosh
TPB	Theory of Planned Behaviour
UK	United Kingdom
URTI	Upper Respiratory Tract Infection
USA	United States of America
UTI	Urinary Tract Infection
WHO	World Health Organization

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Chapter 1: Introduction

This chapter sets out the context for the programme of research. It starts with a general background to antimicrobial agents, antimicrobial resistance (AMR) and antimicrobial stewardship (AMS). The chapter concludes with an overview of the literature on AMS interventions designed to improve clinicians' antimicrobial prescribing behaviour from a global perspective, and more specifically from the Middle East and the State of Qatar, the setting for the primary research.

1.1 Setting the context

1.1.1 Antimicrobials: definition and modes of action

Since the discovery of penicillin in 1928 by Alexander Fleming (1), antimicrobials have been the major cornerstone of treatment and have saved people from life-threatening infections (e.g. malaria, pneumonia and tuberculosis) across the globe (2). The World Health Organization (WHO) estimates that antimicrobials add on average twenty years to everyone's life (3). Achievements in modern medicine, such as major surgeries (e.g. hip replacements), organ transplants and cancer chemotherapy would not be possible without the existence of effective antimicrobials (4).

Although 'antimicrobials' and 'antibiotics' are terms that are often used interchangeably, there are important differences between these terms. The term 'antibiotic' is derived from the Greek words: anti (against) and biotikos (concerning life), and refers to substances naturally produced by microorganisms (also called microbes) that act against other microorganisms, mainly bacteria (5). The term 'antimicrobial', on the other hand, is a wider term derived from the Greek words: anti (against), mikros (little) and bios (life), and refers to all agents that act against all types of microorganisms (e.g. bacteria, viruses, fungi and parasites) (5). It covers a wide variety of therapeutic classes that includes antibacterials (often called antibiotics, e.g. drugs for bacterial pneumonia), antimycobacterials (e.g. drugs for tuberculosis), antivirals (e.g. drugs for herpes), antifungals (e.g. drugs for yeast infections) and antiparasitics (e.g. drugs for malaria). The types of these classes and the microorganisms they are active against are summarised in Figure 1.1.

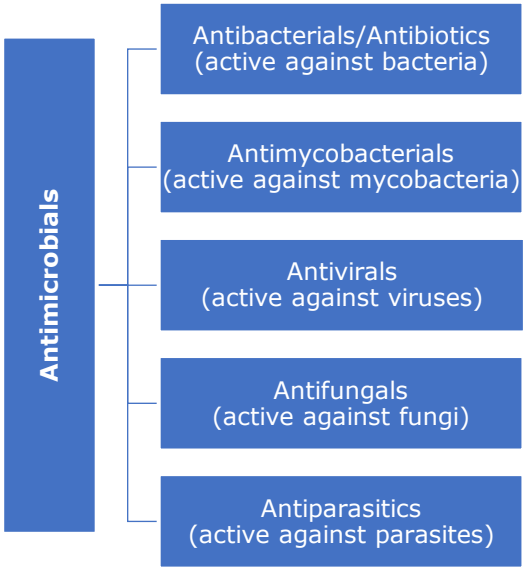


Figure 1.1: Classification of antimicrobials and the microorganisms they are active against (5)

With antimicrobial use, regardless of whether it is appropriate, some microorganisms can adapt which can result in the development of antimicrobial resistance (AMR).

1.1.2 Antimicrobial resistance: definition, implications and drivers

Antimicrobial resistance (AMR) is the ability of a microorganism to resist the effects of an antimicrobial agent used for prophylaxis or treatment of infections caused by that microorganism (6). The WHO and the Centers for Disease Control and Prevention (CDC) highlight that AMR is a worldwide public health threat that could send healthcare back into a pre-antibiotic era because it has the potential to increase morbidity and mortality from infections that are currently curable (3, 7). The threat of AMR is further complicated by multidrug-resistant (MDR) pathogens against which most antimicrobial agents are ineffective (3, 7). In 2017, the Global Antimicrobial Resistance Surveillance System (GLASS) report by the WHO confirmed the widespread occurrence of AMR across the world including high, middle and low-income countries (8). There is also an increased rate of AMR in the Middle East and the State of Qatar (the setting for this research) (9-15). In a recent study conducted by Sid Ahmed et al. (12), it was identified that there is a significant prevalence of MDR pathogens, particularly MDR *Pseudomonas aeruginosa* isolates (8.1%, 205/2533), in five Qatar hospitals. The authors reported that the majority of isolates were from patients exposed to antibiotics during 90 days prior to isolation (85.4%, 177/205) and the infections were mostly healthcare-acquired (95.1%, 195/205).

Globally, it is estimated that AMR causes at least 700,000 deaths every year (16). If no measures are taken, AMR would cause the death of 10 million people in 2050 (Figure 1.2). In addition, it would lead to a reduction of 2-3.5% in world Gross Domestic Product (GDP) (Figure 1.3). This is because of the need for more expensive second-line medications and longer hospital stays associated with treatment failure (16).

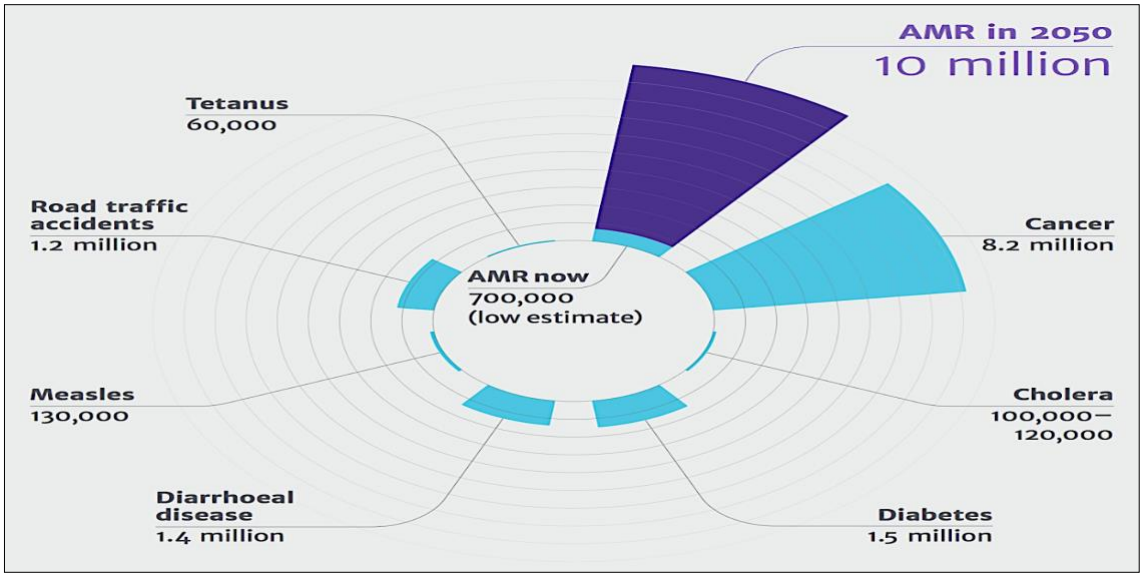


Figure 1.2: Deaths attributable to antimicrobial resistance (AMR) every year compared to other major causes of death worldwide (16)

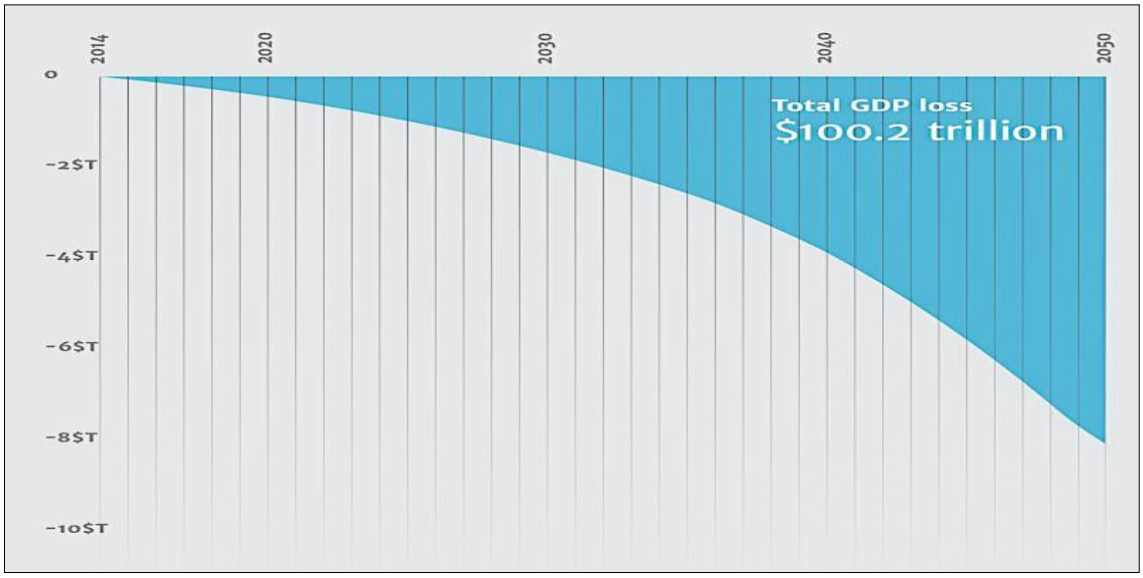


Figure 1.3: Economic implications of antimicrobial resistance on world Gross Domestic Product (GDP), in trillions of USD ($T), by 2050 (16)

A number of factors are known to play a role in the development and spread of AMR, with inappropriate use/prescribing of antimicrobials being one of its most significant drivers (17). The emerging evidence reveals that inappropriate antimicrobial prescribing is prevalent throughout the world. It is estimated that around 20-50% of all prescribed antibiotics are either inappropriate or unnecessary in the USA hospitals (7, 8). Most of these prescriptions are intended to treat viral infections (e.g. common colds, viral sore throats and bronchitis) for which antibiotics have no benefit.

In Qatar, there is also an evidence of inappropriate antimicrobial prescribing. Abdel-Aziz et al. (18) demonstrated that 53.3% of the prescribed antimicrobial prophylaxis for surgical procedures were inappropriate in comparison to the recommended protocol in Hamad General Hospital, Qatar. Another study published in 2017 and conducted over 18 months showed that 45% of 75,000 antibiotic prescriptions were for inappropriate indications in Qatar's private clinics (19). Although overuse of broad-spectrum antimicrobial agents greatly hastens the development of AMR and exposes patients to many side effects (20), Hammuda et al. (21) reported that these agents have been prescribed frequently in Al Amal Hospital, Qatar and the most commonly prescribed class was penicillin/beta-lactamase inhibitor combinations which accounted for nearly 40% of all prescriptions. The authors also reported that approximately a third of prescribed antimicrobial agents did not follow the local antimicrobial prescribing guidelines in the hospital. Furthermore, Garcell et al. (22) described that the prescribing of fluoroquinolones (broad-spectrum antimicrobial agents) experienced a significant increase (40.5%) in 2015 when compared to the year before in the Cuban Hospital, Qatar.

This is alarming, especially when considering that the number of new antibiotics developed has declined in the past few decades (23). The last antibiotic class discovered was the lipopeptides (e.g. daptomycin) in 1980s, as shown in Figure 1.4 (24). According to the recent WHO's Antibacterial Pipeline Report, almost all antibiotics in clinical trials today are derivatives of known antibiotic classes rather than new classes, hence a rapid emergence of AMR to these agents is expected (25). Thus, it is imperative to conserve and steward the existing antimicrobials to deal with the challenges posed by AMR.

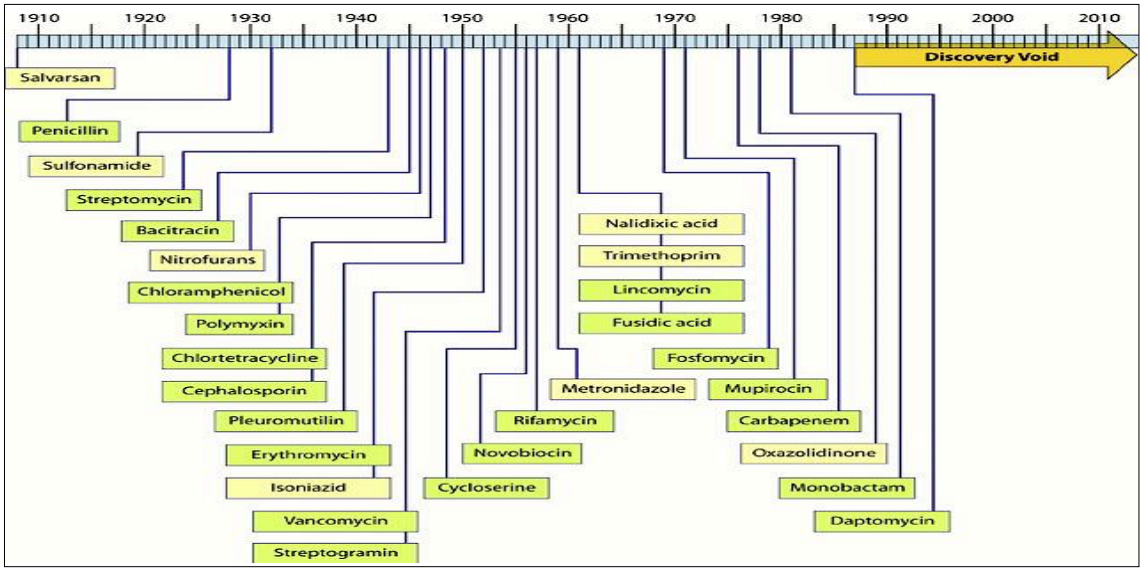


Figure 1.4: Timeline of the discovery of antibiotic classes in clinical use (24)

1.1.3 The role of antimicrobial stewardship

1.1.3.1 Background

Several evidence-based approaches have been considered to tackle AMR across different countries and sectors (e.g. human, animal, plant and environmental health). Such approaches range from simple actions to complex ones, from regulatory to behavioural interventions, and from strategies focusing on infection prevention and control to those focusing on appropriate use/prescribing of antimicrobials. A multifaceted approach encompassing a systems approach through to targeting individual clinicians' behaviours is most likely to achieve more rationale antimicrobial use/prescribing.

A number of regulatory bodies recommended the development and implementation of antimicrobial stewardship (AMS) programmes across all healthcare settings (26, 27). AMS has been defined by the Infectious Diseases Society of America (IDSA), the Pediatric Infectious Diseases Society (PIDS) and the Society for Healthcare Epidemiology of America (SHEA) as 'coordinated interventions designed to improve and measure the appropriate use of (antimicrobial) agents by promoting the selection of the optimal (antimicrobial) drug regimen including dosing, duration of therapy and route of administration' (28). It is a key strategy in the battle against AMR, in terms of reducing the current burden and the future spread of resistance. The benefits of AMS include the following (29):

- improved patient outcomes (e.g. mortality, morbidity and length of stay)
- improved rates of susceptibilities to targeted antimicrobials (i.e. rates of sensitivities)
- reduced adverse events (e.g. infections caused by *Clostridium difficile* and MDR pathogens)
- optimisation of resource utilisation across the continuum of care (i.e. unnecessary healthcare costs)

Implementing and maintaining an effective AMS programmes require coordinated efforts to engage multidisciplinary teams, including doctors, pharmacists, nurses, microbiologists and infection control professionals. According to the IDSA and SHEA, AMS is best led by a coalition between infectious diseases (ID) doctors and clinical pharmacists with specialised ID training (26, 30), hence, the focus of the research presented in this thesis is on these two health professions.

1.1.3.2 Types of antimicrobial stewardship interventions

AMS encompasses a broad range of interventions that can be designed and adapted to fit the infrastructure of any healthcare setting. In hospitals (i.e. the setting for this research), there are two main types of AMS interventions, describing either the 'what' or the 'how' elements (31). The first type (the 'what') describes appropriate antimicrobial use/prescribing practices with regard to indication, drug choice, dose, route, duration and timely drug administration. An example of such interventions is switching from intravenous (IV) to oral (PO) therapy in patients when appropriate. Other examples include: dose optimisation (e.g. for renal or hepatic impairment), escalation and de-escalation of therapy.

The second type (the 'how'), which is the scope of this research, describes behaviour change interventions (BCIs) to ensure that clinicians actually apply the recommended practices in daily hospital practice. These interventions aim to change/improve clinicians' antimicrobial prescribing behaviour (i.e. the care provided to patients) and consequently impact patient outcomes, adverse events, healthcare cost and AMR (32). Examples of such interventions are illustrated in Table 1.1, as reported in a Cochrane review (32).

Table 1.1: Examples of behaviour change interventions to improve clinicians' antimicrobial prescribing (32)

Type of interventions	Example
Persuasive interventions	Educational meetings, distribution of educational materials, local consensus processes, sending reminders, educational outreach visits, and audit and feedback
Restrictive interventions	Formulary restriction, automatic stop orders, requiring prior authorisation of prescriptions, selective reporting of lab susceptibilities, therapeutic substitutions and antibiotic policy change strategies, such as rotation and cross-over studies
Structural interventions	Rapid lab testing, changing from paper into computerised records, computerised decision support systems and introduction of quality monitoring mechanisms

1.2 Behaviour change interventions around antimicrobial prescribing

1.2.1 Background

In the field of behavioural science, BCIs are defined as 'coordinated sets of activities designed to change specified behaviour patterns' (33). These are often 'complex', challenging and consisting of many interacting components (active ingredients) known as behaviour change techniques (BCTs), 'observable and replicable components designed to change behaviour' (33). The dimensions of intervention complexity can be multiple, such as (34):

- the number of and interactions between the components of the intervention
- the number and difficulty of behaviours required by those delivering or receiving the intervention
- the number of groups or organisational levels targeted by the intervention
- the number and variability of outcomes
- the degree of flexibility or tailoring of the intervention permitted

Accordingly, interventions aimed at changing antimicrobial prescribing behaviour will be considered 'complex' given the clinician diversity (countries of training and previous practice, areas of speciality, professional grades, levels of seniority, etc.), the nature and difficulty in understanding the behaviours around antimicrobial prescribing and failure of previous attempts to alter these behaviours (35, 36).

1.2.2 Determinants of antimicrobial prescribing

Existing research has identified a number of factors as potential determinants (influences) of antimicrobial prescribing behaviour, such as cultural, contextual, and behavioural influences (36-39). These factors are likely to be wide-ranging and to vary within and across countries (cultural), practice settings (contextual) and health professions (behavioural). Understanding and addressing these factors is required for successful development and implementation of BCIs around antimicrobial prescribing (37).

A systematic review focusing on antimicrobial prescribing behaviour in tertiary care settings demonstrated that clinicians' prescribing behaviour is influenced by several factors, including the cultural beliefs of the clinician and the patient, socioeconomic factors, and clinicians' desire for clinical autonomy when making decisions (40). Further, medical hierarchy and professional relationships (known as prescribing etiquette) have a greater influence on antimicrobial prescribing behaviour than local AMS guidelines (40).

Another systematic review exploring antimicrobial prescribing behaviour in secondary care settings reported that several factors influenced prescribing, including patients' expectations, uncertainty over diagnosis, severity and duration of infections, and influence of medical companies (41).

A more recent systematic review investigating non-medical prescribers' (NMPs') antibiotic prescribing behaviour in both secondary and primary care settings indicated that managing challenges experienced during consultations, managing patient concerns, peer support and public awareness of AMR are the factors that influence appropriate antibiotic prescribing (42). In addition, social norms, and clinicians' underlying emotions and beliefs were common influences in similar healthcare settings (43).

Several other factors influencing antimicrobial prescribing behaviour have been reported in systematic reviews of primary care settings, including patients'/parents' pressure and expectations, clinicians' fear of possible patient complications, perceptions of external pressure to lower prescribing and previous experience (44-46). Although these factors aid understanding of potential determinants of antimicrobial prescribing behaviour, they are too broad to guide research that seeks to improve such behaviour. It is also unclear which

determinants are the most dominant in the context of antimicrobial prescribing. Therefore, local determinants of antimicrobial prescribing need to be assessed to inform and contextualise interventions to improve prescribing behaviour, according to local circumstances (i.e. context specific).

There is very limited published work around the use of theory in determining behaviours and linked interventions for antimicrobial prescribing change (see Section 1.2.3) yet there is evidence that this work is needed in Qatar to address inappropriate antimicrobial prescribing (see Section 1.1.2).

1.2.3 An overview of the literature

Globally, various interventions have been attempted to improve clinicians' antimicrobial prescribing behaviour across different countries, practice settings and health professions. Theses interventions are usually multifaceted, containing two or more components and addressing different aspects of antimicrobial prescribing (47). As a preparatory step for this research, an overview of systematic reviews on this topic was conducted as described by Grant and Booth (48). The aim of this overview was to identify the current gaps in the evidence base and demonstrate the need for and importance of further research in this area.

1.2.3.1 Methods

MEDLINE®, Cumulative Index to Nursing and Allied Health Literature (CINAHL®), International Pharmaceutical Abstracts (IPA®), and Google Scholar were searched from the inception of databases to October 2018. The scope, features and coverage of these databases are summarised in Table 1.2. The reference lists of the retrieved papers were assessed to locate any further systematic reviews. E-mail alerts were also created to ensure that no recent papers were missed during the time of writing. No date or language restrictions were applied.

Table 1.2: Characteristics of searched electronic databases

Searched database	Scope	Feature	Coverage
MEDLINE®: Medical Literature Analysis and Retrieval System	MEDLINE is a premier bibliographic database of the USA National Library of Medicine, focuses on medicine, pharmacy, nursing, dentistry, veterinary science, and healthcare	It has records with a distinctive feature of indexed with Medical Subject Headings (MeSH®)	1946-present
CINAHL®: Cumulative Index to Nursing and Allied Health Literature	CINAHL is a comprehensive Nursing database produced by EBSCO with major subject areas include health sciences, biomedicine, education and about 17 other allied health disciplines	The Subject Headings in CINAHL also follow the structure of MeSH® used by MEDLINE®	1982-present
IPA®: International Pharmaceutical Abstracts	The American Society of Health-System Pharmacists developed IPA with a wide coverage of pharmaceutical literature, including drug use and development, pharmacy practice and education	It contains unique records, such as pharmacy trade magazines, pharmacy journals, and the meeting abstracts of pharmacy-related associations	1970-present
Google Scholar	Google Scholar provides a simple way to broadly search for scholarly literature across many disciplines and sources	It retrieves more than journal articles and includes theses, books, abstracts and court opinions, from academic publishers, professional societies, online repositories, universities and other web sites	2004-present

Firstly, a Medical Subject Headings (MeSH®) search approach was carried out in order to identify the search terms using a wide variety of words/phrases from the research title/aim. Next, searches of all databases were conducted and the number of hits was recorded in a concept map. Several search strategies were used, such as Boolean (AND, OR) and Truncations (*) to be able to retrieve the most relevant papers. As an example, the search terms used (i.e. both concepts and sub-terms) and the number of hits obtained through MEDLINE® are shown in Table 1.3 below.

Table 1.3: A concept map of searching MEDLINE® database

Concept	Sub-term	Search option	Hit
1. Antimicrobials	1.1 antibiotic*	AB OR TI	325,020
	1.2 anti-bacterial agents	MeSH+	370,403
	1.3 anti-infective agents	MeSH+	697,430
	1.4 antimicrobial*	AB OR TI	156,384
	1.5 antibacterial*	AB OR TI	72,164
	1.6 stewardship*	TX All Text	8,109
	Summary – all 'sub-terms' above combined with OR		946,136
2. Prescribing	2.1 Prescrib*	AB OR TI	142,005
	2.2 therapeutics ▪ prescriptions (MeSH) ▪ inappropriate prescribing (MeSH) ▪ medication errors (MeSH)	MeSH+	4,517,539
	Summary – all 'sub-terms' above combined with OR		4,600,894
3. Intervention	3.1 intervention*	AB OR TI	882,075
	Summary – all 'sub-terms' above combined with OR		882,075
4. Behaviour	4.1 behavior	MeSH+	1,775,983
	4.2 behavior control	MeSH+	13,401
	4.3 professional practice	MeSH+	249,720
	4.4 attitude of health personnel	MeSH+	156,165
	4.5 practise*	TX All Text	10,043
	Summary – all 'sub-terms' above combined with OR		2,107,799
Overall search	Combine all summaries above with AND		3,892
Search limiters (reviews)	Combine all summaries above with AND		551

1.2.3.2 Results

Papers identified were screened and 19 relevant systematic reviews were included. The characteristics of these reviews were extracted and summarised in table 1.4. Data extracted were: authors and year of publication, review aim(s), search method, number of studies and research approach, type of intervention(s), and key findings.

Table 1.4: Systematic reviews of interventions designed to improve clinicians' antimicrobial prescribing behaviour (spelling is as original papers)

Authors and year of publication	Review aim(s)	Search method	Number of studies and research approach	Type of intervention(s)	Key findings
Arroll, Kenealy and Kerse, 2003 (49)	To systematically review controlled trials of delayed prescriptions to establish their capacity to reduce antibiotic intake	MEDLINE, EMBASE, and the Cochrane Controlled Trials Register were searched from 1966 to April 2003	5 quantitative studies	A delayed prescription compared to an immediate prescription for patients with upper respiratory tract infections	The relative risk in the randomised trials for lower antibiotic usage when a delayed prescription was given ranged from 0.54 for the common cold to 0.25 for otitis media. The consistent reduction in antibiotic usage in the five controlled trials included in this review suggests that delayed prescription is an effective means of reducing antibiotic usage for acute respiratory infections. The duration of delay for prescriptions ranged widely, from 1 to 7 days
Arnold and Straus, 2005 (50)	To estimate the effectiveness of interventions, alone or in combination, in improving the selection, dose and treatment duration of antibiotics prescribed by healthcare providers in the outpatient setting; and to evaluate the impact of these interventions on reducing resistance	The Cochrane Effective Practice and Organisation of Care Group specialized register was searched. Additional studies were obtained from the bibliographies of retrieved articles, the Scientific Citation Index and personal files	93 quantitative studies	Printed educational materials for physicians, audit and feedback, educational meetings, educational outreach visits, financial and healthcare system changes, physician reminders, patient-based interventions and multi-faceted interventions	Use of printed educational materials or audit and feedback alone resulted in no or only small changes in prescribing. Interactive educational meetings appeared to be more effective than didactic lectures. Educational outreach visits and physician reminders produced mixed results. Patient-based interventions were not immediately indicated effectively reduced antibiotic use by patients and did not result in excess morbidity. Multi-faceted interventions combining physician, patient and public education in a variety of venues were the most successful in reducing antibiotic prescribing
Ranji et al., 2008 (51)	To assess the effectiveness of quality improvement (QI) strategies to reduce antibiotic prescribing for acute outpatient illnesses	The Cochrane Collaboration's Effective Practice and Organisation of Care database were searched, supplemented by	43 quantitative studies	Clinician education, patient education, delayed prescriptions, audit and feedback, clinician reminder and decision support system and financial	No single QI strategy or combination of strategies was clearly superior. However, active clinician education strategies trended toward greater effectiveness than passive strategies (p=0.096). Compared with studies targeting specific conditions or patient populations, broad-

Authors and year of publication	Review aim(s)	Search method	Number of studies and research approach	Type of intervention(s)	Key findings
	for which antibiotics are often inappropriately prescribed	MEDLINE and manual review of article bibliographies		and regulatory incentives or disincentives	based interventions extrapolated to larger community-level impacts on total antibiotic use, with savings of 17-117 prescriptions per 1000 person-years
Charani et al., 2011 (40)	To assess the extent to which behavioural sciences and social marketing were used and whether this could be related to the effectiveness of reported outcomes	MEDLINE, EMBASE, Applied Social Sciences Index and Abstracts, Business Source Complete, The Cochrane Library, PsychInfo, Database of Abstracts of Reviews of Effectiveness and Health Management Information Consortium were searched from January 1999–April 2011	10 quantitative and qualitative studies	The quantitative studies reported on multimodal interventions used to optimize antimicrobial prescribing. The qualitative studies attempted to investigate health care professionals' perspectives on antimicrobial prescribing and adherence to antibiotic guidelines and policy	Qualitative studies highlight the predominant influence of social norms, attitudes, and beliefs on antimicrobial prescribing behavior. Quantitative studies reporting interventions to optimize antimicrobial prescribing behavior do not use theoretical science or primary research to inform the design and choice of the interventions deployed. The incorporation and application of behavioural sciences supported by appropriate multidisciplinary collaboration is recommended
Davey et al., 2013 (52)	To estimate the effectiveness of professional interventions that, alone or in combination, are effective in antibiotic stewardship for hospital inpatients, to evaluate the impact of these interventions on reducing the incidence of antimicrobial-resistant pathogens or Clostridium difficile infection and their	CENTRAL, MEDLINE, EMBASE and the EPOC specialized register were searched from 1980 to December 2006 and bibliographies of retrieved articles	89 quantitative studies	Interventions that had a restrictive element (restriction of the freedom of prescribers to select some antibiotics) and those that were persuasive (used one or more of the following methods for changing professional behaviour: education, reminders, audit and feedback)	Interventions to reduce excessive antibiotic prescribing to hospital inpatients can reduce antimicrobial resistance or hospital-acquired infections, and interventions to increase effective prescribing can improve clinical outcome. The meta-analysis supports the use of restrictive interventions when the need is urgent, but suggests that persuasive and restrictive interventions are equally effective after six months

Authors and year of publication	Review aim(s)	Search method	Number of studies and research approach	Type of intervention(s)	Key findings
	impact on clinical outcome				
Fleming, Browne and Byrne, 2013 (53)	To collect and interpret the results of studies of interventions to improve the quality of, or appropriateness of antibiotic prescribing in long-term care (LTCF) in order to determine the key components for a successful intervention	A search of The Cochrane Library, PubMed, EMBASE, ISI Web of Knowledge, International Pharmaceutical Abstracts, the Database of Abstracts of Review of Effects, the Health Technology Assessments and Google Scholar was conducted from inception to August 2012. A manual search of the grey literature was also conducted	4 quantitative studies	Three studies directed educational material and sessions at physicians and nurses, with one of the three studies providing prescribing feedback as well. The fourth study provided educational material and prescribing feed-back for physicians only	Due to the mixed and modest effects of the interventions and the variety of interventions implemented, it is difficult to attribute the success of any intervention to just one component alone. It seems that a multifaceted intervention involving small group educational sessions and the provision of educational materials is generally acceptable to nurses and physicians in LTCF. The involvement of local consensus procedures when developing guidelines and interventions may improve the success of the intervention
Vodicka et al., 2013 (54)	To assess the effectiveness of primary care based interventions to reduce antibiotic prescribing for children with respiratory tract infections (RTIs)	MEDLINE, Embase, CINAHL, PsycINFO, and the Cochrane library were searched from inception through June 2012	17 quantitative studies	Educational and/or behavioural interventions to change antibiotic prescribing	Interventions that combined parent education with clinician behaviour change decreased antibiotic prescribing rates by between 6-21%; structuring the parent-clinician interaction during the consultation may further increase the effectiveness of these interventions. Automatic computerised prescribing prompts increased prescribing appropriateness, while passive information, in the form of waiting room educational materials, yielded no benefit
Holstiege, Mathes and Pieper, 2014 (55)	To assess the effectiveness of computer-aided clinical decision support systems	A literature search utilizing Medline, PubMed and Embase was conducted up to November 2013	7 quantitative studies	The intervention contained a computer-aided CDSS aiming at improving antibiotic prescribing	Studies showed marginal to moderate statistically significant effects of CDSS in improving antibiotic prescribing behavior. CDSS that automatically provided decision support were more likely to

Authors and year of publication	Review aim(s)	Search method	Number of studies and research approach	Type of intervention(s)	Key findings
	(CDSS) in improving antibiotic prescribing in primary care			practice and was compared to an intervention that contained a different computer-aided CDSS, any other intervention, or no intervention	improve prescribing practice in contrast to systems that had to be actively initiated by healthcare providers
Roque et al., 2014 (56)	To review of educational programs aimed at improving antibiotic-prescribing by physicians and/or antibiotic-dispensing by pharmacists, in both primary care and hospital settings	A search of the MEDLINE and PubMED from January 2001 through December 2011 was conducted	78 quantitative studies	Educational interventions include any attempt to persuade physicians to modify their practice performance by communicating clinical information strategies and by communication skills training	Twenty-nine studies (62%) in primary care and twenty-four (78%) in hospital setting reported positive results for all measured outcomes; fourteen studies (30%) in primary care and six (20%) in hospital setting reported positive results for some outcomes and results that were not statistically influenced by the intervention for others; only four studies in primary care and one study in hospital setting failed to report significant post-intervention improvements for all outcomes. Antibiotic use could be improved by educational interventions, being mostly used multifaceted interventions
Davey et al., 2015 (57)	To investigate (i) the extent to which the behaviour change techniques (BCTs) of goal setting, self-monitoring, feedback and action planning are used in interventions to improve antibiotic prescribing in hospital inpatients, (ii) examine the detail	MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, PubMed, the Cochrane Database of Systematic Reviews and the Database of Abstracts of Reviews of Effects were searched, as well as the bibliographies of included articles	116 quantitative studies	Educational meetings, reminders, audit and feedback, educational outreach and structural interventions	Both the content and reporting of interventions for antimicrobial stewardship fell short of scientific principles and practices. There is a strong evidence base regarding BCTs in other contexts that should be applied to antimicrobial stewardship now if we are to further our understanding of what works, for whom, why and in what contexts

Authors and year of publication	Review aim(s)	Search method	Number of studies and research approach	Type of intervention(s)	Key findings
	with which they are reported and (iii) consider how they could be improved				
Baysari et al., 2016 (58)	To review evidence of the effectiveness of information technology (IT) interventions to improve antimicrobial prescribing in hospitals	MEDLINE (1950-March 2015), EMBASE (1947-March 2015) and PubMED (1966-March 2015) were searched	45 quantitative studies	IT interventions: (1) stand-alone computerized decision support systems (CDSSs), (2) decision support embedded within a hospital's electronic medical record or computerized provider order entry system, (3) computerized antimicrobial approval systems and (4) surveillance systems	IT interventions increased appropriate use of antimicrobials (pooled RR: 1.49, 95%CI: 1.07-2.08); however, no evidence of an effect was found when analysis included only studies with a quality score of five or above on the 10-point quality scale (pooled RR: 1.53, 95%CI: 0.96-2.44). There was little evidence of an effect of IT interventions on patient mortality or hospital length of stay
McDonagh et al., 2016 (59)	To assess the comparative effectiveness of interventions for improving antibiotic use for acute respiratory tract infections (RTIs) in adults and children	Electronic databases (MEDLINE from 1990 and the Cochrane Library databases from 2005 to February 2015), reference lists of included systematic reviews, and Scientific Information Packets from point-of-care test manufacturers and experts were searched	133 quantitative and qualitative studies	Education interventions, point-of-care tests and electronic decision support	The best evidence supports the use of specific education interventions for patients/parents and clinicians, procalcitonin in adults, and electronic decision support to reduce overall antibiotic prescribing for acute RTIs without causing adverse consequences, although the reduction in prescribing varied widely. Other interventions also reduced prescribing, but evidence on adverse consequences was lacking, insufficient, or mixed
Davey et al., 2017 Update (32)	To estimate the effectiveness and safety of interventions to	The Cochrane Central Register of Controlled Trials, MEDLINE, and Embase were	221 quantitative and qualitative studies	Restriction (using rules to reduce the opportunity to engage in the target	Interventions are effective in increasing compliance with antibiotic policy and reducing duration of antibiotic treatment. Lower use of antibiotics probably does

Authors and year of publication	Review aim(s)	Search method	Number of studies and research approach	Type of intervention(s)	Key findings
	improve antibiotic prescribing to hospital inpatients and to investigate the effect of two intervention functions	searched, as well as the bibliographies of included articles and personal files. The last search from which records were evaluated was January 2015		behaviour) and enablement (increasing means/reducing barriers to increase capability or opportunity)	not increase mortality and likely reduces length of stay. Enablement consistently increased the effect of interventions, including those with a restrictive component. Although feedback further increased intervention effect, it was used in only minority of enabling interventions
Köchling et al., 2018 (60)	To summarise the evidence on the effectiveness of interventions in primary care aiming to reduce antibiotic (Abx) prescriptions in patients ≥ 13 years for acute RTI	MEDLINE, PubMed and Cochrane Library were searched from January 1, 2005, to August 31, 2016	17 quantitative studies	Studies used multifaceted interventions of educational seminars, feedback on prescribing behaviour, patient education, communication skills training (CST) for physicians and diagnostic tools such as point-of-care tests (POCT) or CDSS	Twelve out of 17 included studies showed statistically significant lower Abx prescription rates in the intervention groups, but only six of them reported a clinically relevant reduction. CST and POCT were the most effective interventions. Pre-intervention Abx prescription rates varied between 13.5% and 80% and observed reductions ranged from 1.5-23.3%. Studies with post-intervention rates lower than 20% had no significant effects. The design of the trials was heterogeneous precluding calculation of pooled effect size. The reporting of many RCTs was poor
Saha, Hawes and Mazza, 2019 (61)	To assess the effectiveness of antibiotic stewardship programmes (ASPs) involving pharmacists at improving antibiotic prescribing by general practitioners (GPs)	Medline, Embase, Emcare, PubMed, PsycINFO, Cochrane CENTRAL, CINAHL Plus and Web of Science databases were searched to February 2018	15 quantitative studies	The intervention approaches were academic detailing or educational outreach visits, group meetings, clinical guidelines, educational mailing, educational sessions, delayed prescribing, workshop training and antibiotic prescribing feedback	Antibiotic prescribing rate (APR) reductions (OR 0.86, 95% CI 0.78–0.95, moderate-certainty evidence) and antibiotic prescribing adherence rate (APAR) improvements (OR 1.96, 95% CI 1.56–2.45, high-certainty evidence) were observed at 6 months median intervention follow-up. GP education plus prescribing feedback, and group meetings were effective in both outcomes, whereas GP education, academic detailing and workshop training were effective in APAR outcome.

Authors and year of publication	Review aim(s)	Search method	Number of studies and research approach	Type of intervention(s)	Key findings
					However, substantial heterogeneity was demonstrated
Crayton et al., 2020 (62)	To specify the component behaviour change techniques (BCTs) of stewardship interventions in long-term care facilities and identify those components associated with improved outcomes	Sources included MEDLINE, EMBASE, PsycINFO, the Cochrane Library, Web of Science and reference lists of included full text articles. The search was run from inception until July 2018	20 quantitative studies	Intervention types were: 'enablement', 'environmental restructuring', 'education', 'persuasion', 'training', 'restriction' and 'incentivisation'	The majority of studies did not explicitly report the use of theory to inform the design of their intervention (19/20 studies). Seven interventions (37%) were 'very promising', eight 'quite promising' (42%) and four 'not promising' (21%). Most promising intervention types were 'persuasion' (n=12; promise ratio (PR)=5.0), 'enablement' (n=16; PR=4.33) and 'education' (n=19; PR=3.75). Most promising BCTs were 'feedback on behaviour' (n=9; PR=8.0) and 'restructuring the social environment' (n=8; PR=7.0)
Matuluko et al., 2020 (63)	To synthesize current evidence for the effectiveness of interventions to ensure the timely review of antibiotics in acute care hospitals	MEDLINE, CINAHL, Embase, Web of Science and PsycINFO databases were searched from 1 January 2015 to 8 March 2019, as well as the reference lists of included articles	14 quantitative studies	Studies tested interventions comprising more than one strategy. The three most commonly utilized strategies within interventions were clinical practice guidelines, audit and feedback, and educational materials	Most studies (11 out of 14) were conducted in single sites. Nine out of 14 reported intervention delivery by more than one healthcare professional. Physicians were the main targets of interventions in all studies. Only one study employed theory in intervention evaluation. Reported interventions led to timely review and switch of IV antibiotic therapy, and shortened durations of overall antibiotic therapy
Nair et al., 2021 (64)	To explore the current evidence on interventions to influence antibiotic prescribing behaviour of health professionals in outpatient settings in low-income and lower-middle-income	PubMed, Embase and the Cochrane Central Register of Controlled Trials were searched for studies published in English between 2001 and 2019	13 quantitative studies	Interventions were classified as persuasive (prescription audits and feedback), enabling (education or guidelines on antibiotic use), restrictive (expert approval), structural	All studies were conducted in the outpatient or ambulatory setting: eight took place in primary health centres, two in private clinics and three in pharmacies. Our review found that enabling or educational interventions alone may not be sufficient to overcome the ingrained incentives to link revenue generation to sales of antibiotics, and hence, their inappropriate prescription or misuse.

Authors and year of publication	Review aim(s)	Search method	Number of studies and research approach	Type of intervention(s)	Key findings
	countries, an underrepresented area in the literature			(introduction of a new diagnostic test or clinical algorithm) or bundle (mix of interventions)	Bundle interventions appear to be very effective at changing prescription behaviour among healthcare providers, including drug sellers and pharmacists
Nabovati et al., 2021 (65)	To examine the effects and characteristics of Information technology (IT) interventions on improving antibiotic prescribing for patients with acute respiratory infection (ARI)	A search was performed in Medline, PubMed, ISI web of science, Embase and Cochrane databases from inception to August 2020	18 quantitative studies	Text messaging and four types of CDSS interventions (A' interventions provided information only. 'B' interventions presented information on appropriateness or guidelines. C' interventions required clinician to justify why they were overriding the decision support recommendation. D' interventions prevented the clinician from ordering a test contrary to the CDSS determination of inappropriateness, until permission obtained)	In 12 studies (66.7%), IT interventions improved the level of antibiotic prescribing, and in eight of the 12 studies the effect was statistically significant. In two studies the intervention had a statistically significant negative effect, and in two studies the level of antibiotic prescribing was not changed. Seventeen studies (94.4%) used CDSSs for the intervention and one study used text messaging. In 12 studies (66.7%) CDSSs were integrated with electronic health records

Summary of literature

While a number of systematic reviews of interventions around antimicrobial prescribing behaviour have been published, these all have limitations.

First, most SRs focused mainly on methodology and intervention outcomes, with a wide range of effects (in terms of success and sustainability) and varying quality of evidence. Davey et al. (52) described how the effect size of educational interventions varied between 3.1% and 50.1% and that few studies reported sustained improvements in prescribing behaviours.

Second, little attention has been paid to the use of theory (see Chapter 2) in the development and evaluation of interventions (32, 40, 52, 57, 62, 63). This may contribute to the large differences in success (i.e. improvement in prescribing behaviours) reported between studies testing similar types of interventions. A systematic review of 10 studies investigating the effectiveness of interventions designed to influence antimicrobial prescribing in acute care found that behavioural theories had been poorly used to inform the design and choice of interventions (40). The behavioural determinants of antimicrobial prescribing (see Section 1.2.2), including the barriers and facilitators were also not considered in the choice of most interventions, although qualitative evidence demonstrated the influence of these determinants on prescribing (40). This can make it difficult to build on research findings or replicate the intervention.

Another limitation is that the reporting of evidence-based BCTs (e.g. feedback and action planning) as intervention components was inexplicit with little detail of BCT characteristics, for example inadequate description of certain aspects of an educational session (32, 57, 62). A Cochrane review of 116 studies evaluating the extent to which the BCTs were used in interventions designed to improve antibiotic prescribing in hospital inpatients reported that both the content and reporting of interventions fell short of scientific principles and practices (57). The review authors recommended that researchers need to carefully report the components of interventions to allow for better replication or adaption by others.

In addition, the majority of studies reported in the reviews have originated from western countries, predominantly from the UK and the USA. Given the differences in the volume and appropriateness of antimicrobial prescribing/use

between countries, practice settings and health professions (37), the findings of studies conducted elsewhere cannot necessarily be generalised or transferred to the Middle Eastern countries and specifically to the State of Qatar. There is a need for robust and rigorous research conducted within the State of Qatar to strengthen the evidence in this area. Such research should be grounded in behavioural theories to understand the key determinants of antimicrobial prescribing behaviour and so select the BCTs of interventions. This will be the focus of the present programme of research.

1.3 The State of Qatar

This section will provide an insight into the State of Qatar's geography, demographics, culture, economy and healthcare system with prime focus on AMS initiatives in Qatar to address the threat of AMR.

1.3.1 Qatar's profile

The State of Qatar is a country located in Western Asia, in a part of a geographical region known as the Middle East (66, 67). It is situated on a small peninsula (around 11,600 square kilometres) on the southern coast of the Persian Gulf (Arabian Gulf), with Saudi Arabia to the southwest, the United Arab Emirates to the southeast and Bahrain to the northwest (Figure 1.5). The climate of Qatar is generally hot and dry, with summer temperatures exceeding 40 degrees Celsius (104 Fahrenheit).

Figure 1.5: Map of Qatar in the Middle East (67)

Qatar is a multicultural country with an estimated population of 2.7 million (313,000 Qatari and 2.3 million non-Qatari) according to figures by the Ministry of Development, Planning and Statistics in 2017 (68). Of the total population, Arabs are 40%, South Asian are 36% (18% Indian and 18% Pakistani), Iranian are 10% and other ethnic groups are 14%. Qatar's culture is similar to other countries in the Middle East, being considerably influenced by Islam. Islam is the most prevalent religion in Qatar (65.5% Muslim) followed by Hinduism (15.1%) and Christianity (14.2%) (69). Arabic is the official language in Qatar and English is commonly used as a second language (70). Many other languages are also used, such as Persian, Baluchi, Hindi, Urdu, Nepali, Bengali and Indonesian.

Despite being a small country, Qatar is a high-income economy with substantial revenues produced mainly from the energy sectors. It has the world's third greatest natural gas and oil reserves, after Russia and Iran (71). In 2016, the International Monetary Fund reported that Qatar was one of the top 10 wealthiest nations in the world per capita (72). Qatar is also classified by the United Nations as a country with 'very high human development' among Arab countries based on the 'Human Development Index' which describes expected and mean years of schooling, life expectancy at birth, as well as gross national income per capita (Figure 1.6) (73).

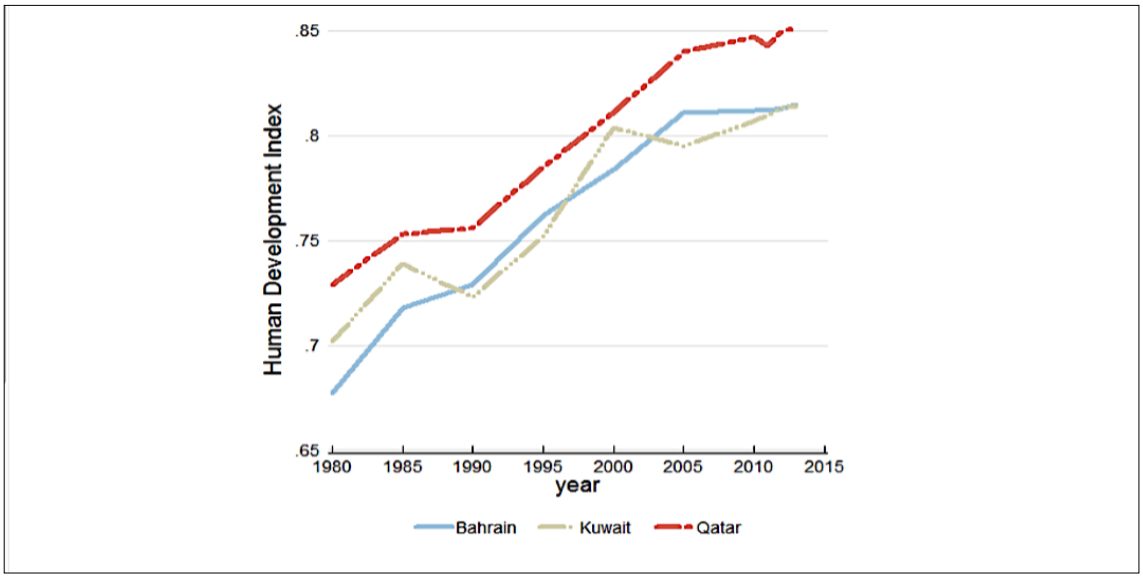


Figure 1.6: Human development in Qatar vs. Kuwait and Bahrain 1980-2015 (73)

1.3.2 Qatar's healthcare system

In addition to the major advances in economic and human development, Qatar's healthcare system continues to evolve. Expenditure on healthcare in Qatar is among the highest in the Middle East, with 4.7 billion USA dollars being invested in healthcare alone in 2014 (74). The 2030 National Vision statement by the Qatari government aims at 'a comprehensive world-class healthcare system' where services are less costly and more accessible to the whole population (75). In order to achieve this, every healthcare professional should play a collaborative role with common objectives. The Ministry of Public Health (MoPH) which was established in 2005 (previously known as Supreme Council of Health) controls the healthcare system in the State. It is mainly responsible for the development of healthcare policies and strategies, as well as monitoring both public and private health sectors (76). Recently, the MoPH has published the Qatar's National Health Strategy 2018-2022 entitled: 'Our Health, Our Future: Improved health for Qatar's population, meeting the needs of existing and future generations' (77). This Strategy focuses on the following five priority areas to improve Qatar's healthcare system:

1. strengthening integrated care services (i.e. high quality and safe care)
2. enhancing health promotion and disease prevention
3. enhancing health protection spans across country borders
4. considering health in all policies and decision-making processes
5. creating effective system of governance and leadership

National targets for 2022 have also been set for each priority area. With regard to priority area 3, enhancing health protection spans across country borders, the Strategy aims to decrease AMR (including MDR infections) and dangerous environmental exposures (e.g. food poisoning and air pollution) in the State.

Under the regulations of MoPH, the healthcare providers in Qatar are structured into public (free services) and private (paid services) health sectors as the following (78):

- Primary Health Care Corporation centres (PHCC: 27 public health centres)
- Hamad Medical Corporation hospitals (HMC: 12 public hospitals, National Ambulance Service and Home Healthcare Service)
- private hospitals (6 main hospitals) and clinics (>70 clinics)

- community pharmacies (>250 pharmacies)
- pharmaceutical companies

The HMC (the settings for data collection and generation in this research) is the main public healthcare provider in Qatar, established by the Qatari government in 1979, and one of the leading hospital providers in the Middle East (79) (Figure 1.7). Since its establishment, the HMC has been dedicated to delivering the safest, most effective and cost-effective care to all its patients, regardless of nationality, based on clinical need rather than ability to pay. It manages a total of 12 hospitals, a mixture of secondary and tertiary healthcare settings, as well as the National Ambulance Service and Home Healthcare Service. Table 1.5 outlines the different areas of speciality and levels of care provided by each HMC hospital.

Figure 1.7: The Hamad Medical Corporation (79)

Table 1.5: Areas of speciality and levels of care provided by Hamad Medical Corporation hospitals (79, 80)

Hospital name	Level of care	Capacity	Area of speciality
Hamad General Hospital	Tertiary	603 beds	Trauma, Emergency medicine, Paediatrics, Critical care, Specialised surgery, Specialised medicine, Laboratory medicine and Radiology
Rumailah Hospital	Secondary	570 beds	Adult rehabilitation, Children's rehabilitation, Dermatology, Dentistry, Ear, Nose and Throat, Ophthalmic surgery, and Psychiatry and residential care
Women's Hospital*	Tertiary	352 beds	Obstetrics & gynaecology, Neonatal care, Emergency care and New-born screening

Hospital name	Level of care	Capacity	Area of speciality
Al Wakra Hospital	Secondary	320 beds	General medicine, General surgery, Emergency medicine, Paediatrics, and Obstetrics & gynaecology
Qatar Rehabilitation Institute	Tertiary	193 beds	Stroke, Traumatic brain injury, Spinal cord injury, Rehabilitation, Pain management and Paediatrics
Hazm Mebaireek General Hospital	Secondary	118 beds	General medicine, General surgery Emergency medicine, Rehabilitation and Dentistry
Heart Hospital	Tertiary	116 beds	Cardiology, Cardiothoracic, Non-invasive cardiac surgery, Cardiac intermediate, and Intensive and emergency care
Al Khor Hospital	Secondary	110 beds	General medicine, General surgery, Emergency medicine, Paediatrics and Obstetrics
The Cuban Hospital	Secondary	80 beds	General medicine, General surgery, Emergency medicine, Paediatrics and Obstetrics
Ambulatory Care Centre	Tertiary	66 beds	Day case surgery, Podiatry, Urology, Ear, Nose and Throat, Ophthalmology, and Gastroenterology
Communicable Disease Centre	Tertiary	65 beds	Clinical imaging, Dietetics, Pharmacy, Laboratory and Social services
National Centre for Cancer Care & Research**	Tertiary	60 beds	Medical oncology, Radiotherapy, Chemotherapy, Pain management and Specialist laboratory services
*known as Women's Wellness & Research Centre **Known as Al Amal Hospital			

In 2016, the Joint Commission International awarded accreditation (under the Academic Medical Centre accreditation program) for all HMC hospitals (78). The National Ambulance Service and Home Healthcare Service have received this accreditation since 2011. Besides that, the HMC is the first hospital provider in the Middle East to receive institutional accreditation from the Accreditation Council of Graduate Medical Education-International, which demonstrates excellence in how medical graduates are trained through internship and residency programs (78).

1.3.3 Antimicrobial stewardship initiatives in Qatar

In line with Qatar's National Health Strategy, a multidisciplinary AMS programme had been implemented across Qatar's public healthcare providers including HMC hospitals by 2015 (81-83), but without a behavioural lens. This programme aims to improve antimicrobial practice and combat AMR at national level. An ID doctor leader and pharmacist are responsible for the performance of the programme at each HMC hospital (82). The elements of programme's performance are presented in Table 1.6 below.

Table 1.6: The elements of antimicrobial stewardship programme's performance in Qatar (84)

Antimicrobial consumption measure	Process measure	Outcome measure	Financial measure
▪ Days of therapy per 1,000 patient days ▪ Defined daily dose per 1,000 patient days	▪ Percentage of cases with appropriate therapy ▪ Frequency of de-escalation and antimicrobial review ▪ Timely cessation of surgical prophylaxis ▪ Timely administration of therapy in suspected sepsis ▪ Cultures obtained ▪ Guidelines adherence	▪ Length of stay due to infection related issues ▪ Hospital readmissions for select infections ▪ Hospital onset of *C. difficile* infections ▪ Adverse drug reactions ▪ AMR focusing on hospital onset cases	▪ Antimicrobial cost per day ▪ Antimicrobial cost per admission ▪ Total hospital cost per admission

AMR, antimicrobial resistance; *C. difficile, Clostridium difficile*

The programme involves several interventions, including prospective audit with feedback, restrictions on antibiotics (e.g. formulary restrictions, pre-authorisations and 48 h automatic stop orders), IV-to-oral switch, dose optimisation, as well as supplemental strategies such as clinicians' education and local guidelines development (82, 84). The local antimicrobial prescribing guidelines, available in English as a PDF booklet on the HMC intranet, are evidence-based and take into account local AMR patterns. They cover diagnosis, treatment and prophylaxis of common infections. These guidelines were first designed in 2006 and reviewed every three years to incorporate feedback from stakeholders across Qatar.

While several studies conducted in Qatar showed that the AMS programme is successful in reducing antimicrobial consumption, its economic burden and AMR (12, 22, 85-87), there are some challenges encountered during the programme's implementation including clinicians' antimicrobial prescribing behaviour (82, 88-90). Therefore, there is a crucial need for developing an intervention to improve clinicians' antimicrobial prescribing behaviour in Qatar. Emphasis should be placed first on identifying the behavioural determinants (contextual influences) of antimicrobial prescribing in Qatar before developing/implementing any new intervention (see Section 1.2.2), thus, it is the main focus of this research.

1.4 Aim and objectives of the research

The overarching aim of the programme of research was to identify, quantify and explore clinicians' behavioural determinants of antimicrobial prescribing in HMC, Qatar. The findings could inform a later programme of research on developing a theoretically-based intervention designed to improve antimicrobial prescribing behaviour of clinicians in Qatar, initially targeting the HMC hospitals.

The primary research objectives were (Figure 1.8):

1. systematically review, critically appraise, synthesise and present the existing evidence on the application and use of theory in the development and evaluation of BCIs designed to improve clinicians' antimicrobial prescribing **(Phase 1: Chapter 3)**
2. identify and quantify potential determinants of antimicrobial prescribing behaviour in HMC, Qatar, using the Theoretical Domains Framework **(Phase 2: Chapter 4)**
3. explore in depth the determinants of clinicians' antimicrobial prescribing behaviour in HMC, Qatar **(Phase 3: Chapter 5)**

The secondary research objectives were to:

1. determine barriers and facilitators to appropriate antimicrobial prescribing in HMC, Qatar **(Phase 3)**
2. map the above findings to relevant BCTs that can be used as the basis for the development of future interventions **(Phases 2 and 3)**

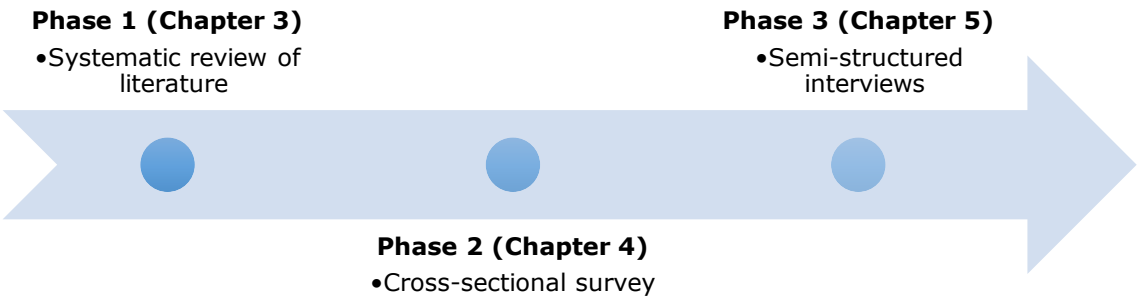


Figure 1.8: An outline of the programme of research

1.5 Chapter summary

This chapter provides a general introduction to the thesis and sets the stage for upcoming chapters. Prior to the research conducted, it was important to know about the State of Qatar, its demographics and healthcare system, AMS interventions, what has been already published, and what needs to be addressed around this area.

Chapter 2: Methodology and methods

2.1 Introduction

This chapter will describe the research paradigms, methodologies and key methodological approaches in general and in relation to this programme of research. This will be followed by information about the theory/framework, research design, methods and data analysis used. Aspects of robustness in quantitative research and rigour in qualitative research will also be discussed, with emphasis on data validity and trustworthiness.

2.2 Philosophical paradigms

Saunders (91) prepared a diagrammatic representation of the various elements of the research process, outlining the range of approaches at each stage and the alignment across stages. Identification of the research philosophy is positioned at the outermost layer of Saunders's 'Research Onion' and, as a result, will be considered first (Figure 2.1).

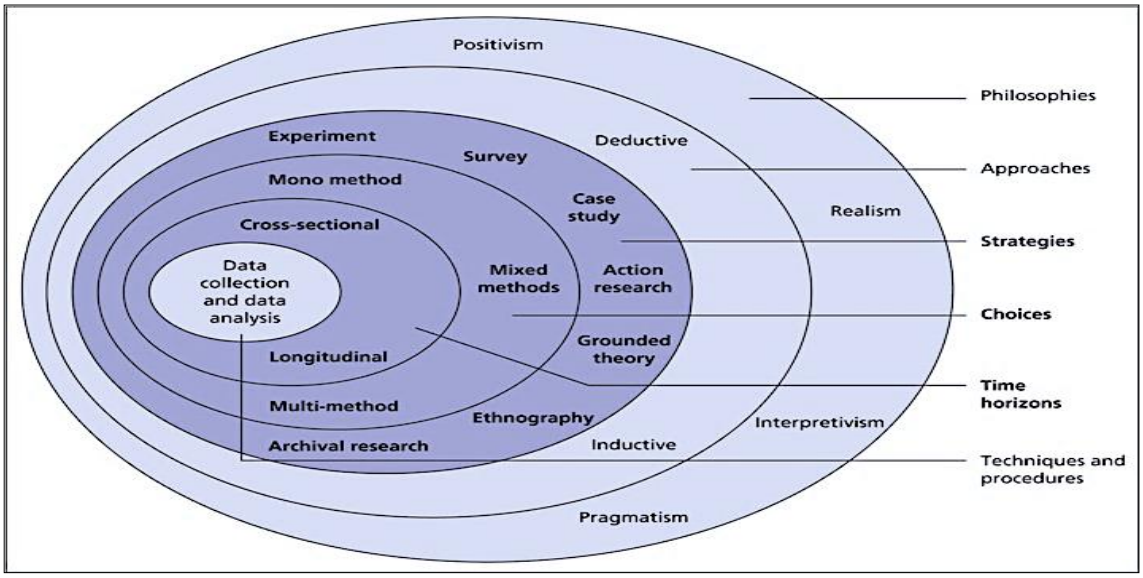


Figure 2.1: The Research Onion (91)

Derived from the ancient Greek word for 'love of wisdom', philosophy is defined as a 'set of beliefs concerning the nature of the reality being investigated' (92). The term paradigm is described as a 'worldview' and refers to 'a general philosophical orientation about the world and the nature of research that a researcher brings to a study' (93). While several philosophical paradigms exist, Dr John Creswell (93), a leading expert in research methods, focused on

postpositivism (evolved from positivism), constructivism (often combined with interpretivism), transformative and pragmatism. Importantly, the research aim/questions determine the appropriate philosophical paradigm. Table 2.1 below presents each philosophical paradigm, applied research approaches and major elements.

Table 2.1: The philosophical paradigms (93, 94)

Paradigm	Research approach	Element
Postpositivism	Mostly quantitative	▪ Determination ▪ Reductionism ▪ Empirical observation and measurement ▪ Theory verification/testing
Constructivism	Mostly qualitative	▪ Understanding ▪ Multiple participant meanings ▪ Social and historical construction ▪ Theory generation/building
Transformative	Mostly qualitative	▪ Political ▪ Power and justice oriented ▪ Collaborative ▪ Change-oriented
Pragmatism	Both quantitative and qualitative (mixed methods)	▪ Consequences of actions ▪ Problem-centred ▪ Pluralistic ▪ Real-world practice oriented

2.3 Research methodological approaches

To address any research aim/questions, three main research approaches can be utilised: quantitative, qualitative and mixed methods. Creswell defined each methodological approach as the following (93):

1. **quantitative research:** an approach for examining objective theories by investigating the relationship between different variables
2. **qualitative research:** an approach for understanding and exploring the meaning people ascribe to a human/social problem
3. **mixed-methods research:** an approach to inquiry including collecting both qualitative and quantitative data, integrating the two forms and using different designs that may involve theoretical frameworks

Additionally, each methodological approach uses different designs, methods and data collection tools, and hence generates different types of data. Table 2.2 below summarises the key characteristics of these research approaches.

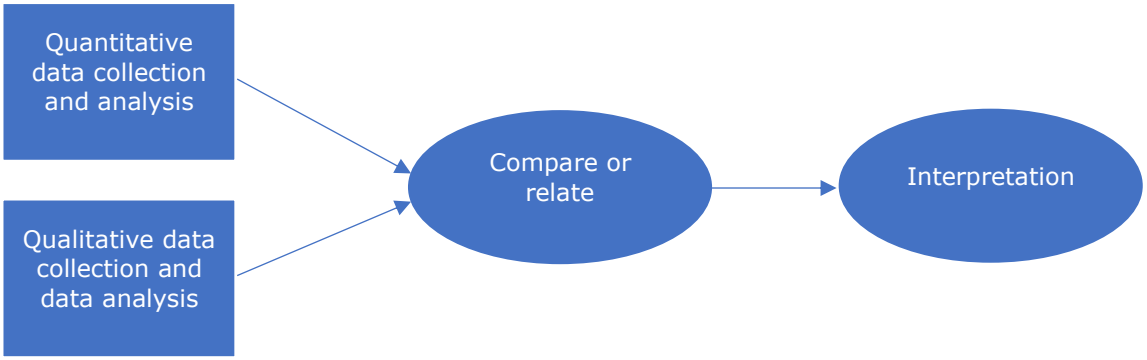
Table 2.2: Characteristics of quantitative, qualitative and mixed-methods research approaches (93, 94)

Characteristic	Quantitative approach	Qualitative approach	Mixed-methods approach
Paradigm	Postpositivism	Constructivism, Transformative	Pragmatism
Design	Experimental and non-experimental	Narrative, phenomenology, grounded theory, ethnographies and case study	Convergent, explanatory sequential, exploratory sequential and transformative, embedded or multiphase
Use of theory	Deductively	Inductively	Deductively or inductively
Methods	Pre-determined methods	Emerging methods	Both pre-determined and emerging methods
Questions	Instrument based questions	Open-ended questions	Both open- and closed-ended questions
Data	Performance, attitude, observational and census data	Interview, focus group, observation, documents and audio-visual data	Multiple forms of data
Collecting tools	Validated tools (e.g. questionnaires)	Researcher	Both researcher and validated tools
Analysis	Statistical analysis	Text and image analysis	Statistical analysis, and text and image analysis
Interpretation	Statistical interpretation	Themes and patterns interpretation	Across databases interpretation

2.3.1 Mixed-methods research

Various published studies have employed mixed-methods research in different fields. Mixed-methods research involves the collection and analysis of both quantitative and qualitative data, sequentially, in response to the research aim/questions. It includes four basic designs: the convergent parallel mixed-methods design, explanatory sequential mixed-methods design, exploratory sequential mixed-methods design and the embedded mixed-methods design (95), as is shown in Figure 2.2. The choice of designs by researchers depends on whether the intent is to specify the type of data to be collected before the study or to allow it to emerge from research participants in the study.

- **The convergent parallel design mixed-methods design**



- **The explanatory sequential mixed-methods design**

- **The exploratory sequential mixed-methods design**

- **The embedded mixed-methods design**

Figure 2.2: The designs of mixed-methods research (95)

One of the advantages of the mixed-methods approach is that the data collection can be spaced out over time (96). In addition, it allows researchers to address complex health issues in a way that is more comprehensive than could be attained by either qualitative or quantitative approach (96). As outlined in Table 2.2, the philosophical paradigm that fits the mixed-methods approach is pragmatism. Creswell (93) described that the pragmatism paradigm arises out of actions, situations and consequences instead of antecedent conditions. It opens the door to several methods, multiple designs, and different forms of data collection and analysis.

This research adopted a multimodal methodological approach to investigate clinicians' behavioural determinants of antimicrobial prescribing in Qatar. It consisted of two stages aligned to the research aim. Stage 1 was a systematic review of the literature (Phase 1). Stage 2 was an explanatory sequential mixed-methods design of quantitative (Phase 2) and qualitative (Phase 3) approaches. Phase 2 (cross-sectional survey) quantified potential determinants of antimicrobial prescribing while Phase 3 (semi-structured interviews) explored and described the phenomenon of antimicrobial prescribing behaviour in more detail. The field work of primary data collection in Phase 2 (questionnaire) aligned to the postpositivism paradigm and Phase 3 data generation (interviews) to constructivism. These are described in more detail in Table 2.3 below.

Table 2.3: The distinct methodological approaches employed in Phases 2 and 3 of the research

Characteristic	Phase 2	Phase 3
Paradigm	Postpositivism	Constructivism
Research approach	Quantitative (deductive)	Qualitative (inductive)
Research design	Cross-sectional	Phenomenology
Research method	Survey	Interviews
Data collection tool	Online questionnaire	Online, semi-structured interviews
Population/ sampling	The entire population (without sampling)	A purposive sample of Phase 2 participants who expressed interest in participation. Responses were coded and analysed until saturation achieved
Data analysis	Descriptive, inferential and Principal Component Analysis	Thematic analysis

The choice of the explanatory sequential mixed-methods design, in Stage 2, allows the use of qualitative data to help explain in greater depth and provide more insight into the quantitative results. The research began with a broad quantitative survey to obtain information about the large population/setting and then, in the next phase, focused on qualitative interviews to collect detailed views from participants in order to clarify and understand the initial results. This is particularly important when little is known about the behaviour under investigation, as is the case for antimicrobial prescribing in Qatar (see Chapter 1). Table 2.4 below illustrates the main features of this design.

Table 2.4: Features of the explanatory sequential mixed-methods design (93)

Feature	Description
Data collection	Qualitative data collection builds directly on the quantitative results
Data analysis	Quantitative and qualitative data are analysed separately
Interpretation	Researchers report the quantitative and then qualitative results. This is followed by a discussion on how the qualitative results help to explain the quantitative results
Validity	Researchers establish the validity of the scores from the quantitative measures and discuss the validity of the qualitative findings
Strengths	▪ Explaining the mechanism in more depth through the qualitative follow-up ▪ Data collection can be spaced out over time
Limitations	▪ Sample size may be inadequate on either quantitative or qualitative side ▪ Findings accuracy may be compromised because researchers do not weigh all of the options for following up on the quantitative results

All phases of this research were conducted in line with the phases of the United Kingdom (UK) Medical Research Council (MRC) framework for developing and evaluating complex interventions (34) (see Section 2.4.1).

2.4 Selected framework and theory

This section will describe the need to use theory throughout the research and the selection of the theoretical framework utilised.

2.4.1 The Medical Research Council framework

The design of this research was informed by the application of the UK MRC guidance on 'Developing and Implementing Complex Interventions' (34). In 2008, the UK MRC proposed a framework to assist researchers to choose and implement appropriate methods for this. This internationally accepted framework involves four non-linear phases: development, feasibility/pilot testing, evaluation and implementation (Figure 2.3). Although the UK MRC guidance does not include specific details on how to use theory to develop or evaluate complex interventions (97), it recommends that researchers should identify the intervention's theoretical underpinning and existing evidence base in the initial development phase. This may involve conducting a systematic review of similar interventions (see Chapter 3) in addition to the primary research (see Chapter 4 and Chapter 5). Following intervention development, the feasibility/pilot testing phase should be carried out to ensure that the intervention will be delivered as intended. This may detect weaknesses and lead to modifications before embarking on an expensive or lengthy evaluation. Next, the evaluation phase

should be considered to explain discrepancies between predicted and observed outcomes, as well as providing insights for future implementation.

This research focused on the first phase of the UK MRC framework, development:

- identifying the evidence base
- identifying/developing appropriate theory
- modelling process and outcomes

The use of theory is a key aspect of the development phase in order to understand the likely process involved in behaviour change. 'You also need to be aware of the relevant theory, as this is more likely to result in an effective intervention, than is a purely empirical or pragmatic approach' (34). Applying the UK MRC guidance and embedding appropriate and relevant theory in intervention development has the potential to result in successful intervention outcomes (34).

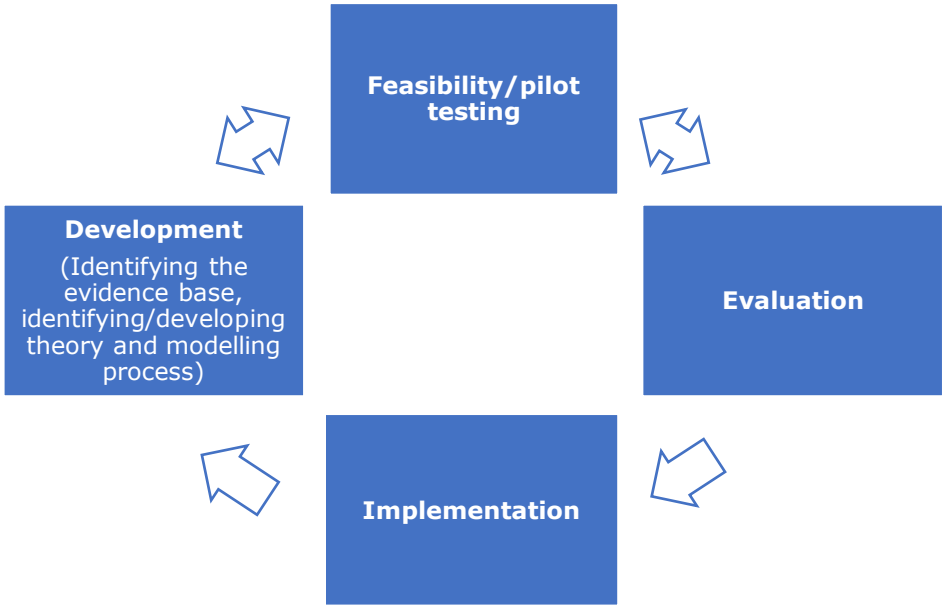


Figure 2.3: Key phases of developing and evaluating complex interventions (34)

2.4.2 The Theoretical Domains Framework

The literature shows that theory provides a useful basis for developing and evaluating interventions which aim to change human behaviour (98). The term 'theory' is derived from ancient Greek 'theoria', meaning 'looking at' or 'being aware of' (99). It has been defined as 'a set of analytical principles or statements designed to structure our observation, understanding and explanation of the world (thus) provides a clear explanation of how and why specific relationships lead to specific events' (100).

While the use of theory cannot guarantee intervention success, there are several advantages to considering it at the outset of planning interventions. These advantages include enhancing the robustness and rigour of studies and, thus, the potential impact of the research findings (99). The use of appropriate theory can inform all research phases by helping to frame the research aim/questions, identify the methodological stance, design data collection/generation tools and consider a framework for data analysis/interpretation (99). In addition, theory can be used to summarise the state of cumulative knowledge by describing the barriers which contribute to unsuccessful interventions and facilitators contributing to successful interventions (98, 101). It can also improve intervention design/development and facilitate the evaluation of intervention effectiveness (102).

Various behaviour change theories at the individual level exist. Given the large number of theories within health behaviour research and to overcome the challenge of selecting the most appropriate one, the Theoretical Domains Framework (TDF), a framework of behavioural theories, was developed and validated by a group of psychological theorists, health psychologists, health service researchers and behavioural experts (103). It aims to 'simplify and integrate a plethora of behaviour change theories and make theory more accessible to, and usable by, other disciplines (104). The TDF is not one theory but a framework of 33 psychological theories of behaviour change and 128 theoretical constructs (i.e. parts of theories), which are organised into 14 distinct theoretical domains. Definitions of each domain are given in Table 2.5 below.

Table 2.5: Definitions of the TDF domains (104)

TDF domain	Definition of domain
1. Knowledge	'An awareness of the existence of something'
2. Skills	'An ability or proficiency acquired through practice'
3. Social/professional role & identity	'A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting'
4. Beliefs of capabilities	'Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use'
5. Optimism	'The confidence that things will happen for the best or that desired goals will be attained'
6. Beliefs of consequences	'Acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation'
7. Reinforcement	'Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus'
8. Intentions	'A conscious decision to perform a behaviour or a resolve to act in a certain way'

TDF domain	Definition of domain
9. Goals	'Mental representations of outcomes or end states that an individual wants to achieve'
10. Memory, attention & decision processes	'The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives'
11. Environmental context & resources	'Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour'
12. Social influences	'Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours'
13. Emotion	'A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event'
14. Behavioural regulation	'Anything aimed at managing or changing objectively observed or measured actions'
TDF, Theoretical Domains Framework	

Wacker (105) outlined the criteria of what he referred to as 'a good theory', as being explanatory, plausible, explicit and parsimonious. The TDF meets these four criteria and can be used to characterise and understand the domains (i.e. the determinants) of behaviour which need to be targeted in any intervention (105). In 2017, an observational study from 12 countries reported that the TDF is one of the most used theories in the field of implementation science (106). It has been used extensively within healthcare-related research, embedded into a range of research methodologies and methods. Fields of study have included: smoking cessation, physical activity, hand hygiene, acute low back pain and schizophrenia (107). Of note, it has been recently used in the Middle East in studies of medication management in older people (108), medication error reporting (109, 110), patient safety (111) and antimicrobial prescribing (112).

In recognition of the complexity of BCIs (see Section 1.2.1), Michie et al. (113) developed the Behaviour Change Technique Taxonomy version 1 (BCTTv1) which is a methodological tool used for specifying content (i.e. BCTs) of complex BCIs delivered to the individuals whose behaviour is targeted. It is a cross-disciplinary taxonomy which consists of 93 clearly labelled, well-defined evidence-based BCTs that are clustered into 16 groups. Following the development of this taxonomy, Michie et al. (114) developed and tested a methodology for mapping BCTs to the TDF domains with the aid of 400 researchers across different countries.

As an example, relevant BCTs mapped to TDF domain of 'Social influences' are:

- drawing attention to others' performance to allow comparison with the person's own performance **(BCT: social comparison)**
- advising on, arranging or providing emotional social support (e.g. from colleagues or staff) for performance of the behaviour **(BCT: social support)**
- prompting observation of the consequences, including rewards and punishments for others when they perform the behaviour **(BCT: vicarious reinforcement)**

In this research, the TDF was used throughout Phases 2 and 3 to inform the design of data collection and generation tools, analysis, and reporting (see Chapter 4 and Chapter 5 respectively). The TDF was chosen over other theoretical frameworks, such as the Consolidated Framework of Implementation Research (115), as it allowed for identifying determinants of prescribing at an individual clinician's level, which could then be used to select relevant, evidence-based BCTs.

2.5 Research design, methods and analysis

2.5.1 Phase 1: Systematic review of literature

The first stage of this research was a systematic review of published literature (Phase 1) on the use of theory in BCIs to improve antimicrobial prescribing worldwide (116, 117). This was conducted and reported according to best practice to identify the key gaps and explore methodological strengths/limitations of studies published (see Chapter 3). In addition, findings from this systematic review informed the development of the second stage of the research (Phases 2 and 3).

Systematic reviews provide a summary of literature on a specific research question, using explicit methods to search, appraise and synthesise the evidence base systematically (118). As a result, more reliable and precise findings will be obtained. In addition to setting out what is already known about a specific topic, systematic reviews are used to demonstrate where knowledge is lacking and guide future research (119, 120). Furthermore, the importance of conducting

systematic reviews is emphasised within the first phase of the UK MRC framework, development (34).

Based on the methodological quality, systematic reviews and meta-analyses of randomised controlled trials (RCTs) are placed at the top of the hierarchy of research evidence (also known as levels of evidence) (121, 122) (Figure 2.4).

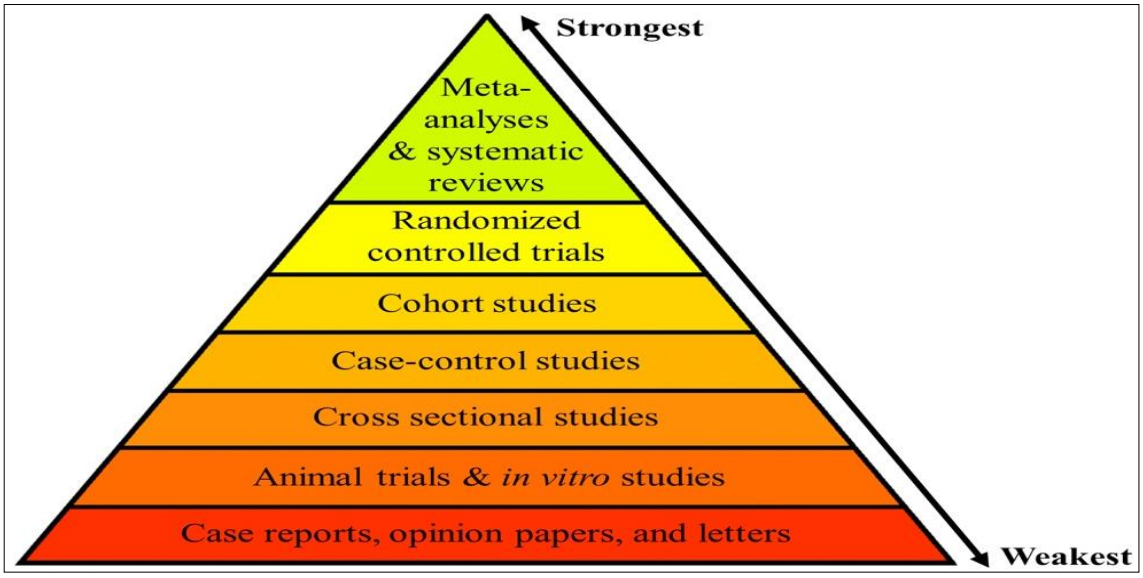


Figure 2.4: Hierarchy of research evidence (122)

It is important to note that systematic review differs from narrative (traditional) literature reviews in several ways. The main differences are summarised in Table 2.6 below.

Table 2.6: Differences between narrative and systematic reviews (48, 123)

Characteristic	Narrative review	Systematic review
Research question	Often broad in scope and can cover wide range of subjects at various levels	Often focused and adhering to guidelines on the conduct of a review
Search sources	Not usually specified	Comprehensive sources
Search strategy	Potentially biased	Explicit strategy
Study selection	Not usually specified	Criterion-based selection
Quality assessment	Variable	Robust and rigorous
Data synthesis	Often a narrative summary	Meta-analysis, meta-synthesis or narrative
Strengths	▪ Can identify what has been accomplished ▪ Allows for building on previous work	▪ Draws together all known knowledge on a specific topic ▪ Subjects the literature to critical appraisal
Limitations	▪ Lacks an explicit intent to maximise scope or analyse data ▪ Susceptible to bias	▪ Inclusion of a single study design can limit the application of this review ▪ Requires more time/effort than traditional review

2.5.1.1 Organisations of systematic reviews

Several public and private sector organisations exist with the aim of supporting systematic reviews, including the Joanna Briggs Institute (JBI) (124), the Cochrane Collaboration (125) and the Centre for Reviews and Dissemination (CRD) (126). The Phase 1 systematic review was conducted and registered with the CRD which aims to promote high standards in review commissioning and conduct.

The CRD was established in January 1994 and is one of the largest health services research centres in the world based within the University of York, England. It specialises in evidence synthesis, assembling and evaluating data to inform health policy and practice. It is also involved in methods research and creates internationally accepted guidelines for conducting systematic reviews. The CRD collaborates with several leading entities across the world, including the Centre for Health Economics, based at the University of York, and the UK Cochrane Centre. It produces the following three freely available databases which are used by health professionals, policy makers and researchers both in the UK and internationally:

1. **Database of Abstracts of Reviews of Effects (DARE):** holds more than 1000 structured abstracts of systematic reviews which have met strict quality criteria and covers a wide spectrum of healthcare related topics (127)
2. **NHS Economic Evaluation Database (NHS EED):** contains over 17,000 records of quality assessed abstracts of published economic evaluations of competing healthcare interventions (128))
3. **Health Technology Assessment Database (HTA):** provides access to over 15,000 summaries of ongoing and published health technology assessments being conducted worldwide (129)

All the three databases are also available as part of The Cochrane Library. The doctoral researcher (HT) undertook CRD training prior to conducting the systematic review.

2.5.2 Phase 2: Cross-sectional survey

Numerous categories and subcategories of quantitative research designs have been identified. Broadly, these are classified as either non-experimental (i.e. descriptive or correlational) or experimental designs (i.e. true-experimental or quasi-experimental) as shown in Table 2.7. In addition, non-experimental research designs are further classified based on the time of data collection (i.e. cross-sectional or longitudinal) or the time of the event studied (i.e. retrospective or prospective) (130).

Table 2.7: Description of quantitative research designs (130, 131)

Quantitative research design	Description
Non-experimental	*Descriptive design:* researchers observe, describe and document various aspects of a phenomenon
	Correlational design: researchers investigate the relationships/associations between and among variables rather than direct cause-effect relationships
Experimental	*True-experimental design:* researchers examine the cause-effect relationships between variables under controlled conditions
	Quasi-experimental design: almost the same as true-experimental designs but lacking random assignment of subjects

The selection of a research design is based on the research aim/questions. A quantitative approach (non-experimental design) using a cross-sectional (i.e. data collected at one point in time) survey methodology and an online questionnaire data collection tool was selected for Phase 2 (Chapter 4). As noted earlier, the philosophical paradigm that fits the quantitative approach is postpositivism which reflects the need to identify and assess the causes that influence effects/outcomes (93). Postpositivism philosophy intends to reduce ideas into a small set to test (e.g. the variables that comprise research aim/questions). It is concerned with the subjectivity of reality and moves away from the purely objective stance adopted in positivism (93).

Surveys are commonly used in research due to the ease of use, structured format, ability to compare data statistically and identify characteristics of a large population from a small group (94). Although they are restricted by the depth of information that can be attained, they offer an opportunity to increase the generalisability of findings. Table 2.8. outlines a number of issues which need to be considered when conducting survey-based research.

Table 2.8: Key issues to consider when conducting survey-based research (132)

Survey intention	Survey target	Survey administration
▪ *Descriptive survey:* describe the participants by gathering either demographic, behaviours or attitudinal information ▪ *Explanatory survey:* determines cause and effect and builds complex understandings (i.e. why certain phenomena occur)	▪ *Cross-sectional survey:* uses a sample or cross-section of respondents selected to represent a target population ▪ *Census survey:* involves individuals in a defined population ▪ *Longitudinal survey:* similar to cross-sectional but at more than one point of time	▪ *Face-to-face survey*: e.g. shopping mall survey, when a participant is stopped by someone with a clipboard to ask few questions ▪ *Telephone survey:* e.g. market research ▪ *Self-administered survey*: e.g. E-mail and online surveys

2.5.2.1 Data collection tools

The questionnaire is the most popular data collection tool used in survey research, with two main formats: paper based and online. There are several advantages and disadvantages of using questionnaires, highlighted in Table 2.9 below.

Table 2.9: Advantages and disadvantages of using questionnaires (131)

Advantage	Disadvantage
Gathering data from large numbers of people or cases	Limited researcher access to in-depth experience and feelings
Gathering data in the same way for all the respondents	Limited opportunities for respondents to answer questions in their own way
Questions and most answers are determined by the researcher	May exclude some groups of people
Data is ready-coded for analysis	Low response rates may result in a biased sample

The online approach was chosen for Phase 2 of this research for several reasons including, convenience, lower cost, ease of data entry and questionnaire distribution.

2.5.2.2 Sampling and analysing quantitative data

Sampling is the selection of some cases from a large group of potential ones (i.e. population) (131). In general, there are two types of sampling methods: probability sampling and non-probability sampling. Probability sampling (also known as random sampling) is defined as 'a sample that can be shown to be highly representative of the whole population or all the potential cases in terms of relevant criteria' (131). It is more commonly applied to quantitative research and includes: simple random sampling, systematic sampling, stratified sampling and cluster sampling (Table 2.10).

Table 2.10: Types of probability sampling methods (131)

Sampling method	Definition
Simple random sampling	Every case has an equal chance of being selected
Systematic sampling	Cases are chosen at specific intervals
Stratified sampling	Organising a population in order to improve the representativeness of a sample
Cluster sampling	A sample consisting of cases selected because of their proximity to one another

For the Phase 2 cross-sectional survey reported in Chapter 4, the specific number of clinicians involved in antimicrobial prescribing was unknown and could not be obtained prior to the study, as a result, there was no sampling and the entire populations was surveyed.

Analysis is summarising, describing and explaining the data in terms of the hypothesis or research aim/questions (131). There are various statistical methods used to analyse quantitative data (i.e. numerical data). These can be broadly classified into:

- **descriptive statistics:** statistics that describe data (e.g. mean, median, standard deviation and range)
- **inferential statistics:** statistics that make inferences about more general situations beyond the actual data set (e.g. t-tests, analysis of variance, correlation and regression)

These statistics can be calculated manually or using statistical software. In Phase 2, the approach to data analysis was largely quantitative based on both descriptive and inferential statistics, using the Statistical Package for the Social Sciences SPSS® Statistics version 25 (133).

2.5.2.3 Quality in quantitative research

Internal validity, external validity (generalisability), objectivity and reliability are the main criteria for achieving the goal of robustness in quantitative research. Study validity is defined as 'how well the results among the study participants represent true findings among similar individuals outside the study' (134). There are two types: internal and external validity. Internal validity refers to the extent to which the observed results represent the truth in the population studied, while external validity (generalisability) refers to the extent to which the results can be extrapolated to similar populations in a different setting (134). Although there are different approaches to determining validity (e.g. face, content, construct,

criterion, etc.), those considered in Phase 2 were largely face and content (see Chapter 4). Face validity relates to the superficial appearance of whether a data collection tool (i.e. questionnaire) measures the concept intended, whereas content validity relates to the extent to which a data collection tool accurately measures all aspects of a given construct (134).

Objectivity refers to the extent to which studies are undistorted by the biases of researchers (e.g. researchers' characteristics, personalities, perceptions, values, etc.) (135). Accordingly, the results should only be based on the nature of what was studied. As described by Guba (136), objectivity can be assured if the methods are explicit, open, replicable and the biases of the researcher are effectively screened out.

Reliability considers the extent to which results are consistent over time (137). The attributes of reliability are described in table 2.11 below.

Table 2.11: Attributes of reliability in quantitative research (137)

Attribute	Definition
Homogeneity/internal consistency	The extent to which all the items on a scale measure one construct
Equivalence	The consistency among responses of multiple users of a data collection tool, or among alternate forms of a tool
Stability	The consistency of results using a data collection tool with repeated testing

These attributes could not be applied in Phase 2 due to the online nature of the survey. Internal consistency was, however, determined (see Chapter 4).

2.5.3 Phase 3: Qualitative semi-structured interviews

Creswell (93) describes five different research designs commonly used in qualitative research: narrative research, phenomenological research, grounded theory, ethnography and case studies. Key characteristics of these are highlighted in Table 2.12 below.

Table 2.12: Key characteristics of qualitative research designs (93)

Research design	Key characteristic
Narrative research	Researchers study the lives of individuals and asks one or more individuals to provide stories about their lives. This is then retold by the researchers into a narrative chronology
Phenomenological research	Researchers describe the 'lived experiences' of individuals about a phenomenon as described by participants
Grounded theory	Researchers derive a general theory of a process, action or interaction grounded in the views of participants
Ethnography	Researchers study the shared patterns of behaviours, language or actions of a group in a natural setting over a prolonged period of time
Case studies	Researchers develop an in-depth analysis of a case or a small number of cases, bounded by time and activity

The aim of the last phase of this research (Phase 3) was to explore the determinants of clinicians' antimicrobial prescribing behaviour, using the TDF in the development of the interview schedule and to aid analysis. It employed a qualitative approach (phenomenological design) to investigate, in more depth, issues identified from the questionnaire analysis (Chapter 5). The phenomenological design allowed for understanding of the 'lived experiences' of individuals around a specific phenomenon (in the case of this research, clinicians' antimicrobial prescribing) (92). There are two major approaches to phenomenology cited in the health literature, as described by Neubauer and colleagues (138):

- **transcendental phenomenology:** the researcher brackets (i.e. sets aside) his/her subjectivity/experience during data generation/analysis and focuses on the participants' experience of the phenomenon (also known as psychological phenomenology)
- **hermeneutic phenomenology:** the researcher reflects on essential themes of participant experience with the phenomenon while simultaneously reflecting on his/her own experience

The doctoral researcher believes that, as far as possible, the researcher should bracket his/her experience and take a fresh perspective toward the phenomenon under examination in order to minimise his/her influence on the data generation/analysis process. Thus, the transcendental approach to phenomenology was taken in Phase 3 of this research (see Chapter 5).

As noted earlier, the philosophical paradigm that fits the qualitative approach is constructivism, which addresses the understanding of the world as others (i.e.

participants) experience it, through social interaction and reflection (93). This leads the researchers to look for the complexity of participants' views rather than narrowing meanings.

2.5.3.1 Data generation methods

Interviews, focus groups and observations are the most common data generation methods used in qualitative research. Since inappropriate prescribing of antimicrobials can be a sensitive/personal topic, face-to face interviews were initially selected from other options (e.g. telephone and online interviews) to provide a more confidential setting for participants (i.e. clinicians). Other advantages of conducting face-to face interviews include the detection of social cues and body language, the ability of participants to provide historical information and the control over the line of questioning (92). Despite these advantages, online video interviews using a videoconferencing software programme, Zoom (139), were considered more appropriate due to the COVID-19 pandemic situation (i.e. physical distancing measures, national lockdowns and travel restrictions) (see Chapter 5). Within the qualitative health research context, Zoom possesses a number of advantages including its relative ease of use, cost-effectiveness, data management features and security options (140). It has been suggested that online video interviews are considered to be most similar to the traditional face-to-face interviews (141). Online conduct of interviews allows studying contexts of crisis while protecting participants and researchers around the world (142). The strengths and limitations of conducting online interviews are summarised in Table 2.13 below.

Table 2.13: Strengths and limitations of video interviews (141)

Strengths	Limitations
Savings of costs (e.g. travel cost, transcription cost)	Requires reliable technology (e.g. stable Internet connection, and good quality camera and microphone)
Researcher does not need to consider aspects of distance or safety	Some individuals may be excluded because they do not feel comfortable with the technology required
Individuals can participate regardless of where they live	Confidentiality (e.g. another uninvited individual is present in the room)
Researcher can see/observe the interviewee and interpret facial expressions, body language and other non-verbal signals	Individuals may not be fully engaged with the interview whilst dealing with interruptions

Structured, semi-structured and unstructured are the most common types of interviews utilised in qualitative research. Key aspects of these are highlighted in Table 2.14 below.

Table 2.14: Aspects of structured, semi-structured and unstructured interviews (94)

Type of interviews	Key aspect
Structured interviews	▪ Follow a common set of questions ▪ Ask the questions in exactly the same way, words, probes etc ▪ Provide the participant a set of answers to choose from
Semi-structured interviews	▪ Follow a common set of topics/questions ▪ Introduce the topics or questions in different ways/orders ▪ Allow the participant to answer the questions in their own way
Unstructured interviews	▪ Focus on a broad area ▪ Enable the participant to talk about the topic in their own way

A semi-structured approach was chosen for Phase 3 of this research (Chapter 5) to explore both the information clinicians can give about antimicrobial prescribing behaviour and how they talk about their personal experiences in their own way. In addition, using a semi-structured interview schedule helped to ensure that the same areas were covered in each interview conducted.

2.5.3.2 Sampling and analysing qualitative data

Non-probability sampling (also known as non-random sampling) is widely used in qualitative research. In non-probability sampling, the sample is selected using a subjective method and not every case of the population has a chance of being chosen, unlike probability sampling (131). Types of non-probability sampling methods include: convenience sampling, purposive sampling, quota sampling, snowball sampling and theoretical sampling. Each of these types is described in turn in Table 2.15.

Table 2.15: Types of non-probability sampling methods (131)

Sampling method	Definition
Convenience sampling	Selecting a sample on the basis of its convenience or ease of access (also known as opportunistic sampling)
Purposive sampling	Selecting a sample that will best enable the researcher to explore the research aim/questions in depth
Quota sampling	Selecting a convenience sample based on predetermined criteria
Snowball sampling	Existing cases are asked to nominate future cases required for a research study
Theoretical sampling	Used in grounded theory research. Initial cases are selected based on unstructured basis, further cases are selected to explore and test the emerging theory. This continues until theoretical saturation is reached

In Phase 3, a purposive sampling method was adopted to recruit those individuals who it was considered could contribute most to the research aim and questions. The main advantage of this type of sampling is that it enables researchers to select a sample based on the aim of the study and knowledge of a population which leads to better insights and more accurate research findings (131). Besides this, it is less costly and less time consuming.

Sample size for qualitative research is often determined on the basis of data saturation. According to Francis et al. (143), data saturation is 'the point in data collection when no new additional data are found that develop aspects of a conceptual category'. Four principles of establishing whether data saturation had been reached are described by Francis et al. (143) as follows:

1. **initial analysis sample:** specifying in advance the sample size at which the first round of analysis is considered to be complete (based on the research aim/questions, interview schedule, diversity of participants and the nature of data analysis)
2. **stopping criteria:** specifying in advance how many more interviews would be conducted and analysed without new themes emerging (usually three consecutive interviews)
3. **independent coding and agreement:** performing the analysis of responses independently by at least two research members
4. **report of analysis and results:** reporting the data saturation methods and findings so that the readers can evaluate the evidence described

Several approaches are available to analyse qualitative data (e.g. thematic analysis, grounded theory, narrative analysis, etc.). In Phase 3, thematic analysis (144) using the Framework Approach was selected and carried out according to the six stages outlined by Ritchie and Spencer (145):

1. **data familiarisation:** becoming familiar with the close details of the transcript and any other data sources
2. **generating initial codes:** coding data line-by-line which, leading to the generation of themes (determined by the literature or underpinning theoretical framework)
3. **searching for themes:** employing more analytical effort to transform the initial codes into meaningful themes

4. **reviewing themes:** examining the themes generated against the original data
5. **defining, naming and mapping themes:** labelling emerging themes
6. **producing the report:** writing a detailed description of all the stages of the research

It has been found that using of a specialised software in qualitative research enhances the rigour of data analysis (146). Thus, NVivo® version 11 Software (147) was used by the doctoral researcher as a qualitative data management tool to support data analysis.

2.5.3.3 Quality in qualitative research

In qualitative research, rigour is demonstrated by the concept of trustworthiness. Guba (136) proposed four constructs that need to be considered by qualitative researchers to establish trustworthiness of a study. An overview of these constructs is given in Table 2.16 below.

Table 2.16: Constructs of trustworthiness in qualitative research (136, 148)

Construct	Description	Possible provision made by researcher
Credibility	Similar to internal validity and is concerned with whether the findings are an accurate reflection of a wider reality	Adopting well-established methods, providing detailed description of the phenomenon under investigation, achieving triangulation via use of different sites and methods, allowing member checks, encouraging participant honesty through direct instructions, establishing rapport, giving opportunities to refuse to participate, and meeting with research team for debriefing sessions
Transferability	Similar to external validity (generalisability) and focuses on whether the findings can be applied to other settings and populations	Providing detailed information about the context in which the work was undertaken and the phenomenon under investigation to allow readers to judge the applicability of findings to their own settings/populations
Confirmability	Similar to objectivity and ensures that the findings are the result of the experiences and ideas of the participants, rather than the preferences and characteristics of researchers	Providing background information on the researchers' characteristics, acknowledging beliefs underpinning decisions made and methods adopted, explaining the reasons for favouring one approach when others could have been taken, reflexivity and admitting the limitations in the methods employed
Dependability	Similar to reliability and refers to the extent to which similar findings would be obtained if the study were repeated with the same context and methods	Reporting the processes within the study (e.g. research design and data gathering) should be in detail, thereby enabling a future researcher to repeat the work, if not necessarily to gain the same results

The specific constructs considered to promote trustworthiness are described throughout Chapter 5.

2.6 Chapter summary

To sum up, this chapter has highlighted the methodological approaches and methods which are applied across all three phases of this research. Greater detail is given in Chapter 3, Chapter 4 and Chapter 5.

Chapter 3: The use of theory in the development and evaluation of behaviour change interventions to improve antimicrobial prescribing: a systematic review

3.1 Introduction

This chapter outlines the aim, methods, results and discussion of a PROSPERO (International Prospective Register of Systematic Reviews) registered systematic review on the use of theory in the development and evaluation of BCIs to improve clinicians' antimicrobial prescribing. The systematic review was conducted in line with the development phase of the UK MRC framework for complex interventions, which recommends that researchers explore the existing evidence base of the topic of interest and address any noted gaps in the current literature (34).

As highlighted in Chapter 1 (Section 1.2.3), a number of systematic reviews (and meta-analyses) of interventions to improve clinicians' antimicrobial prescribing behaviours have been published which focus mainly on methodology and intervention outcomes, with a wide range of effects (in terms of success and sustainability) and varying quality of evidence. One factor which may have contributed to some lack of intervention success is the apparent absence of theory in the primary research reported in these systematic reviews. There is, therefore, a need to conduct a systematic review to investigate literature specifically considering theory in the development and evaluation of such interventions.

An initial search of the JBI Database of Systematic Reviews and Implementation Reports, the Cochrane Library, the Cochrane Database of Systematic Reviews (CDSR), the CRD and PROSPERO revealed that there was no registered systematic review protocol in this context. In addition, a search of MEDLINE®, indicated several published studies hence the potential for carrying out a systematic review.

3.2 Review aim and questions

The systematic review presented here aimed to systematically review, critically appraise and synthesise the evidence on the application and use of theory in the development and evaluation of BCIs designed to improve clinicians' antimicrobial prescribing.

The review sought to answer the following questions linked to the UK MRC framework (34) in relation to the development and evaluation of BCIs designed to improve clinicians' antimicrobial prescribing:

1. which theories have been used and why **(development)**?
2. to what extent have these interventions been feasibility and pilot tested, in what context (i.e. medical condition, healthcare setting and country) and what were the findings **(feasibility/pilot testing)**?
3. to what extent have these interventions been evaluated, what outcome measures have been reported and what were the findings **(evaluation)**?

3.3 Methods

All methods of this review were determined a *priori*. A review protocol was developed using the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) checklist (Appendix 3A) (149) and registered with the PROSPERO at the CRD in the UK (Appendix 3B) (116). The systematic review was reported herein broadly in line with the PRISMA statement (150) which maps out the number of studies identified, included and excluded, as well as the reasons for exclusions through different stages of a systematic review.

3.3.1 Inclusion criteria

3.3.1.1 Types of studies

The systematic review included peer-reviewed, English-language primary research studies in order to avoid evidence of lower methodological quality. All study designs and methodologies including quantitative, qualitative and mixed methods were considered.

3.3.1.2 Participants/population

The review considered studies investigating theoretically-based BCIs targeting the following populations:

- qualified clinicians of all ages and levels of experience who prescribe (i.e. including NMPs: pharmacists, nurses, etc.) any class of antimicrobial agents in any healthcare setting or country. This would include, but was not limited to, community, primary, secondary and tertiary care settings
- patients of all ages (i.e. including adults and children) prescribed at least one antimicrobial agent for any medical condition

3.3.1.3 Intervention(s)/exposure(s)

Studies that investigated any type of theoretically-based BCIs designed to improve clinicians' antimicrobial prescribing were included. Any prescribing behaviour was included in this systematic review (e.g. decision to prescribe or not, type of antimicrobial agent, duration of treatment, etc.) in any healthcare setting and for any medical condition.

3.3.1.4 Comparator(s)/control

- **quantitative and mixed-methods studies:** any other BCIs designed to improve clinicians' antimicrobial prescribing or no intervention
- **qualitative studies:** a comparator is not appropriate

3.3.1.5 Outcomes

Based on the systematic review questions, eligible studies must have considered at least one of the following outcomes related to theoretically-based BCIs, as illustrated in Table 3.1.

Table 3.1: Outcome measures to be included linked to the phases of the UK MRC framework and systematic review questions (34)

MRC phase	Systematic review question	Example of outcomes
Development	Question 1	▪ Types and characteristics of theories or model or framework applied/used ▪ Rational/justification for selection ▪ Methods of application and use of theories including details of the extent to which they informed development of interventions
Feasibility/pilot testing	Question 2	▪ Measures of views, attitudes, knowledge and experiences of those delivering or receiving the intervention
Evaluation	Question 3	*Prescribing outcomes* ▪ rates (or proportion) of antimicrobial prescribing ▪ number of antimicrobial prescriptions written ▪ number of patients prescribed antimicrobial agents for either immediate or delayed use

MRC phase	Systematic review question	Example of outcomes
		Clinical outcomes ▪ infections due to antimicrobial resistance including multiple drug resistance ▪ adverse drug reactions, events, complications, etc. (e.g. nausea and diarrhoea) ▪ re-consultations for the same illness ▪ hospital length of stay ▪ quality of life ▪ mortality rates ▪ healthcare cost *Other outcomes of interest* ▪ adherence to prescribing guidelines or AMS policies ▪ quality of patient–clinician communication ▪ rate of patient satisfaction with care ▪ sustainability of interventions

MRC, Medical Research Council; AMS, antimicrobial stewardship

3.3.1.6 Capture dates

Studies published from the inception of databases up to the completion of the review (October 2018) were included. Furthermore, E-mail alerts were set up on MEDLINE® to ensure that no papers that were subsequently published were missed.

3.3.2 Exclusion criteria

Studies were excluded if they did not state a theory (or synonym, e.g. model, framework, etc.) underpinning their intervention or intervention components. Grey literature (e.g. government reports), abstracts, conference proceedings and literature reviews were also excluded due to the lack of detail for quality assessment and data extraction.

3.3.3 Search strategy

A sequential, three-step search strategy was performed in the review, as follows:

1. firstly, an initial electronic search was carried out in MEDLINE® using a wide variety of words/phrases and their synonyms from the review aim/questions followed by analysis of key words, text words and index terms found in the retrieved titles and abstracts. Initial search terms used were focused around four key concepts: 'antimicrobial agents', 'prescribing', 'theory' and 'interventions'

2. secondly, a search using all identified keywords, text words and index terms was carried out across all relevant databases, as listed below. The search string used to search in title-abstract (TI OR AB), all-text (TX All Text) or MeSH® is illustrated in Table 3.2. Modifications were applied as required per each database, in accordance with advice from a specialist subject librarian. Various combinations along with Boolean (NOT), Truncations (*), Wild Cards ($), hyphens (-) and other search options were used where allowed by the databases in order to ensure the comprehensiveness of the search process
3. thirdly, the reference lists of included papers and previous systematic reviews were screened manually to identify any additional records

The following electronic databases and search engines were searched:

- MEDLINE®
- CINAHL®
- IPA®
- PsycINFO®
- ScienceDirect
- CDSR
- CRD
- DARE
- JBI
- Google Scholar

Table 3.2 The search terms used through electronic databases

Concepts	Sub-terms	Search options
1. Antimicrobial agents	1.1 Antimicrob*	TI OR AB
	1.2 Antibiotic*	TI OR AB
	1.3 Anti-bacterial agents	MeSH+
	1.4 Anti-infective agents ▪ Antifungal agents (MeSH) ▪ Antiparasitic agents (MeSH) ▪ Antiviral agents (MeSH)	MeSH+
2. Prescribing	2.1 Prescrib*	TI OR AB
	2.2 Therapeutics ▪ Inappropriate prescribing (MeSH) ▪ Drug prescriptions (MeSH) ▪ Deprescriptions (MeSH) ▪ Medication errors (MeSH)	MeSH+
	2.3 Delivery of Health Care ▪ Practice patterns, physicians' (MeSH) ▪ Practice patterns, nurses' (MeSH) ▪ Professional practice gaps (MeSH)	MeSH+

Concepts	Sub-terms	Search options
3. Theory	3.1 Theor*	TX All Text
	3.2 Principle*	TX All Text
	3.3 Construct*	TX All Text
	3.4 Framework*	TX All Text
	3.5 Concept*	TX All Text
	3.6 Psychological phenomena and processes	MeSH+
	3.7 Behavior	MeSH+
4. Interventions	4.1 Intervention*	TX All Text

Searches and results were documented using Microsoft Word® and reference lists managed using RefWorks® bibliographic software. All documentations were stored in a secure folder on the University research drive to which all research team members have access.

3.3.4 Screening and selection

Following removal of duplicates, a sequential three-step selection process was carried out. Based on the review aim/questions and inclusion/exclusion criteria, all retrieved titles were first assessed for eligibility by the doctoral researcher and a 10% sample was independently reviewed by SC, DS and TM. Titles which did not meet criteria were excluded and the reasons documented; where there was doubt they were included and reviewed again in the next step. Second, abstracts of potentially included studies were assessed for eligibility as above. Again, where there was doubt they were included. Third, full texts of all studies retained after step 2 were obtained and assessed as above. Any disagreements arising about studies' eligibility was resolved through face-to-face discussion to reach consensus or by consultation with a third research team member. A PRISMA flow chart presenting the study selection process including reasons for inclusion/exclusion was prepared (150).

3.3.5 Data extraction

Based on the review aim/questions and in consultation with the research team members, a data extraction form was developed by the doctoral researcher. Data extraction was performed independently by two research team members (HT plus one other), with a third included if any disagreement arose. Data extracted were: year of publication, country of origin, methods, study aim/objective, setting, participants, medical condition, type of intervention, underpinning theory, outcome measures and key findings/results. A record of corrections or

amendments to the data extraction form was kept for future reference and publication.

3.3.6 Quality assessment

Methodological quality was independently assessed by two research team members (HT plus one other) using three adapted reporting tools: Consolidated Standards of Reporting Trials (CONSORT) for randomised controlled trials (Appendix 3C) (151), CONSORT for randomised feasibility/piloting trials (Appendix 3D) (152) and Consolidated Criteria for Reporting Qualitative Research (COREQ) for qualitative studies (Appendix 3E) (153). Each study was quality assessed, classifying each of the items as 'yes' (reported), 'no' (not reported), 'partly' (reported but unsatisfactory) or 'not relevant', along with detailed justification. A third research team member was consulted if consensus could not be reached. Given the small number of studies included, no studies were excluded because of poor methodological quality.

3.3.7 Assessment of theory

The Theory Coding Scheme (TCS) was independently applied by two research team members to assess the methods by which theories had been applied and used (Appendix 3F) (154). Any disagreement was resolved through face-to-face discussion to reach consensus or by consultation with a third research team member. The TCS consists of 19 items providing a detailed method for assessing the extent to which BCIs are theoretically-based. This research tool has six main categories: referencing theory, targeting related theoretical constructs, using theory to select participants or tailor interventions, measuring constructs, testing mediation and refining theory based on the study outcomes. It has been successfully used within several intervention studies ranging from surveys to systematic reviews and meta-analyses, as well as meta-regressions. Fields of study have included weight loss (155), physical activity (156, 157), medication adherence (158), multiple health behaviours (159) and alcohol consumption (160).

3.3.8 Data synthesis

Due to clinical and methodological heterogeneity in study designs, data collection tools, type of interventions, theoretical underpinnings and outcome measures, a narrative approach to data synthesis was chosen. This was done in accordance

with the CRD's Guidance for Undertaking Reviews in Health Care (126) as follows:

- **textual descriptions of studies:** a descriptive paragraph on each included study was produced to provide an initial summary and explanation of the characteristics and findings of the included studies. The TCS was used to describe the methods by which theories had been applied and used
- **groupings and clusters:** studies were grouped and mapped to the phases of the UK MRC framework (34) to aid the process of description. Review questions were considered to inform decisions about how to group the included studies
- **tabulation**: tables and figures were used to aid in data presentation where appropriate

3.4 Results

3.4.1 Searching

In October 2018, the electronic search resulted in 7311 potentially relevant articles. An additional 10 articles were identified from other sources (e.g. reference lists, E-mail alerts, etc.). Removal of duplicates resulted in 4227 articles, 4217 of which were excluded based on assessment of title, abstract or full text. Ten studies (which originated from six bodies of research) met the inclusion criteria and were included in the final review and narrative synthesis. The E-mail alerts identified no further studies to include up to September 2019. The PRISMA flowchart is given in Figure 3.1.

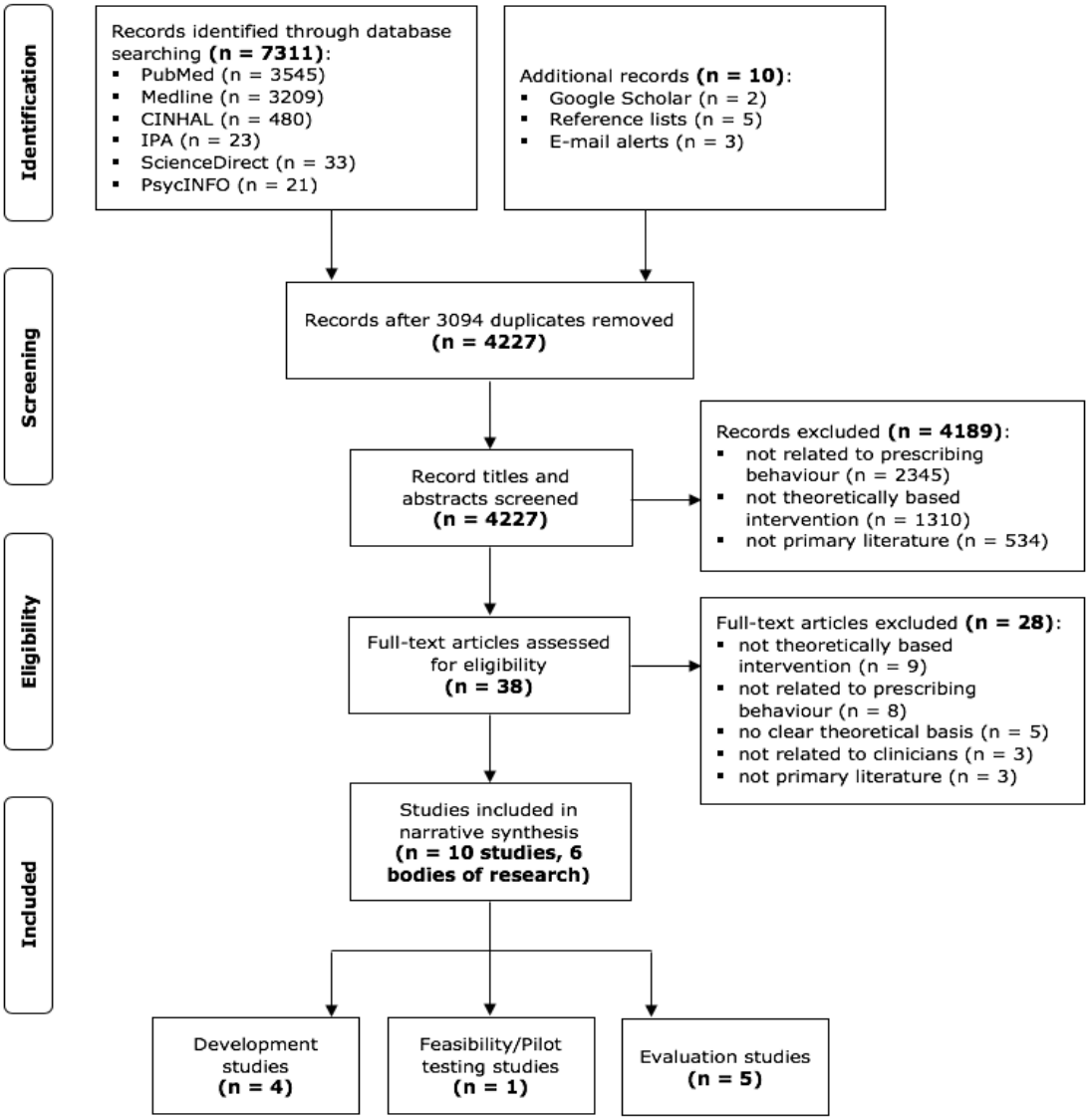


Figure 3.1: PRISMA flow chart presenting study selection process including reasons for inclusion/exclusion (150)

Of the 10 studies, four reported intervention development (161, 164), one reported feasibility/pilot testing (165) and the remaining five reported intervention evaluation (166-170). Five studies employed quantitative designs (mainly cross-sectional surveys) (162, 166-168, 170) and three employed qualitative designs (mainly semi-structured interviews) (161, 163, 169). The remaining two were sequential explanatory, mixed-methods studies of a cross-sectional survey followed by either semi-structured interviews (165) or focus groups (164).

Table 3.3 below presents mapping of included ten studies to the phases of the UK MRC framework (34). Note that studies which related and originating from the same body of research are presented consecutively.

Table 3.3: Mapping of included ten studies (i.e. six bodies of research) to the phases of the UK MRC framework (34)

Body of research number	Study	Development	Feasibility/pilot testing	Evaluation
Body of research 1	Hrisos et al. Part 1 (161)	√		
	Hrisos et al. Part 2 (166)			√
Body of research 2	Milos et al. (167)			√
Body of research 3	Treweek et al. Part 1 (162)	√		
	Treweek et al. Part 2 (168)			√
Body of research 4	Bekkers et al. Part 1 (169)			√
	Butler et al. Part 2 (170)			√
Body of research 5	Lucas et al. Part 1 (163)	√		
	Blair et al. Part 2 (165)		√	
Body of research 6	Chambers et al. (164)	√		

MRC, Medical Research Council

3.4.2 Characteristics of studies included (N=10)

The extracted data are summarised in Table 3.4 in relation to the phases of the UK MRC framework (34).

Table 3.4: Characteristics and key findings of studies included (spelling is as original papers) (N=10)

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
DEVELOPMENT STUDIES (n=4)							
Hrisos et al. (2008, UK) Part 1 (161)	To design two theoretically-based interventions to promote the management of URTI without prescribing antibiotics	Qualitative study applying the Intervention Modeling Process (IMP) and using previous findings of research (171, 172)	▪ Primary care ▪ GPs (sample size is published elsewhere, (n= 15 (165); n=185 (166)) ▪ URTI	<u>Paper-based behavioural interventions:</u> 1. Graded task: targeted self-efficacy and required GPs to consider more difficult situations in a 'graded task', to generate alternative strategies as a way of 'rehearsing' alternative actions and to develop an 'action plan' when confronted by a clinical situation in which a patient presented with an URTI 2. Persuasive communication: targeted anticipated consequences and required GPs to respond	Theory of Planned Behaviour, Social Cognitive Theory and Operant Learning Theory		It is feasible to systematically develop theoretically-based interventions to change professional practice. Two interventions were designed that differentially target generalisable constructs predictive of GP management of URTI

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
				to a 'persuasive communication' containing a series of pictures representing the consequences of managing URTI with and without antibiotics			
Treweek et al. (2014, UK) Part 1 (162)	To evaluate the robustness of the Web-based Intervention Modeling Experiment (IME) methodology as a way of developing and testing behavioral change interventions before a full-scale trial by replicating an earlier paper-based IME	Online questionnaire survey	▪ Primary Care ▪ GPs (n=270) ▪ URTI	<u>Web-based behavior change interventions:</u> ▪ Persuasive communication (161) ▪ Action plan: targeted beliefs about capabilities, and behavioral regulation, asked GPs to make an action plan following a template, which included context and frequency	Theory of Planned Behavior, Social Cognitive Theory, Operant Learning Theory and Theoretical Domains Framework		The constructs that predicted simulated behavior and intention were attitude, perceived behavioral control, risk perception/anticipated consequences, and self-efficacy, which match the targets identified in the earlier paper-based IME. The choice of persuasive communication as an intervention in the earlier IME was also confirmed. A new intervention, an action plan, was developed

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
Lucas et al. (2017, UK) Part 1 (163)	To develop an evidence-based, theory-informed, intervention to reduce antibiotic prescriptions in primary care for childhood RTI	Qualitative study using previous findings of a multi-method programme of research	▪ Primary care ▪ Clinicians and parents (sample size is published elsewhere (165)) ▪ RTI	A web-based within-consultation intervention: It comprised three active elements: explicit elicitation of parent concerns and expectations (to reduced clinician-perceived pressure to prescribe), the results of a CPR accompanied by delayed or no-antibiotic guidance (to reduce clinical uncertainty), and provision of a personalized printout for carers (to provide an alternate treatment action for clinicians)	Green and Krueter's Precede/Proceed logic model which draws on social cognitive theories		Current evidence suggests that interventions which reduce clinical uncertainty, reduce clinician/parent miscommunication, elicit parent concerns, make clear delayed or no-antibiotic recommendations, and provide clinicians with alternate treatment actions have the best chance of success
Chambers et al. (2018, Canada) (164)	To better understand barriers and facilitators that contribute to antibiotic overuse in long-term care and to use this information to inform an evidence and	Online questionnaire survey and focus groups	▪ LTCFs ▪ Survey: infection control practitioners (n=643), anyone in LTCFs involved in the prevention, identification, diagnosis, and/or treatment of	A multifaceted program: 19 distinct barriers and facilitators were mapped to eight domains from the Theoretical Domains Framework (TDF): knowledge, skills, environmental context and resources, professional role or	TDF		The use of a stepped approach was valuable to ensure that locally relevant barriers and facilitators to practice change were addressed in the development of a regional program to help long-term care facilities minimize

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
	theory-informed program		UTIs and LTCFs residents and families ▪ Focus groups: staff from two LTCFs (n=9), including a nurse practitioner, registered nurses, the directors of care, the infection control lead, a physician and a staff member responsible for reporting and quality improvement ▪ ASB and UTIs	identity, beliefs about consequences, social influences, emotions, and reinforcements. The assessment of barriers and facilitators informed the need for a multifaceted approach with the inclusion of strategies: 1. to establish buy-in for the changes; 2. to align organizational policies and procedures; 3. to provide education and ongoing coaching support to staff; 4. to provide information and education to residents and families; 5. to establish process surveillance with feedback to staff; and 6. to deliver reminders			antibiotic prescribing for asymptomatic bacteriuria.
FEASIBILITY/PILOT TESTING STUDY (n=1)							
Blair et al. (2017, UK)	To investigate recruitment and retention, data	Feasibility cluster RCT, using a web-based data	▪ Primary care ▪ GPs and prescribing nurses	<u>Web-based within-consultation intervention:</u> Clinical rule to	Green and Krueter's Precede/Proceed logic model	Assessing intervention use by recording number of	Overall prescribing rates were 25% and 15.8% (p=0.018)

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
Part 2[*] (165)	collection methods and the acceptability of a 'within-consultation' complex intervention designed to reduce antibiotic prescribing	collection tool and semi-structured interviews	(n=104 in the full trial), (n=28 in the interviews), children (n=542 in the full trial) and carers (n=14 in the interviews) ▪ Acute cough and RTI	predict risk of future hospitalisation and printed leaflet with individualised child health information for carers <u>Controls:</u> Usual practice, with clinicians recording symptoms, signs, treatment decisions	which draws on social cognitive theories	times clinicians used intervention and time spent. Medical notes reviews conducted to collect data on 30 days following recruitment consultation. Clinicians from both arms and carers from the intervention arm only invited to participate in interviews to explore their views	in intervention and control groups. Evidence of postrandomisation differential recruitment: number in intervention arm was higher (292 vs 209); over half recruited by nurses compared with less than a third in control arm; children in intervention arm were more unwell. Interviews with clinicians confirmed preferential recruitment of less unwell children in the control arm. Using intervention added around 5 min to consultation time
EVALUATION STUDIES (n=5)							
Hrisos et al. (2008, UK) **Part 2**[**] (166)	To evaluate the effect of two theory-based interventions on the behavioural	2×2 factorial RCT using baseline and post	▪ Primary care ▪ GPs (n=1225) ▪ URTI	<u>Paper-based behavioural interventions designed to change beliefs, previously</u>	Theory of Planned Behaviour (TPB), Social Cognitive	Assessing two theoretical constructs: ▪ Behavioural intention by	GPs completing Intervention 1 reported stronger self-efficacy scores (Beta =

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
	intention and simulated behaviour of GPs in relation to the management of uncomplicated URTI	intervention, postal questionnaire survey (randomisation is at a group level, general practices)		identified as predictors of prescribing: 1. Graded task: targeted the theoretical construct of self-efficacy (SCT) using the behaviour change techniques of graded task, rehearsal and action planning 2. Persuasive communication: targeted the theoretical constructs of anticipated consequences and risk perception Controls: Not received intervention	Theory (SCT) and Operant Learning Theory (OLT)	questionnaire questions ▪ Behavioural simulation by written scenarios (included in the questionnaire, informed by a previous study (165) required the respondent to simulate the behaviour they would enact in the real situation	1.41, 95% CI: 0.64 to 2.25) and GPs completing Intervention 2 had more positive anticipated consequences scores (Beta = 0.98, 95% CI = 0.46 to 1.98). Intervention 2 had a significant effect on intention (Beta = 0.90, 95% CI = 0.41 to 1.38) and simulated behaviour (Beta = 0.47, 95% CI = 0.19 to 0.74)
Bekkers et al. (2010, UK) Part 1 (169)	To assess participants' views regarding their engagement with the Stemming the Tide of	Semi-structured telephone interviews	▪ Primary Care ▪ GPs and nurses (n= 244 in the full trial), (n=31 in the interviews) ▪ Common infections	The STAR intervention: consisted of five core parts, supplemented with an ongoing web forum (part 6), and a booster session	Theory of Planned Behaviour and Social Learning Theory	Assessing process evaluation components: i) intervention delivery fidelity, ii) feasibility	Participants reported increased awareness of antibiotic resistance, greater self-confidence in

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
	Antibiotic Resistance (STAR) Educational Program			(part 7) provided approximately six months after completion of the core program. Steps 1-5 include online learning, face-to-face seminars and clinical video scenarios responses and reflections on practice		and efficacy of the program in daily practice, and iii) areas for intervention refinement by the interview questions	reducing antibiotic prescribing and at least some change in consultation style and antibiotic prescribing behaviour. Reported practical changes included adopting a practice-wide policy of antibiotic prescription reduction. Many GPs also reported increased insight into patients' expectations, ultimately contributing to improved doctor-patient rapport
Butler et al. (2012, UK) Part 2[+] (170)	To evaluate the effectiveness and costs of a multifaceted flexible educational programme aimed at reducing antibiotic dispensing at the practice	RCT (randomisation is at a group level, general practices)	▪ Primary care ▪ GPs and nurses (n=263 in the full trial) ▪ RTI	<u>The STAR intervention</u>: A blended learning experience for participants that included various learning methods (reflection on own practice, provision of new research evidence and guidelines, video-rich material	Theory of Planned Behaviour and Social Learning Theory	Assessing numbers of antibiotics dispensed for all causes per 1000 practice patients in the year after the intervention, by the Prescribing Audit Reports and Prescribing Catalogues, as	The STAR educational programme led to reductions in all cause antibiotic dispensing over the subsequent year with no significant change in admissions to hospital, reconsultations or costs. The rate of

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
	level in primary care			presenting communication skills based on motivational interviewing, practice in usual clinical contexts, sharing experiences and views on a web form and participating in a facilitator led, practice-based seminar) <u>Controls:</u> Not exposed to intervention and provided usual care		well as reconsultations, admissions to hospital for selected causes and costs by the Patient Episode Database for Wales	oral antibiotic dispensing decreased by 14.1 in the intervention group but increased by 12.1 in the control group, a net difference of 26.1. Reductions were found for all classes of antibiotics other than penicillinase-resistant penicillins but were largest and significant individually for penicillin V (7.3%, 0.4% to 13.7%) and macrolides (7.7%, 1.1% to 13.8%)
Milos et al. (2013, Sweden) (167)	To study whether interventions based on behavioural theories can reduce the prescribing of antibiotics against URTIs in primary care	RCT using postal questionnaire survey (randomisation is at a group level, general practices)	▪ Primary care ▪ GPs (n=139) ▪ URTIs	<u>Paper-based behavioural interventions, validated in a previous study (166):</u> ▪ A questionnaire assessing attitudes, beliefs and subjective	Social Cognitive Theory, Operant Learning Theory and Theory of Planned Behaviour	Assessing changes in the rate of prescription of antibiotics against URTIs in patients of all ages and in patients aged 0–6 years, before and after	No significant differences were seen in the prescription rates before and after the interventions when patients of all ages were analysed together. However, for

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
				norms were sent to all participants ▪ Intervention 1 group also received the graded task intervention (GTI): including a set of questions and the GP asked to describe a difficult situation of managing a patient with URTI without antibiotics ▪ Intervention 2 group also received the persuasive communication intervention (PCI) aimed at influencing the GP's belief about the positive consequences of managing URTIs without antibiotics <u>Controls:</u> Received only the questionnaire		the interventions, and between the groups, by data from the Swedish National Pharmacy Register	patients aged 0–6 years, there was a significant lower rate in the PCI group (P = 0.037), but not the GTI group

Authors (year published, country of origin)	Study aim/objective	Methods	Setting, participants (n), medical condition	Type of intervention (s)	Underpinning theory/model /framework	Outcome measures	Key findings/results
Treweek et al. (2016, UK) Part 2[$] (168)	To test the Intervention Modeling Experiment (IME) methodology in a Web-based IME that replicated the trial component of an earlier, paper-based IME	Three-arm, web-based randomized evaluation using online questionnaire survey, no details about level of randomisation	▪ Primary care ▪ GPs (n=198 in the full trial) ▪ URTI	<u>Web-based behavior change interventions:</u> ▪ Persuasive communication (161) ▪ Action plan (162) <u>Controls:</u> No intervention	Theory of Planned Behaviour, Social Cognitive Theory, Operant Learning Theory and Theoretical Domains Framework	Assessing two theoretical constructs: ▪ Behavioral intention by questionnaire questions ▪ Behavioral simulation by eight clinical scenarios	The persuasive communication group did not prescribe an antibiotic in 0.70 more scenarios (95% CI = 0.17-1.24) than those in the control arm. For the action plan, GPs did not prescribe an antibiotic in 0.63 (95% CI = 0.11-1.15) more scenarios than those in the control arm. Behavioral intention was unaffected by both interventions

GPs, General practitioners; RTIs, Respiratory tract infections; URTIs, Upper respiratory tract Infections; UTIs, Urinary tract infections; ASB, Asymptomatic bacteriuria; LTCFs, Long-term care facilities; RCT, Randomised controlled trial

[*]Linked to Lucas et al. Part 1 (163)
[**]Linked to Hrisos et al. Part 1 (161)
[+]Linked to Bekkers et al. Part 1 (169)
[$]Linked to Treweek et al. Part 1 (162)

All studies were conducted in high-income countries, the majority in the UK *(n=8)* (161-163, 165, 166, 168-170), followed by one study each for Canada (164) and Sweden (167). Out of the 10 studies, two were published in 2008 (161, 166) and two were published in 2017 (163, 165), while the remaining six were published as one study each in 2010 (169), 2012 (170), 2013 (167), 2014 (162), 2016 (168) and 2018 (164).

The majority of studies were carried out in primary care settings *(n=9)* (161-163, 165-170), targeting respiratory tract infections *(n=8)* (161-163, 165-168, 170). Study participants were: GPs only *(n=5)* (161, 162, 166-168), GPs and nurses *(n=2)* (169, 170), GPs and carers/parents *(n=1)* (163), GPs, nurses and carers/parents *(n=1)* (165), and GPs, nurses and infection control practitioners in Canadian Long-Term Care Facility (LTCF) settings *(n=1)* (164).

All of the interventions included were complex in nature and consisted of various behavioural and educational techniques, including online learning (163, 165, 169, 170), practice-based seminars (169, 170), printed leaflets intended for patients or carers (163, 165), feedback (164), reminders (164), clinical scenarios (161, 162, 166, 168-170), reflection on own practice (167, 169, 170) and provision of research evidence/guidelines (163, 169, 170).

Use of theory to inform the design and choice of intervention varied considerably across the studies. The most common theories were: Theory of Planned Behaviour (TPB) *(n=7)* (161, 162, 166-170), Social Cognitive Theory (SCT) *(n=5)* (161, 162, 166-168) and Operant Learning Theory (OLT) *(n=5)* (161, 162, 166-168).

3.4.3 Methodological quality of studies included

Tables 3.5 and 3.6 present the quality assessment of data collection/generation in feasibility/pilot testing and evaluation studies using CONSORT and COREQ tools. The remaining development studies were assessed using the TCS tool (see Section 3.4.4). Blair et al. (165) Part 2 was a mixed-methods study hence assessed using both CONSORT and COREQ.

Table 3.5: Assessment of methodological quality of included quantitative designs using adapted Consolidated Standards of Reporting Trials 2010 (151, 152)

Criteria		Hrisos et al. Part 2* (161)	Bulter et al. Part 2** (170)	Milos et al. (167)	Treweek et al. Part 2+ (168)	Blair et al. Part 2$ (165)
Objectives	Specific objectives/hypotheses	Yes	Yes	Yes	Partly	Yes
Trial design	Description of trial design including allocation ratio	Yes	Yes	Yes	Partly	Yes
	Important changes to methods after commencement, with reasons	Not reported	Not reported	Not relevant	Not reported	Not reported
Participants	Eligibility criteria for participants	Partly	Yes	Yes	Not reported	Yes
	Settings/locations where data collected	Yes	Yes	Yes	Yes	Yes
Interventions	Interventions for each group with sufficient details to allow replication	Yes	Yes	Partly	Partly	Yes
Outcomes	Prespecified assessments or measurements defined, including how/when assessed	Yes	Yes	Not reported	Yes	Yes
	Changes to assessments or measurements after commencement, with reasons	Not reported	Not reported	Not relevant	Not reported	Not reported
Sample size	How sample size was determined?	Yes	Yes	Yes	Yes	Yes
	When applicable, explanation of any interim analyses and stopping guidelines	Not reported	Not reported	Not relevant	Not relevant	Not reported
Randomisation	Method used to generate the random allocation sequence	Yes	Yes	Yes	Yes	Yes
	Type of randomisation(s); details of any restriction	Yes	Yes	Not relevant	Yes	Not reported
	Mechanism used to implement random allocation sequence	Not reported	Yes	Not reported	Not reported	Not relevant
	Who generated the random allocation sequence, enrolled participants and assigned participants to interventions	Not reported	Not reported	Not reported	Not reported	Not reported
Blinding	If done, who was blinded after assignment to interventions and how?	Not reported	Not relevant	Not relevant	Not reported	Not relevant
	If relevant, description of the similarity of interventions	Yes	Not relevant	Not relevant	Not reported	Not relevant
Participant flow	Participants who were approached/assessed for eligibility/randomly assigned, received intended treatment and were analysed	Yes	Yes	Yes	Yes	Yes

Criteria		Hrisos et al. Part 2* (161)	Bulter et al. Part 2** (170)	Milos et al. (167)	Treweek et al. Part 2+ (168)	Blair et al. Part 2$ (165)
	Losses and exclusions after randomisation, together with reasons	Yes	Yes	Not reported	Yes	Yes
Recruitment	Dates defining the periods of recruitment and follow-up	Yes	Not reported	Yes	Not reported	Not reported
	Why the trial ended or was stopped?	Yes	Not reported	Not reported	Not reported	Not relevant
Baseline data	Baseline demographic and clinical characteristics for each group	Yes	Partly	Yes	Yes	Yes
Numbers analysed	Number of participants included in each analysis	Yes	Yes	Partly	Yes	Yes
Outcomes and estimation	Results including expressions of uncertainty for any estimates	Yes	Not reported	Yes	Yes	Yes
Ancillary analyses	Results of any other analyses performed	Not reported	Not relevant	Partly	Not relevant	Not relevant
Harms	All-important harms or unintended effects in each group	Not relevant	Not reported	Not reported	Not relevant	Not reported
Limitations	Trial limitations, addressing sources of potential bias and imprecision	Yes	Yes	Yes	Yes	Yes
Funding	Sources of funding and other support, role of funders	Yes	Yes	Yes	Yes	Yes

*Linked to Hrisos et al. Part 1 (161)
**Linked to Bekkers et al. Part 1 (169)
+Linked to Treweek et al. Part 1 (162)
$Linked to Lucas et al. Part 1 (163)

Table 3.6: Assessment of methodological quality of included qualitative designs using adapted Consolidated Criteria for Reporting Qualitative Research (135)

Criteria		Bekkers et al. Part 1 (169)	Blair et al. Part 2* (165)
Aim	Specific aim/objectives	Yes	Yes
Personal characteristics	Which author/s conducted the interview or focus group?	Yes	Not reported
	What characteristics were reported about the inter viewer/facilitator?	Not reported	Not reported
Methodological orientation	What methodological orientation was stated to underpin the study?	Not reported	Not reported
Sampling	How were participants selected?	Not reported	Yes
Method of approach	How were participants approached?	Yes	Not reported
Sample size	How many participants were in the study?	Yes	Yes
Non-participation	How many people refused to participate or dropped out? Reasons?	Not reported	Not reported
Setting of data collection	Where was the data collected?	Not reported	Not reported
Description of sample	What are the important characteristics of the sample?	Yes	Yes
Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Partly	Not reported
Audio/visual recording	Did the research use audio or visual recording to collect the data?	Yes	Not reported
Field notes	Were field notes made during and/or after the interview or focus group?	Not reported	Not reported
Data saturation	Was data saturation discussed?	Not reported	Not reported
Number of data coders	How many data coders coded the data?	Yes	Yes
Description of the coding tree	Did authors provide a description of the coding tree?	Not reported	Not reported
Derivation of themes	Were themes identified in advance or derived from the data?	Yes	Not reported
Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified?	Yes	Yes
Data and findings consistent	Was there consistency between the data presented and the findings?	Yes	Yes

*Linked to Lucas et al. Part 1 (163)

For the quantitative designs (165–168, 170), key areas of strength were the clarity of reporting of study aim/objectives, and description of participants, settings/locations where data were collected and outcome measures. It is worth noting that one study (170) focused on a primary outcome of antibiotics dispensed rather than prescribing only and so this introduces an element of patient behaviour to the outcome. Fewer studies provided information regarding blinding and follow-up.

For the qualitative designs (165, 169), key areas of strength were aspects of research trustworthiness (e.g. representing the participants' voices by illustrative quotes). Areas of weakness were the lack of details around the methodological orientation (e.g. phenomenology, grounded theory) and description of approaches to data saturation.

3.4.4 Synthesis of findings

The heterogeneity of the studies included limited the approach to data synthesis.

3.4.4.1 Use of theory in intervention development, feasibility/pilot testing and evaluation

Tables 3.7 and 3.8 illustrate the assessment of the use of theory (i.e. the extent to which researchers had employed the theory with fidelity) in the 10 studies included, highlighting the lack of homogeneity in theory use in each. Studies which were related and originated from the same body of research (i.e. the studies were linked) are presented consecutively.

Table 3.7: Assessment of the use of theory in the ten studies included using the Theory Coding Scheme (154)

Criteria	Body of research 1		Body of research 2	Body of research 3		Body of research 4		Body of research 5		Body of research 6
	Hrisos et al. Part 1 (161)	Hrisos et al. Part 2 (166)	Milos et al. (167)	Treweek et al. Part 1 (162)	Treweek et al. Part 2 (168)	Bekkers et al. Part 1 (169)	Butler et al. Part 2 (170)	Lucas et al. Part 1 (163)	Blair et al. Part 2 (165)	Chambers et al. (164)
1. Theory/model of behaviour mentioned	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Targeted construct mentioned as predictor* of behaviour	Yes	Yes, in Part 1	Yes	Yes	Yes	Yes	Yes	Yes	Yes, in Part 1	Yes
3. Intervention based on single theory	No	No	No	No	No	No	No	No	No	No
4. Theory/predictors used to select intervention recipients	No	No	No	Yes, in Part 2	Yes	No	No	No	No	No
5. Theory/predictors used to select/develop intervention techniques	Yes	Yes	Yes	Yes	Yes	Yes	Yes, in Part 1	Yes	Yes, in Part 1	Yes
6. Theory/predictors used to tailor intervention techniques to recipients	No	No	No	No	No	No	No	No	No	No
7. All intervention techniques are explicitly linked to at least one theory relevant construct/predictor	Yes	Yes, in Part 1	Yes	Yes	Yes	No	No	No	No	Partly
8. At least one, but not all, of the intervention techniques are explicitly linked to at least one theory-relevant construct/predictor	No	No	No	No	Yes	No	No	No	No	No
9. Group of techniques are linked to a group of constructs/predictors	No	No	No	No	No	No	No	No	No	No
10. All theory-relevant constructs/predictors are explicitly linked to at least one intervention technique	No	No	No	Yes	No	No	No	No	No	Partly

Criteria	Body of research 1		Body of research 2	Body of research 3		Body of research 4		Body of research 5		Body of research 6
	Hrisos et al. Part 1 (161)	Hrisos et al. Part 2 (166)	Milos et al. (167)	Treweek et al. Part 1 (162)	Treweek et al. Part 2 (168)	Bekkers et al. Part 1 (169)	Butler et al. Part 2 (170)	Lucas et al. Part 1 (163)	Blair et al. Part 2 (165)	Chambers et al. (164)
11. At least one, but not all, of the theory relevant constructs/predictors are explicitly linked to at least one intervention technique	Yes	Yes, in Part 1	Yes	No	Yes	No	No	No	No	No
12. Theory-relevant constructs/predictors are measured		Yes	No		Yes	No	No		No	
13. Quality of measures		Partly	Partly		Partly	No	Partly		No	
14. Randomisation of participants to condition		Yes	Yes		Yes	No	Yes		Partly	
15. Changes in measured theory-relevant constructs/predictor		Yes	No		No	No	No		No	
16. Mediational analysis of construct/s/predictors		Partly	No		No	No	No		No	
17. Results discussed in relation to theory		Yes	No		Yes	No	No		No	
18. Appropriate support for theory		Yes	No		No	No	No		No	
19. Results used to refine theory		No	No		No	No	No		No	

*A predictor refers to a construct that is not explicitly linked to a theory by the authors, but is targeted for intervention (as a means to change behavior) because it predicts behaviour (154)

Table 3.8: Justifications of chosen theory (as reported by study authors in included bodies of research) (N=6)

Body of research number	Underpinning theory/model/framework	Justification
Body of research 1 (161, 166)	TPB, SCT and OLT	A previous study found that three theories included constructs that predicted GPs' prescribing behaviour for URTI: TPB, SCT and OLT. These theories explain behaviour in terms of factors amenable to change (171)
Body of research 2 (167)	TPB, SCT and OLT	Based on the findings of research reported by Hrisos et al. (161, 162)
Body of research 3 (162, 168)	TPB, SCT, OLT and TDF	TPB, SCT and OLT: based on the findings of research reported by Hrisos et al. (161, 162) TDF: based on the methods proposed by Michie et al. (97) to map identified constructs onto behaviour change techniques. This was expected to lead to one or more potential interventions for evaluation
Body of research 4 (169, 170)	TPB and SLT	To addresses both the 'how' and the 'why' of clinician behaviour change
Body of research 5 (163, 165)	Green and Krueter's Precede/Proceed logic model	It draws on social cognitive theories which hypothesize that behaviour is influenced by context and by personal perceptions of costs, benefits and efficacy of actions
Body of research 6 (164)	TDF	It helps the user categorize known barriers and facilitators to practice change and select implementation strategies
TPB, Theory of Planned Behaviour; SCT, Social Cognitive Theory; OLT, Operant Learning Theory; TDF, Theoretical Domains Framework; SLT, Social Learning Theory		

As shown in Table 3.7, all six bodies of research were based on multiple theories/frameworks and all mentioned targeted theoretical constructs (i.e. as predictors of behaviour). Out of six bodies of research, two used a combination of TPB, SCT and OLT (161, 166, 167), one used a combination of TPB, SCT, OLT and the TDF (162, 168), and one used both TPB and Social Learning Theory (SLT) (169, 170). One body of research used the Green and Krueter's Precede/Proceed logic model (i.e. draws on social cognitive theories) (163, 165), whereas another used the TDF (164).

The majority of bodies of research provided some justification for the choice of theory *(n=5)* (161–163, 165, 166, 168–170), while one referenced earlier research (167), as described in Table 3.8.

Most bodies of research *(n=5)* did not use theory/predictors to select intervention recipients (161, 163–167, 169, 170). While all bodies of research included used theory/predictors to select/develop intervention techniques, none used theory/predictors to tailor intervention techniques to recipients. The majority of bodies of research *(n=4)* did not test/measure the underpinning theory (165, 167–170) or clearly report the quality of measures of theory-relevant constructs/ predictors *(n=6)* (165–170). In addition, the majority of bodies of research *(n=5)* did not carry out a mediational analysis of constructs/predictors (165–170) or discuss the results in relation to theory *(n=3)* (165, 167, 169, 170). Notably, none of the bodies of research included reported theory refinement based on the study results/findings.

3.4.4.2 Extent and context of intervention development, feasibility/pilot testing and evaluation

In 2008, the development of two paper-based behavioural interventions: 'graded task', targeting the theoretical construct of self-efficacy, and 'persuasive communication', targeting the theoretical constructs of anticipated consequences and risk perception, was reported by Hrisos et al. Part 1 (161). The two interventions were evaluated in a partner study for effect on GPs' behavioural intention (i.e. by questionnaire) and stimulated behaviour (i.e. by clinical scenarios), in relation to managing urinary tract infections without antibiotics in UK primary care (166). The authors indicated that each intervention had a significant effect on its targeted theoretical construct, compared with a control

group. While intervention 2 had a significant effect on GPs' behavioural intention (Beta = 0.90, 95% CI = 0.41 1.38) and simulated behaviour (Beta = 0.47, 95% CI = 0.19–0.74), intervention 1 did not (166).

In 2013, Milos et al. (167) replicated and evaluated the two interventions in primary care in Sweden to assess the rate of prescription of antibiotics by GPs against upper respiratory tract infection (URTI) using data from the Swedish National Pharmacy Register. There was no significant difference in the prescription rates before and after the interventions when patients of all ages were analysed (167). However, for patients aged 0–6 years, there was a significantly lower prescription rate (P=0.037).

In 2014, Treweek et al. Part 1 (162) replicated the 'persuasive communication' intervention, but in a web-based format, as well as developing a new web-based intervention: 'action plan', targeting two theoretical domains of beliefs of capabilities, and behavioural regulation. As Hrisos et al. (166), Treweek et al. Part 2 (168) reported the evaluation of these two web-based interventions on GPs' behavioural intention and stimulated behaviour in a sister study in 2016. This study revealed that both interventions had a significant effect on GPs' simulated behaviour, compared with a control group as in the earlier work (166). However, behavioural intention was unaffected by both interventions (168).

In 2010, Bekkers et al. Part 1 (169) reported the evaluation (i.e. by interviews) of GPs' and nurses' views (e.g. delivery fidelity, feasibility, efficacy and area of refinement) on the Stemming the Tide of Antibiotic Resistance (STAR) educational intervention, which aimed to enhance the quality of antibiotic prescribing and raise awareness about antibiotic resistance in UK primary care. This STAR intervention produced wide-ranging, positive changes in participants' attitudes and clinical practice. In a linked study, the effectiveness of the STAR intervention was evaluated by assessing numbers of antibiotics dispensed for all causes per 1000 practice patients in the year following the intervention, using the Prescribing Audit Reports and Prescribing Catalogues (170). Re-consultations, admissions to hospital for selected causes and costs were also assessed using the Patient Episode Database for Wales. The authors concluded that the STAR intervention led to reductions in all-cause oral antibiotic dispensing over the subsequent year, with no significant change in admissions to hospital,

re-consultations or costs. Notably, neither the development nor the feasibility/pilot testing of the STAR intervention was reported.

In 2017, Lucas et al. Part 1 (163) described the development of a web-based intervention, 'within-consultation' tool, to reduce GPs' and nurses' prescribing of antibiotics for childhood coughs in UK primary care, using previous findings of a multi-method programme of research (i.e. five systematic reviews and four primary studies, three qualitative and one cohort). A sister study investigating the feasibility of that intervention (i.e. recruitment and retention, data collection methods and acceptability) was assessed by recording the number of times the clinicians used the intervention and time spent on each page of the website (165). Clinicians and parents were invited to participate in semi-structured interviews to explore their views of web-based data collection and the intervention. It was found that the overall antibiotic prescribing rates for children's RTIs were 25%and 15.8% (P=0.018) in the intervention and control groups respectively. This was attributed to differential recruitment (i.e. the intervention children were more unwell and over half of them were recruited by prescribing nurses compared with less than a third in the control arm) and potential Hawthorne effect. In their conclusion, the authors advocate avoiding patient recruitment at the clinician level and using data already routinely collected by the practices themselves.

More recent work from Canada described the development of a multifaceted intervention focusing on barriers to and facilitators of antibiotic overuse for asymptomatic bacteriuria identified from a mixed-methods survey and from focus groups with stakeholders working in long-term care (164). In this work, 19 different barriers and facilitators were mapped to eight corresponding theoretical domains (i.e. relevant to practice change) and nine implementation strategies were selected. The authors concluded that the stepped approach employed helped to ensure that local barriers and facilitators to practice change were addressed.

3.5 Discussion

3.5.1 Summary of evidence

This systematic review has highlighted that there is a lack of theoretically-based interventions to improve clinicians' antimicrobial prescribing. Only 10 studies (from six bodies of research) were retrieved, with no optimal use of theory as recommended in the TCS (154).

The data synthesis has shown that there is a lack of theoretically-based interventions around antimicrobial prescribing. Despite the apparent advantages of applying theory to BCIs (33, 98, 99, 101), the interventions identified were suboptimal in terms of the TCS criteria (154). In particular, details relating to the way in which theory was used to select intervention recipients or tailor intervention techniques to recipients were lacking. This could be attributed to the fact that the UK MRC guidance does not include details on how to use theory to develop or evaluate complex interventions (97).

Reflecting on the applicability of the TCS, some aspects may be challenging to understand for non-psychologists. Michie et al. (154) provide some explanation of what is intended by each of the criteria set within the TCS. For example, it should be noted that for 'Criterion 3: Intervention based on single theory' there is elaboration of this and additional guidance within the paper which states that 'The intervention is based on a single theory (rather than a combination of theories or theory + predictors)'. They also indicate that interventions that are based on several different theories make the understanding of links between the theory and the intervention more complicated and difficult to comprehend. Michie et al. (154) also indicate that this in turn makes subsequent theory testing more difficult. It is also worth noting that studies can use a wide variety of multiple behaviour change techniques endeavouring to effect a 'change' without specifying what the expected 'change' is. This too makes linkage to multiple theories that may have been used to develop the intervention even more difficult. For Criterion 6: 'Theory/predictors used to tailor intervention techniques to recipients', Michie et al. (154) explain that there may be a necessity to vary the intervention dependent on particular circumstances. An example of this may be where behaviours are influenced by the particular 'stage of change' at which the person is located. In relation to antimicrobial prescribing, if someone was at

the ‘pre-contemplation stage’ of behaviour change, then an intervention around provision of positive information about the benefits of reducing antimicrobial prescribing may motivate them to move ‘stage of change’—if individuals are at the ‘action’ stage then provision of more detailed information on drug choice and prescribing may be more appropriate.

The majority of studies identified in previous systematic reviews failed to pay attention to the use of theory (32, 52, 57). This appears to explain our findings on the suboptimal use of theory. Where a theoretical basis was included, there was seldom reference to a method explaining how the theory informed the development and evaluation of the intervention (101). It is, therefore, uncertain why some published, theoretically-based interventions succeed and others do not.

It should be acknowledged that it may not only be theoretically-based interventions that are effective in effecting change. However, the rationale for the use of theory is that it is perhaps more likely to result in interventions that have positive process, clinical and implementation outcomes (e.g. around feasibility, acceptability, economics, etc.) since they will have, through the use of theory, addressed many of the barriers and enhanced the facilitators to implementation. In summary, it is important to acknowledge that neither approach is likely to always be perfect but the use of theory may enhance the trustworthiness (i.e. credibility, transferability, confirmability and dependability, etc.) of the developed interventions and so ultimately the process, clinical and implementation outcomes (see Chapter 2).

In addition, this review has mapped existing antimicrobial prescribing interventions in relation to the phases of the UK MRC framework (34). However, there was a lack of systematic application of all phases of the framework amongst the included studies.

While most antibiotics are prescribed in low- and middle-income countries (173), the majority of studies identified originated from high-income, western countries, predominantly from the UK. Given the differences in healthcare systems, processes, cultures, etc., the findings of the studies cannot necessarily be generalised or translated to other settings. Although NMPs, of whom there are 35000 across the UK, predominantly prescribe independently in primary care for

respiratory conditions and infections (174), we have found that the main profession targeted was medical doctors (i.e. mainly GPs). This emphasises the potential of multidisciplinary, theoretically-based interventions around antimicrobial prescribing, targeting NMPs.

This systematic review demonstrates the need for further theoretically-based primary research, targeting multidisciplinary professions (e.g. NMPs) and more medical conditions. This review was designed to include articles from any healthcare setting. Most studies identified were conducted either in primary care or LTCF settings and so there seems to be a gap which needs to be addressed in the use of theory for developing and evaluating AMS interventions in the acute care hospital setting. Considering the under-representation of studies from low and middle-income countries, the development and evaluation of similar interventions within such areas are also needed. Moreover, outcome measures need to be standardised to enable pooling of data and meta-synthesis/meta-analysis.

3.5.2 Strengths and limitations

The systematic review was conducted according to best practice and reported in accordance with the PRISMA standards (150). The use of TCS is original, providing a reliable and systematic method of assessing the degree to which BCIs were theoretically-based (154). Furthermore, theoretically-based interventions identified were mapped to the phases of the UK MRC framework (34).

Review limitations include restricting study inclusion to peer-reviewed, English, primary literature. It should also be noted that it is likely that some papers were excluded based on their title and abstract for not having mention of the use of theory or a theoretically-based intervention. Systematic review methodology dictates that stringent parameters must be set for the criteria used to search for and select studies. It was, therefore, decided that this review would focus on literature with clear reporting of theory within the papers.

Although this could be considered a limitation, such an approach ensures a robust and resource-efficient approach to searching, study selection and other steps of the review process, including only those studies that clearly showed that they had considered the use of theory. No studies have yet completed all steps

of the UK MRC framework (34), but it was felt that any studies that did not include 'theory' or related terms in the title or abstract were not likely to have had a systematic and comprehensive approach to the use of theory. This, therefore, was to be the main focus of this review in line with the UK MRC guidance (34) which has clear recommendations around the advantages of the use of theory (see Section 2.4.1).

As discussed previously in Chapter 1, the current reporting of implementation research in AMS generally is lacking in the detail and focus on the use of theory in studies. For those studies identified in this systematic review, the extent of inclusion of structured information on the rationale for and use of theory was lacking. It is possible, therefore, that the focused criteria set for this review may have resulted in some studies not being identified for consideration. An approach to improve this situation would be for researchers to consider and adopt the TCS to help develop studies and support and frame the reporting of theoretically-based interventions.

This review stresses the potential for theoretically-based interventions around antimicrobial prescribing. It should be recognised, however, that developing interventions using co-design approaches or using qualitative methods to identify the needs of target populations (and barriers and facilitators to target behaviours) are also useful in developing effective interventions, and these have been shown to work for AMS interventions (52, 32). Additionally, it should be noted that there are a number of examples of AMS interventions, particularly in general practice in Europe, which have been shown to be effective at reducing antimicrobial prescribing (50, 54, 55). It is important to consider the development and implementation of theoretically-based interventions in order to develop even more robust and effective evidence-based approaches; however, non-theoretically-based interventions may sometimes offer value. Researchers and clinicians should consider the use of a combination of contextual and theoretically-based approaches.

3.6 Conclusion

This systematic review has identified a limited evidence base on theoretically-based interventions around antimicrobial prescribing and the need for researchers to consider carefully how they use and report theory in their efforts to develop effective evidence-based interventions. An approach that could help includes the systematic use of the TCS. Findings of this review may influence the direction of future research and policy around AMS interventions, thereby, contributing to regional and global efforts to slow down the progression of AMR. Future research should be designed to overcome the biases encountered in current publications.

3.7 Implications for next research phase

This systematic review identified the paucity of robust and rigorous research on theoretically-based BCIs around antimicrobial prescribing. Furthermore, it identified a notable absence of research conducted within the Middle East. The systematic application of the phases of the UK MRC framework was also lacking. The primary research (i.e. Phases 2 and 3) of this programme of research seeks to fill these gaps, as will be described in the next chapters.

Chapter 4: A cross-sectional survey of clinicians in Qatar around antimicrobial prescribing

4.1 Introduction

The findings of the systematic review presented in Chapter 3 demonstrated the need for theoretically-based BCIs in the area of antimicrobial prescribing. For development of such complex interventions, emphasis should be placed on using theory to systematically identify the behavioural determinants of antimicrobial prescribing, as described in Chapter 1 (Section 1.2.2). This chapter outlines the method, results and discussion of a theoretically-based cross-sectional survey of clinicians in Qatar around antimicrobial prescribing behaviour (112).

4.2 Aim

The aim of this phase of research (Phase 2) was to identify and quantify potential determinants of antimicrobial prescribing behaviour in HMC, Qatar using the TDF (104).

The detailed research questions were:

1. which behavioural determinants are potentially influential in impact antimicrobial prescribing?
2. are there significant differences in behavioural determinants between demographic variables?

4.3 Methods

4.3.1 Design

A postpositivist, quantitative approach was employed with a cross-sectional survey methodology and an online questionnaire data collection tool. Justification for this approach is given in Chapter 2.

4.3.2 Setting

The research was conducted across all 12 hospital settings of HMC, Qatar, as described in Chapter 1.

4.3.3 Eligibility criteria

All medical doctors (both physicians and surgeons) and pharmacists who prescribe/recommend antimicrobials as an integral part of their role were invited

to participate. Full-time and part-time prescribers were included, with no exclusions.

4.3.4 Questionnaire development

A draft questionnaire was developed based on the specific research questions and the published systematic review presented in Chapter 3 (117), with contextualisation for practice in Qatar. As described in Chapter 2, the draft was reviewed for face and content validity by six experienced academics, researchers and practitioners in Qatar and the UK with experience in the use of the TDF. These individuals were identified from the research team members' professional networks. A convenience sample of five doctors and five pharmacists in HMC (purposively selected in strata of profession, country of training and experience) was interviewed individually by the doctoral researcher, face-to-face (~30 minutes) to discuss questionnaire content thus ensuring appropriateness to Qatari practice. This was followed by 'think aloud' testing with one doctor and one pharmacist (based outwith HMC) being invited to talk through their thought and decision-making processes while completing the questionnaire. 'Think aloud' testing permits assessments of clarity and simplicity from the respondent's perspective (175). Comments were received, mainly with regards to wording of items, and the draft questionnaire was modified accordingly. Piloting was then undertaken in a sample of 15 doctors and 15 pharmacists in HMC. Findings indicated that no amendments to the questionnaire were needed.

The final questionnaire was developed in SurveyMonkey® Software (176), and presented as a web-based survey hosted online and tested for compatibility with different platforms (tablet, smartphone, etc.), browsers and HMC E-mail/Internet filters. Questionnaire items were grouped into different sections of personal and practice demographics, and four aspects of antimicrobial practice (177) namely:

- **Aspect 1:** prescribing/recommending antimicrobials (i.e. right medication, right dose, right patient, right time and right route)
- **Aspect 2:** review/amendment (i.e. broad spectrum to narrow spectrum, IV-to-oral and/or discontinuation where appropriate)
- **Aspect 3:** monitoring for efficacy/toxicity
- **Aspect 4:** management (i.e. medication errors and adverse drug reactions)

Question types were closed, 5-point Likert scales and open to allow free text comments as appropriate. Items on potential determinants of prescribing were based on the TDF (104). As mentioned in Chapter 2, the TDF was chosen as the most relevant theoretical framework on which to base questionnaire items related to determinants of behaviour.

The Determinants of Implementation Behaviour Questionnaire (DIBQ) was utilised as a basis for the development of the questionnaire items (i.e. modifications were made as relevant to the context of antimicrobial prescribing) (178). The DIBQ is a 100-item generic questionnaire derived from the 14 theoretical domains of the TDF. It has been shown to be valid and reliable tool, and can be adapted and applied to any behaviour of interest (178, 179). In the demographics section, clinicians classified themselves as *innovators, early adopters, early majority, late majority* and *laggards* based on receptivity to change (180). At the final part of the questionnaire, participants were invited to express interest in participating in the next phase of the research (Chapter 5).

4.3.5 Recruitment and data collection

An E-mail developed by the research team (Appendix 4A) with a link to the online questionnaire was sent by the HMC's Corporate Communications Department to all doctors (~4,000) and pharmacists (~400) working within HMC hospitals (thus eliminating any recruitment bias). The questionnaire included a participant information sheet, which was prepared according to the standardised format required by the HMC ethics committees in Qatar. The final questionnaire document can be found in Appendix 4B. Given that the HMC hospitals were unable to provide specific numbers of those with antimicrobial prescribing/recommending roles, the questionnaire specified that only those who prescribe/recommend antimicrobials as an integral part of their role were eligible for the study. Return of the questionnaire was considered an indication of consent.

The following evidence-based measures were adopted to maximise survey response rate, hence, reducing any response bias: two follow-up E-mail reminders sent at approximately two-months intervals, an information sheet giving full details of the study, potential benefits of participation and confidentiality, a well-designed and visually attractive questionnaire, an

announcement via the official HMC website (Figure 4.1), and highlighting the study via ward communications, as well as other outlets (e.g. posters, pull-up signs and flayers) (181). In addition, the doctoral researcher promoted the work at a continuing professional development (CPD) event (Appendix 4C) at HMC and encouraged the clinicians to participate in the survey. Data collection took place from January to May 2020.

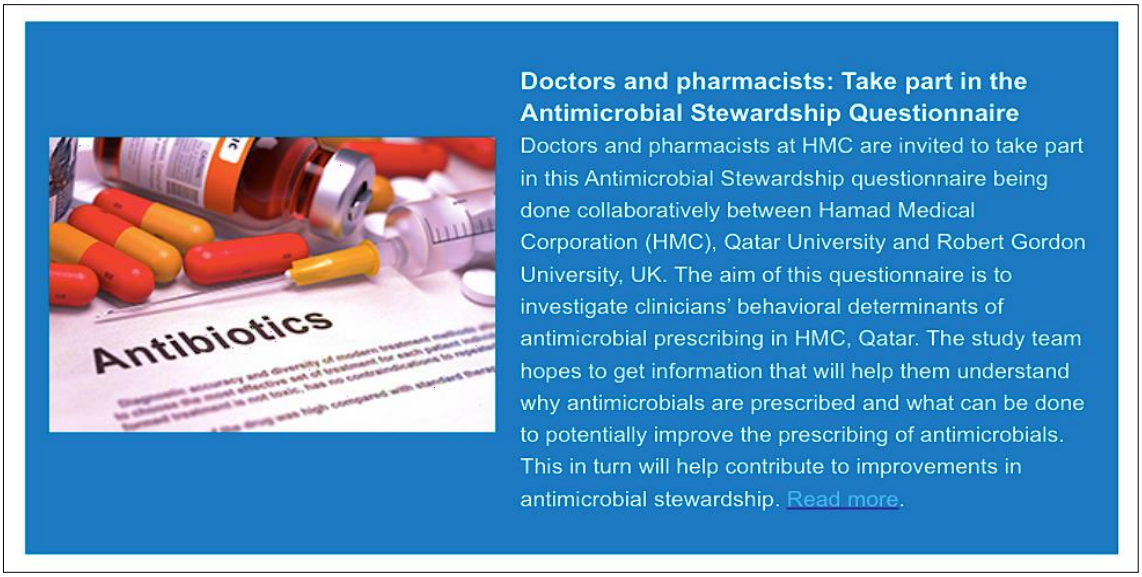


Figure 4.1: Screenshot of the study announcement via Hamad Medical Corporation's website

4.3.6 Data analysis and statistical methods

As described in Chapter 2, data were analysed using descriptive and inferential statistics using the Statistical Package for the Social Sciences SPSS® Statistics version 25 (133), and thematic analysis of free text comments. Descriptive analysis was undertaken for personal and practice demographics, including profession, academic qualification, practice setting, gender, experience and characteristics of the innovation.

Statements relating to the 5-point Likert scale were subjected to Principal Component Analysis (PCA) to reduce the large number of statements to a smaller, more manageable number of components. PCA is a statistical approach used to reduce the dimensionality of large datasets, increase interpretability but at the same time minimise information loss (182). In performing PCA, the correlation matrix for coefficients (≥0.3), the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (≥0.6) and the Bartlett's Test of Sphericity (≤0.05) were used to assess data suitability for PCA (182). The number of components

retained was determined based on the Kaiser criterion (aiming for Eigenvalues>1), visual assessment of the scree plot (aiming for the point at which the 'elbow' flattened) and cumulative percentage variance. Varimax rotation was performed to aid in the component interpretation, and the results were compared to Promax rotation (183). Final scales did not include items that were stand-alone, cross-loaded or resulted in a reduction of internal reliability, and that did not show acceptable communalities with factor structure coefficients above 0.4. Internal consistencies of the resulting components were tested using Cronbach's alpha aiming for values ≥0.7 (182).

Following determination of internal consistencies, total component scores were calculated by assigning scores of 5 (strongly agree) to 1 (strongly disagree) to each of the Likert responses and producing a summed score for statements in each component.

Inferential analysis (non-parametric statistics: Mann-Whitney U test for 2 groups or Kruskal-Wallis test for >2 groups) was used to compare the component scores across key demographic characteristics. Post-hoc analysis (i.e. pairwise comparison) was used to explore the difference between three or more group means when the P-value was statistically significant (P≤0.05), as described previously.

Thematic analysis was independently performed by two researchers on the free text comments looking for patterns/themes, similarities and differences across data set (see Chapter 2). Braun and Clarke reported that thematic analysis can produce insightful and trustworthy research findings (144). The given responses were mapped to the PCA components.

4.3.7 Ethics

Prior to conducting the research, a detailed research protocol was prepared and reviewed by the research team members following which it was approved three weeks later by the Ethical Review Panel of the School of Pharmacy and Life Sciences at Robert Gordon University (RGU), UK (approval reference S181) (Appendix 4D). Ethics approvals were also obtained from Qatar University (QU) Institutional Review Board (approval reference QU-IRB 1171-EA/19) and the Medical Research Center at HMC, Qatar (approval reference MRC-01-19-219), as shown in Appendices 4E and 4F respectively. Both institutions had independent

ethical review processes, documents, requirements and committees. This required an online application submission (known as ABHATH application) accompanied by a Data Use Agreement between HMC and RGU (Appendix 4G) and evidence of ethics approval from RGU. During the application review process, a number of clarifications/changes were requested by HMC ethics committee and addressed by the research team. As an example, Figure 4.2 is a screenshot showing a clarification/change requested by HMC's ethics committee during the ethics approval process.

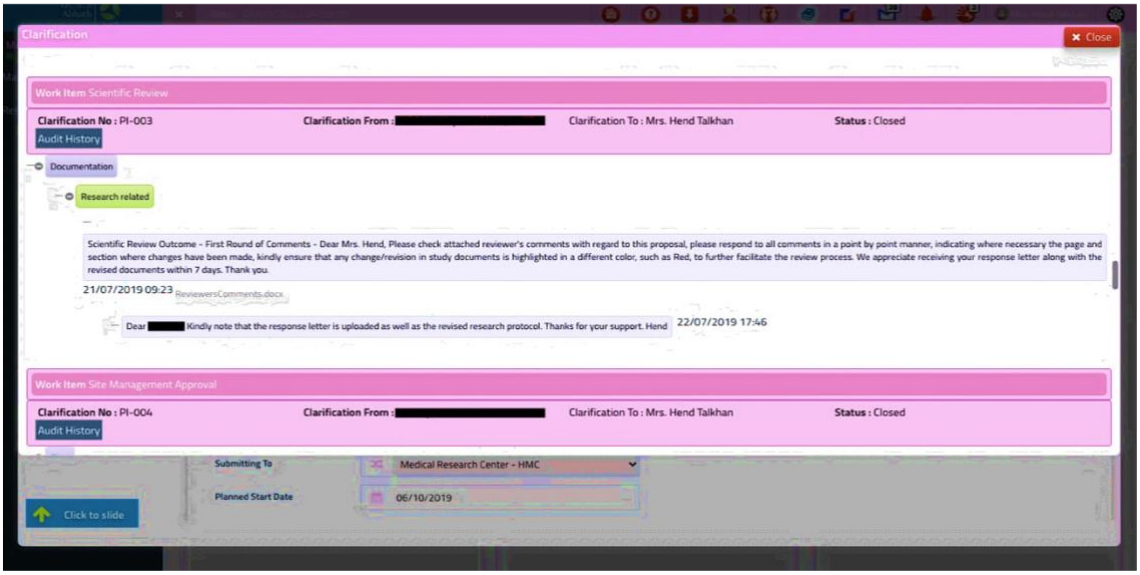
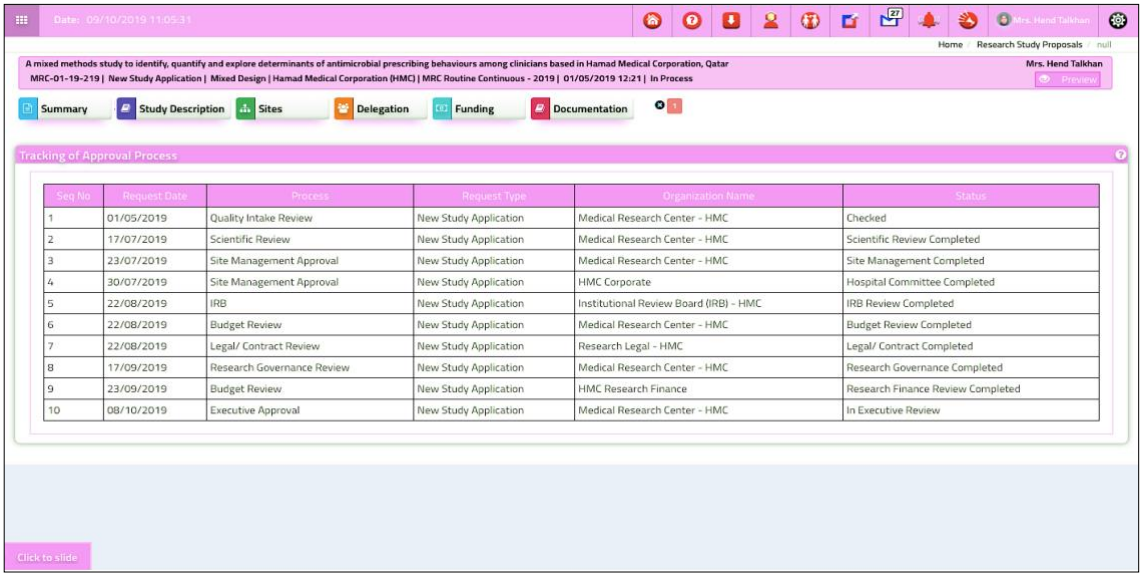


Figure 4.2: Screenshot showing an example of the clarifications/changes requested by Hamad Medical Corporation's ethics committee

Further to this, the doctoral researcher completed three Collaborative Institutional Training Initiative (CITI) training courses required by HMC in Qatar. Each course has a number of modules that must be completed with a score of 80%. The completion certificates for each course completed are shown in Appendix 4H. A face-to-face interview was also conducted between the doctoral researcher and the HMC ethics committees, during which interview questions focused on the recruitment and data collection processes. After a detailed discussion on precautions considered to protect anonymity and confidentiality, the application was approved. All in all, the ethics approval process lasted approximately seven months from the time of submission to RGU to obtaining approvals from both QU and HMC. Figure 4.3 is a screenshot showing the timeline of HMC's ethics approval process.



Seq No	Request Date	Process	Request Type	Organization Name	Status
1	01/05/2019	Quality Intake Review	New Study Application	Medical Research Center - HMC	Checked
2	17/07/2019	Scientific Review	New Study Application	Medical Research Center - HMC	Scientific Review Completed
3	23/07/2019	Site Management Approval	New Study Application	Medical Research Center - HMC	Site Management Completed
4	30/07/2019	Site Management Approval	New Study Application	HMC Corporate	Hospital Committee Completed
5	22/08/2019	IRB	New Study Application	Institutional Review Board (IRB) - HMC	IRB Review Completed
6	22/08/2019	Budget Review	New Study Application	Medical Research Center - HMC	Budget Review Completed
7	22/08/2019	Legal/ Contract Review	New Study Application	Research Legal - HMC	Legal/ Contract Completed
8	17/09/2019	Research Governance Review	New Study Application	Medical Research Center - HMC	Research Governance Completed
9	23/09/2019	Budget Review	New Study Application	HMC Research Finance	Research Finance Review Completed
10	08/10/2019	Executive Approval	New Study Application	Medical Research Center - HMC	In Executive Review

Figure 4.3: Screenshot showing the timeline of Hamad Medical Corporation's ethics approval process

In accordance with RGU's Research Governance and Research Ethics Policies (184), all anonymised responses were stored in password protected databases on secure university servers. Contact details of those interested in participating in the interviews (see Chapter 5) were stored in a restricted access, separate database, linked to the first database by unique codes (e.g. pharmacist 1, etc.). Only key research team members had access to the codes.

4.4 Results

4.4.1 Study participants

In total, 535 responses were received, 339 (63.4%) from doctors and 196 (36.6%) from pharmacists with a wide range of specialties and expertise, as illustrated in Table 4.1. An overall response rate could not be calculated as the total number of clinicians who prescribe/recommend antimicrobials as an integral part of their role, was unknown.

Table 4.1: Participants' job titles and specialities (as reported by themselves in the free text comments) (N=535)

Characteristic	% (n)
Doctors' job title *(n=339)*	
Fellow/resident	52.8 (179)
Specialist	20 (68)
Consultant	19.8 (67)
Senior consultant	2.7 (9)
General practitioner	2.4 (8)
Senior specialist	1.2 (4)
Associate consultant	0.6 (2)
Senior resident	0.6 (2)
Doctors' speciality *(n=339)*	
Cardiology	23 (78)
Internal medicine	16.9 (57)
Infectious diseases	9.4 (32)
Paediatrics	8.6 (29)
Rheumatology	6.5 (22)
General medicine	4.4 (15)
Vascular surgery	4.4 (15)
Emergency medicine	4.1 (14)
Dermatology	3.8 (13)
Ambulatory care	3.5 (12)
Neurology	3.2 (11)
Obstetrics and gynaecology	2.7 (9)
Oncology	2.4 (8)
Microbiology/pathology	2.1 (7)
Psychiatry	2.1 (7)
Pulmonology	2.1 (7)
Gastroenterology	0.6 (2)
Radiology	0.3 (1)
Pharmacists' job title *(n=196)*	
Staff pharmacist	51 (100)
Clinical pharmacist	22 (43)
Junior pharmacist	10.2 (20)
Senior pharmacist	9.2 (18)
Pharmacy supervisor	3.6 (7)
Senior clinical pharmacist	2 (4)
Clinical pharmacy specialist	2 (4)
Pharmacists' speciality *(n=196)*	
Pharmacology	22 (43)
Inpatient/outpatient pharmacy	16.3 (32)
Obstetrics and gynaecology	9.7 (19)
Infectious diseases	8.2 (16)
Cardiology	7.7 (15)
Nuclear pharmacy	7.1 (14)
Ambulatory care	6.6 (13)
Pharmacotherapy	6.6 (13)
Paediatrics	5.1 (10)
Clinical/hospital pharmacy	3.6 (7)
Geriatrics	3.1 (6)
Psychiatry	2 (4)
Otolaryngology	0.5 (1)
Drug information	0.5 (1)
Medication safety	0.5 (1)
Nutrition	0.5 (1)

4.4.2 Personal and practice demographics

Table 4.2 summarises demographics of the study participants. Respondents were 346 (64.7%) males and 185 (34.6%) females. A majority were practicing in secondary care setting as their main job sector (*n=352*, 65.8 %) with 33% *(n=176)* in tertiary care. Around half (*n=285*, 53.3%) had five or fewer years' experience as health professionals. More than half of respondents (*n=319*, 59.6%) rated themselves as *innovators* (i.e. eager to try new ideas), 21 (3.9%) as *early adopters* (i.e. integrate into the local social system more than innovators) and only 1 (2%) as *laggards* (i.e. traditionalists and the last to adopt an innovation) (180).

Table 4.2: Participants' personal and practice demographics (N=535)

Characteristic		% (n)
Profession	Doctor	63.4 (339)
	Pharmacist	36.6 (196)
Main practice setting (N=12)	Secondary care *(n=5)*	65.8 (352)
	Tertiary care (*n=7)*	33 (176)
	Other	1.2 (7)
Gender	Male	64.7 (346)
	Female	34.6 (185)
	Prefer not to say	0.7 (4)
Highest academic qualification	Undergraduate	33.3 (178)
	Postgraduate taught	43.4 (232)
	Doctorate	22.8 (122)
	Other	0.5 (3)
Experience as health professional	≤5 years	53.3 (285)
	6-10 years	34.6 (185)
	≥11 years	12.1 (65)
Characteristics of the innovation	I resist new ways of working	2 (1)
	I am cautious in relation to new ways of working: I tend to change once	7 (4)
	I think for some time before adopting new ways of working	35.5 (190)
	I serve as a role model for others in relation to new ways of working	3.9 (21)
	I am innovative with new ways of working	59.6 (319)

4.4.3 Analysis

Respondents completed all statements relating to the four aspects of antimicrobial prescribing practice. When these statements were subjected to PCA, the correlation matrix contained multiple coefficients >0.3. In addition, the KMO measure of sampling adequacy (0.88) and Bartlett's Test of Sphericity confirmed the factorability of the statements (significance<0.001). For each of the four aspects, there was a three-component solution which had Eigenvalues exceeding 1.0, the three-factor solutions explained cumulative variance of

greater than 50% for each aspect. The scree plots for Aspects 1 to 4 are given in Figures 4.4-4.7, respectively. In these plots, the curves start to flatten (i.e. the 'elbow' point) at Component 4 and, thus, components above this point were retained (i.e. Components 1-3).

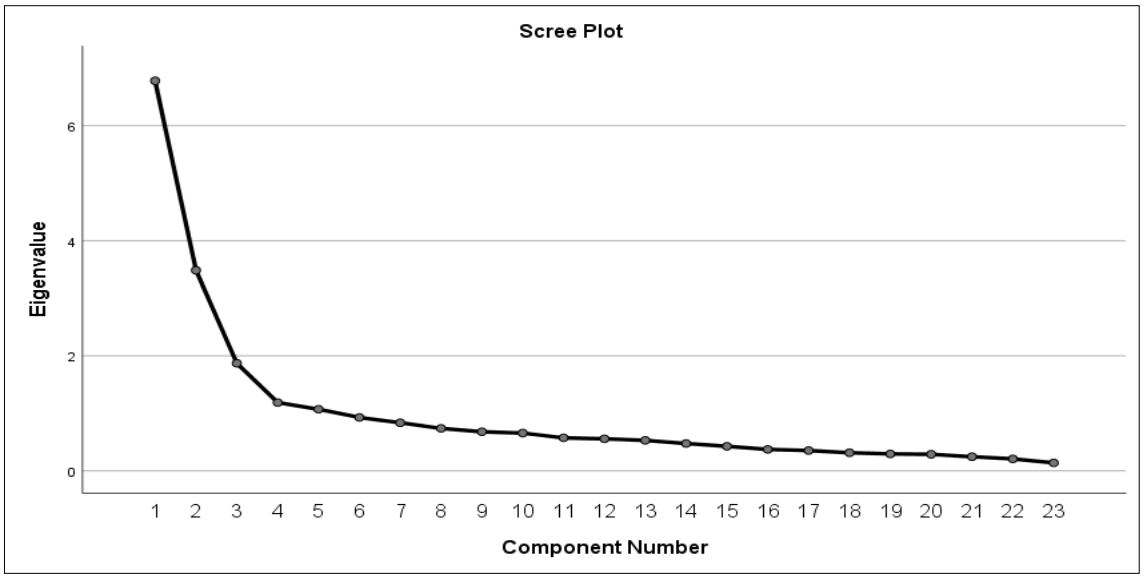


Figure 4.4: Scree plot generated from PCA of the statements within Aspect 1

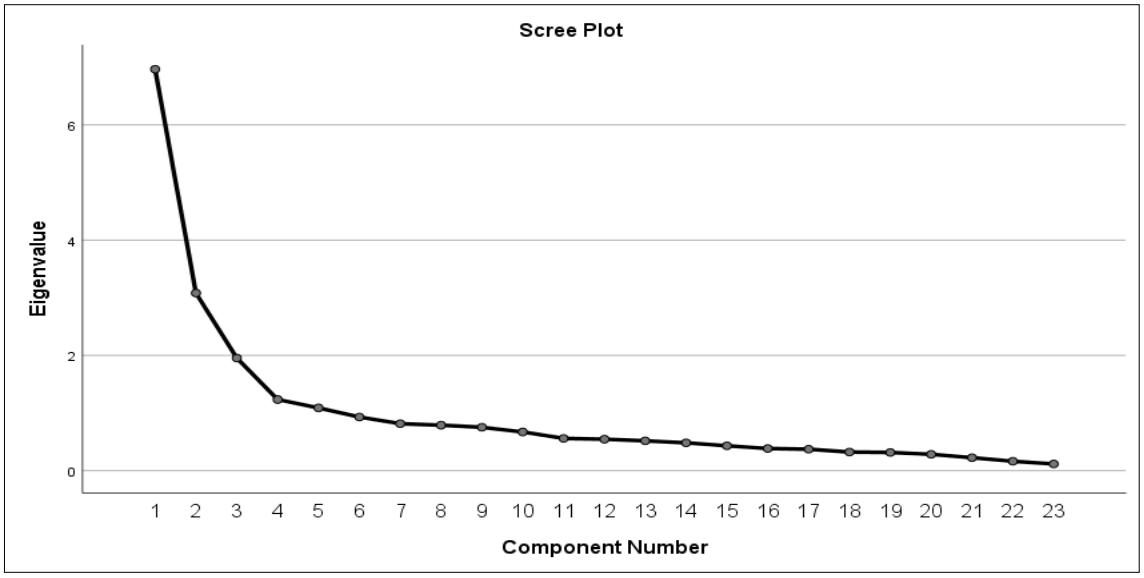


Figure 4.5: Scree plot generated from PCA of the statements within Aspect 2

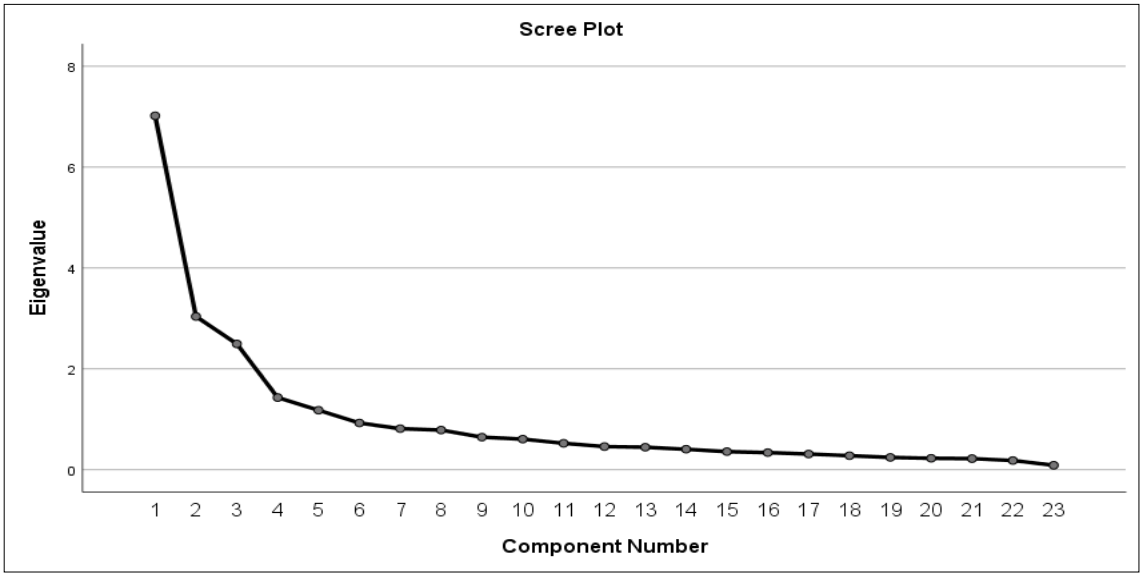


Figure 4.6: Scree plot generated from PCA of the statements within Aspect 3

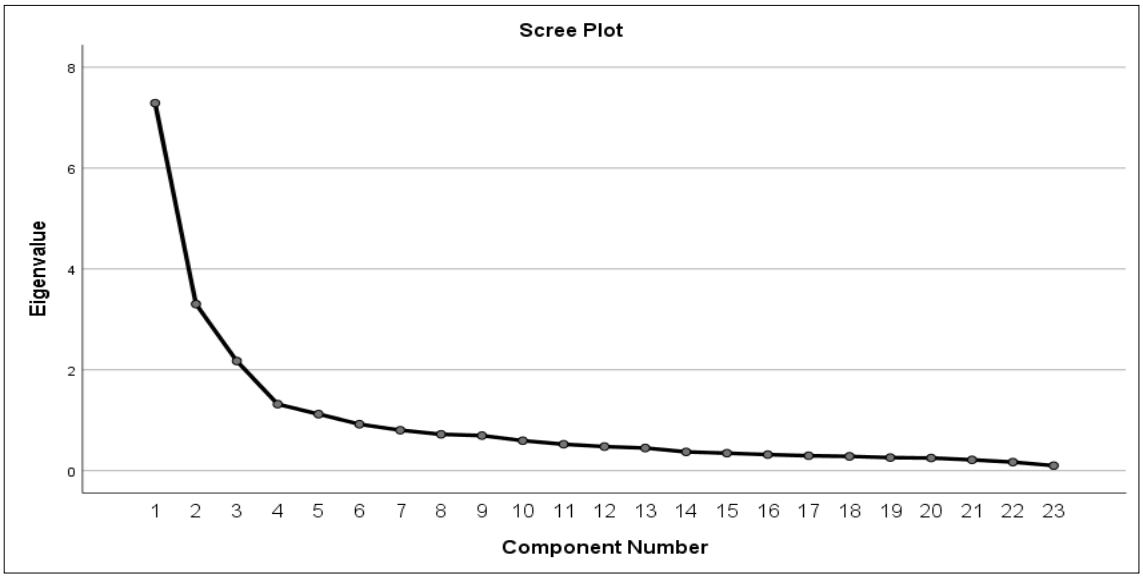


Figure 4.7: Scree plot generated from PCA of the statements within Aspect 4

Tables 4.3-4.6 give the pattern matrix loadings for Aspects 1 to 4 statements onto the three components. Of note, two statements in Aspects 2 to 4 did not load to any component: 'patients put me under pressure to review/monitor/manage antimicrobials outside the guidelines', and 'reviewing/monitoring/managing antimicrobials according to the guidelines is encouraged by superiors'. The Cronbach's alpha values for relevant components with these included were low and, thus, they were excluded.

Table 4.3: Loading of the statements within Aspect 1 onto each of the three components

Statement	C1	C2	C3
With respect to appropriate and timely prescribing/recommending antimicrobials (i.e. right medication, right dose, right patient, right time and right route):			
If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will be treated more effectively	0.803		
I intend to follow the guidelines on prescribing/recommending antimicrobials	0.764		
If I prescribe/recommend antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	0.762		
I intend to encourage others to follow the guidelines on prescribing/recommending antimicrobials	0.719		
Prescribing/recommending antimicrobials according to the guidelines is a high priority for me	0.701		
If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	0.650		
I have clear goals for prescribing/recommending antimicrobials according to the guidelines	0.650		
Prescribing/recommending antimicrobials according to the guidelines is encouraged by superiors		0.662	
Prescribing/recommending antimicrobials according to the guidelines is encouraged by my peers	0.383	0.642	
I have ways of monitoring the quality of my prescribing/recommending of antimicrobials		0.637	
Members of the multidisciplinary team prescribe/recommend antimicrobials according to the guidelines		0.635	
I have sufficient support from specialists to enable me to prescribe/recommend antimicrobials according to the guidelines		0.615	
I have undertaken sufficient CPD to prescribe/recommend antimicrobials according to the guidelines		0.606	0.465
Patients put me under pressure to prescribe/recommend antimicrobials outside the guidelines		0.426	
I am sufficiently skilled to prescribe/recommend antimicrobials according to the guidelines			0.866
I have sufficient knowledge to prescribe/recommend antimicrobials according to the guidelines	0.311		0.807
I am confident in my ability to prescribe/recommend antimicrobials according to the guidelines			0.766
I am competent to prescribe/recommend antimicrobials according to the guidelines			0.641
It is my responsibility to prescribe/recommend antimicrobials according to the guidelines	0.436		0.533
If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will be treated more cost effectively	0.486		
C, component; CPD, continuing professional development			

Table 4.4: Loading of the statements within Aspect 2 onto each of the three components

Statement	C1	C2	C3
With respect to appropriate and timely review/amendment of antimicrobials – for example from broad spectrum to narrow spectrum, intravenous-to-oral and/or discontinuation where appropriate:			
If I review/amend antimicrobials according to the guidelines, I believe that patients will be treated more effectively	0.842		
If I review/amend antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	0.796		
If I review/amend antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	0.748		
Reviewing/amending antimicrobials according to the guidelines is a high priority for me	0.721		0.312
I intend to encourage others to follow the guidelines on reviewing/amending antimicrobials	0.702		0.320
I intend to follow the guidelines on reviewing/amending antimicrobials	0.699		
If I review/amend antimicrobials according to the guidelines, I believe that patients will be treated more cost effectively	0.664		
I have clear goals for reviewing/amending antimicrobials according to the guidelines	0.558		0.398
It is my responsibility to review/amend antimicrobials according to the guidelines	0.429	0.308	0.339
I am sufficiently skilled to review/amend antimicrobials according to the guidelines			0.853
I am confident in my ability to review/amend antimicrobials according to the guidelines			0.814
I have sufficient knowledge to review/amend antimicrobials according to the guidelines			0.806
I am competent to review/amend antimicrobials according to the guidelines			0.686
Members of the multidisciplinary team review/amend antimicrobials according to the guidelines		0.700	
I have ways of monitoring the quality of my reviewing/amending of antimicrobials		0.661	
I have undertaken sufficient CPD to review/amend antimicrobials according to the guidelines		0.613	0.446
I have sufficient support from specialists to enable me to review/amend antimicrobials according to the guidelines		0.605	
Reviewing/amending antimicrobials according to the guidelines is encouraged by my peers	0.374	0.582	
C, component; CPD, continuing professional development			

Table 4.5: Loading of the statements within Aspect 3 onto each of the three components

Statement	C1	C2	C3
With respect to appropriate and timely monitor for efficacy/toxicity of antimicrobials:			
If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, I believe that patients will be treated more effectively	0.833		
If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	0.824		
If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	0.766		
If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, believe that patients will be treated more cost effectively	0.655		
I intend to follow the guidelines on monitoring efficacy/toxicity of antimicrobials	0.596	0.304	
Monitoring for efficacy/toxicity of antimicrobials according to the guidelines is a high priority for me	0.545		
Members of the multidisciplinary team monitor for efficacy/toxicity of antimicrobials according to the guidelines		0.747	
Monitoring for efficacy/toxicity of antimicrobials according to the guidelines is encouraged by my peers	0.321	0.704	
I have ways of monitoring the quality of my monitoring for efficacy/toxicity of antimicrobials		0.674	
I have undertaken sufficient CPD to monitor for efficacy/toxicity of antimicrobials according to the guidelines		0.591	0.489
I have sufficient support from specialists to monitor for efficacy/toxicity of antimicrobials according to the guidelines	0.346	0.584	
I have sufficient knowledge to monitor for efficacy/toxicity of antimicrobials according to the guidelines			0.894
I am sufficiently skilled to monitor for efficacy/toxicity of antimicrobials according to the guidelines			0.893
I am confident in my ability to monitor for efficacy/toxicity of antimicrobials according to the guidelines			0.839
I am competent to monitor for efficacy/toxicity of antimicrobials according to the guidelines			0.826
It is my responsibility to monitor for efficacy/toxicity of antimicrobials according to the guidelines			0.467
I have clear goals for monitoring efficacy/toxicity of antimicrobials according to the guidelines	0.434		
I intend to encourage others to follow the guidelines on monitoring efficacy/toxicity of antimicrobials	0.511	0.319	
C, component; CPD, continuing professional development			

Table 4.6: Loading of the statements within Aspect 4 onto each of the three components

Statement	C1	C2	C3
With respect to appropriate and timely management of antimicrobials – for example medication errors and adverse drug reactions (i.e. drug allergy, side effects, etc.):			
If I manage antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	0.850		
If I manage antimicrobials according to the guidelines, I believe that patients will be treated more effectively	0.834		
If I manage antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	0.817		
I intend to follow the guidelines on managing antimicrobials	0.676		0.357
If I manage antimicrobials according to the guidelines, I believe that patients will be treated more cost effectively	0.662		
Managing antimicrobials according to the guidelines is a high priority for me	0.657		
I intend to encourage others to follow the guidelines on managing antimicrobials	0.612		0.370
I have clear goals for managing antimicrobials according to the guidelines	0.598	0.313	
I have ways of monitoring the quality of my managing of antimicrobials		0.753	
Managing antimicrobials according to the guidelines is encouraged by my peers		0.704	
I have sufficient support from specialists to manage antimicrobials according to the guidelines	0.367	0.664	
Members of the multidisciplinary team manage antimicrobials according to the guidelines	0.393	0.652	
I am sufficiently skilled to manage antimicrobials according to the guidelines			0.859
I have sufficient knowledge to manage antimicrobials according to the guidelines			0.841
I am confident in my ability to manage antimicrobials according to the guidelines			0.757
I am competent to manage antimicrobials according to the guidelines			0.744
I have undertaken sufficient CPD to manage antimicrobials according to the guidelines		0.547	0.564
It is my responsibility to manage antimicrobials according to the guidelines			0.562
C, component; CPD, continuing professional development			

The three components for each aspect of antimicrobial practice were labelled: 'Guidelines compliance' (C1), 'Influences on practice' (C2) and 'Self-efficacy' (C3). Responses to statements within these aspects and components are given in Tables 4.7-4.10. The Cronbach's alpha values for each of the components within Aspects 1 to 4, along with median and interquartile range (IQR) values, are also given. In view of these values being greater than the generally accepted value for reliability of 0.7 (182), they were accepted as scales and subjected to further analysis.

4.4.3.1 Aspect 1: Prescribing/recommending antimicrobials

In general, the component scores all indicated positive responses with the median and IQR values all exceeding the scale midpoints (C1: Median 32, IQR 32-33, Midpoint 24, C2: Median 26, IQR 25-28, Midpoint 21, C3: Median 20, IQR 20-20, Midpoint 15) and all item median responses being 'Agree' (Table 4.7). There were, however, less positive responses in the items within Component 2 relating to determinants of behaviour around influences on practice in prescribing/recommending antimicrobials including items focused on the TDF domains: 'Environmental context and resources', 'Social influences', and 'Behavioural regulation'. The items with the lowest levels of positive responses were: 'Prescribing/recommending antimicrobials according to the guidelines is encouraged by my peers' (agree/strongly agree *n=430*, 80.4%) and 'I have undertaken sufficient CPD to prescribe/recommend antimicrobials according to the guidelines' (agree/strongly agree *n=417*, 78%). The item: 'Patients put me under pressure to prescribe/recommend antimicrobials outside the guidelines' had almost an even spread of agree/strongly agree (*n=217*, 40.6%) and disagree/strongly disagree (*n=243*, 45.4%).

Inferential statistics showed that there was a statistically significant difference in component scores between doctors and pharmacists for each component (C1: $P<0.001$, C2: $P<0.001$, C3: $P=0.01$), with doctors generally having higher scores. Highest academic qualification showed a significant difference between categories (undergraduate, postgraduate taught or doctorate) for each component (C1: $P<0.001$, C2: $P<0.001$, C3: $P=0.009$), with post-hoc analysis showing that undergraduate respondents had lower scores than others. Lastly, for the 'Experience as health professional' categories (≤5 years, 6-10 years and ≥11 years) there was only a difference in C2 ($P<0.001$), with post-hoc analysis showing lower scores for less experienced respondents. All other demographic data categories showed no statistically significant differences ($P>0.05$).

Table 4.7: Aspect 1: Prescribing/recommending antimicrobials in relation to the TDF domains and PCA components (N=535, missing=16)

TDF domain	Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
With respect to appropriate and timely prescribing/recommending antimicrobials (i.e. right medication, right dose, right patient, right time and right route):		**% (n)**	**% (n)**	**% (n)**	**% (n)**	**% (n)**	**% (n)**
COMPONENT 1: GUIDELINES COMPLIANCE							
Beliefs of consequences	If I prescribe/recommend antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	11.2 (60)	84.1 (450)	0.6 (3)	1.1 (6)	0	0
	If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will be treated more cost effectively	13.6 (73)	80 (428)	1.5 (8)	1.3 (7)	0.4 (2)	0.2 (1)
	If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will be treated more effectively	13.5 (72)	81.7 (437)	0.9 (5)	0.9 (5)	0	0
	If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	11.6 (62)	81.1 (434)	2.4 (13)	1.7 (9)	0	0.2 (1)
Goals	I have clear goals for prescribing/recommending antimicrobials according to the guidelines	8.6 (46)	85.8 (459)	1.1 (6)	1.5 (8)	0	0
	Prescribing/recommending antimicrobials according to the guidelines is a high priority for me	12.9 (69)	81.7 (437)	0.7 (4)	1.5 (8)	0	0.2 (1)
Intentions	I intend to follow the guidelines on prescribing/recommending antimicrobials	12.7 (68)	80.6 (431)	2.2 (12)	1.5 (8)	0	0
	I intend to encourage others to follow the guidelines on prescribing/recommending antimicrobials	12 (64)	80 (432)	3 (16)	1.3 (7)	0	0
Component statistics: Cronbach's alpha 0.889, Range 8-40, Midpoint 24, Median 32, IQR 32-33							
COMPONENT 2: INFLUENCES ON PRACTICE							
Environmental context & resources	I have sufficient support from specialists to enable me to prescribe/recommend antimicrobials according to the guidelines	7.3 (39)	80 (428)	5.8 (31)	3.2 (17)	0.6 (3)	0.2 (1)
	I have undertaken sufficient CPD to prescribe/recommend antimicrobials according to the guidelines	17.6 (94)	60.4 (323)	7.5 (40)	11 (59)	0.4 (2)	0.2 (1)
Social influences	Members of the multidisciplinary team prescribe/recommend antimicrobials according to the guidelines	6.2 (33)	78.7 (421)	9 (48)	2.4 (13)	0.6 (3)	0.2 (1)
	Prescribing/recommending antimicrobials according to the guidelines is encouraged by my peers	6.9 (37)	73.5 (393)	13.3 (71)	3 (16)	0.2 (1)	0.2 (1)
	Prescribing/recommending antimicrobials according to the guidelines is encouraged by superiors	9.2 (49)	72.5 (388)	12 (64)	3 (16)	0.4 (2)	0
	Patients put me under pressure to prescribe/recommend antimicrobials outside the guidelines	4.5 (24)	36.1 (193)	9.3 (50)	31.8 (170)	13.6 (73)	1.7 (9)

TDF domain	Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
Behavioural regulation	I have ways of monitoring the quality of my prescribing/recommending of antimicrobials	2.1 (11)	78.5 (420)	12.3 (66)	3 (16)	0.6 (3)	0.6 (3)
Component statistics: Cronbach's alpha 0.700, Range 7-35, Midpoint 21, Median 26, IQR 25-28							
	COMPONENT 3: SELF-EFFICACY						
Knowledge	I have sufficient knowledge to prescribe/recommend antimicrobials according to the guidelines	6.7 (36)	86.9 (465)	2.6 (14)	0.7 (4)	0	0
Skills	I am sufficiently skilled to prescribe/recommend antimicrobials according to the guidelines	5.4 (29)	87.9 (470)	3 (16)	0.7 (4)	0	0
Social/professional role & identity	It is my responsibility to prescribe/recommend antimicrobials according to the guidelines	8.6 (46)	84.1 (450)	3 (16)	0.9 (5)	0	0.4 (2)
Optimism	I am confident in my ability to prescribe/recommend antimicrobials according to the guidelines	6.4 (34)	86.4 (462)	3.2 (17)	1.1 (6)	0	0
Beliefs of capabilities	I am competent to prescribe/recommend antimicrobials according to the guidelines	5.2 (28)	80.7 (432)	8.8 (47)	2.2 (12)	0	0
Component statistics: Cronbach's alpha 0.867, Range 5-25, Midpoint 15, Median 20, IQR 20-20							
PCA, Principal Component Analysis; TDF, Theoretical Domains Framework; Antimicrobials, all antimicrobial agents that act against all types of microbes including bacteria, viruses, fungi and parasites; IQR, interquartile range; CPD, continuing professional development							

4.4.3.2 Aspect 2: Reviewing/amending antimicrobials

Similar to Aspect 1, the component scores all indicated generally positive responses with the median and IQR values all exceeding the scale midpoints (C1: Median 32, IQR 32-33, Midpoint 24, C2: Median 20, IQR 20-21, Midpoint 15, C3: Median 20, IQR 20-20, Midpoint 15) and all item median responses being 'Agree' (Table 4.8). There were; however, less positive responses in the items within Component 2 relating to determinants of behaviour around influences on practice in reviewing/amending antimicrobials including items focused on the TDF domains: 'Environmental context and resources', 'Social influences', and 'Behavioural regulation'. The items with the lowest levels of positive responses were: 'Reviewing/amending antimicrobials according to the guidelines is encouraged by my peers' (agree/strongly agree *n=429*, 80.2%) and 'I have undertaken sufficient CPD to review/amend antimicrobials according to the guidelines' (agree/strongly agree *n=419*, 78.3%).

Inferential statistics showed that there was a statistically significant difference in component scores between doctors and pharmacists for each component (C1: $P<0.001$, C2: $P<0.001$, C3: $P<0.001$), with doctors generally having higher scores. Highest academic qualification showed a significant difference between categories (undergraduate, postgraduate taught or doctorate) for each component (C1: $P<0.001$, C2: $P=0.008$, C3: $P<0.001$), with post-hoc analysis showing that undergraduate respondents had lower scores than others. Lastly, for the 'Experience as health professional' categories (≤5 years, 6-10 years and ≥11 years) there was only a difference in C2 ($P=0.003$), with post-hoc analysis showing lower scores for less experienced respondents.

Table 4.8: Aspect 2: Review/amendment of antimicrobials in relation to the TDF domains and PCA components (N=535, missing=16)

TDF domain	Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
With respect to appropriate and timely review/amendment of antimicrobials – for example from broad spectrum to narrow spectrum, intravenous-to-oral and/or discontinuation where appropriate:		**% (n)**	**% (n)**	**% (n)**	**% (n)**	**% (n)**	**% (n)**
COMPONENT 1: GUIDELINES COMPLIANCE							
Beliefs of consequences	If I review/amend antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	10.5 (56)	83.9 (449)	0.9 (5)	1.7 (9)	0	0
	If I review/amend antimicrobials according to the guidelines, I believe that patients will be treated more effectively	13.1 (70)	82.2 (440)	0.4 (2)	1.3 (7)	0	0
	If I review/amend antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	12.5 (67)	81.3 (435)	1.3 (7)	1.7 (9)	0	0.2 (1)
	If I review/amend antimicrobials according to the guidelines, I believe that patients will be treated more cost effectively	12 (64)	81.1 (434)	2.4 (13)	1.3 (7)	0.2 (1)	0
Goals	I have clear goals for reviewing/amending antimicrobials according to the guidelines	10.5 (56)	83.6 (447)	1.5 (8)	1.5 (8)	0	0
	Reviewing/amending antimicrobials according to the guidelines is a high priority for me	10.7 (57)	83.2 (445)	1.3 (7)	1.9 (10)	0	0
Intentions	I intend to follow the guidelines on reviewing/amending antimicrobials	9.3 (50)	82.2 (440)	3.9 (21)	1.5 (8)	0	0
	I intend to encourage others to follow the guidelines on reviewing/amending antimicrobials	10.1 (54)	81.1 (434)	4.3 (23)	1.5 (8)	0	0
Component statistics: Cronbach's alpha 0.896, Range 8-40, Midpoint 24, Median 32, IQR 32-33							
COMPONENT 2: INFLUENCES ON PRACTICE							
Environmental context & resources	I have sufficient support from specialists to enable me to review/amend antimicrobials according to the guidelines	8.4 (45)	80.2 (429)	5 (27)	3 (16)	0.2 (1)	0.2 (1)
	I have undertaken sufficient CPD to review/amend antimicrobials according to the guidelines	18.9 (101)	59.4 (318)	7.5 (40)	10.7 (57)	0.6 (3)	0
Social influences	Members of the multidisciplinary team review/amend antimicrobials according to the guidelines	6.7 (36)	76.1 (407)	11.2 (60)	2.6 (14)	0.2 (1)	0.2 (1)
	Reviewing/amending antimicrobials according to the guidelines is encouraged by my peers	6.7 (36)	73.5 (393)	13.8 (74)	2.6 (14)	0	4 (2)
Behavioural regulation	I have ways of monitoring the quality of my reviewing/amending of antimicrobials	3 (16)	78.7 (421)	12 (64)	2.4 (13)	0.4 (2)	0.6 (3)
Component statistics: Cronbach's alpha 0.775, Range 5-25 Midpoint 15, Median 20, IQR 20-21							

TDF domain	Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
	COMPONENT 3: SELF-EFFICACY						
Knowledge	I have sufficient knowledge to review/amend antimicrobials according to the guidelines	4.3 (23)	88.4 (473)	3.2 (17)	1.1 (6)	0	0
Skills	I am sufficiently skilled to review/amend antimicrobials according to the guidelines	5.6 (30)	87.9 (470)	2.8 (15)	0.7 (4)	0	0
Social/ professional role & identity	It is my responsibility to review/amend antimicrobials according to the guidelines	9.5 (51)	80.6 (431)	4.9 (26)	1.7 (9)	0.2 (1)	0.2 (1)
Optimism	I am confident in my ability to review/amend antimicrobials according to the guidelines	7.9 (42)	85 (455)	3.2 (17)	0.9 (5)	0	0
Beliefs of capabilities	I am competent to review/amend antimicrobials according to the guidelines	6.7 (36)	79.8 (427)	9.3 (50)	0.9 (5)	0.2 (1)	0
Component statistics: Cronbach's alpha 0.829, Range 5-25, Midpoint 15, Median 20, IQR 20-20							
PCA, Principal Component Analysis; TDF, Theoretical Domains Framework; Antimicrobials, all antimicrobial agents that act against all types of microbes including bacteria, viruses, fungi and parasites; IQR, interquartile range; CPD, continuing professional development							

4.4.3.3 Aspect 3: Monitoring efficacy/toxicity of antimicrobials

Likewise, the component scores all indicated generally positive responses with the median and IQR values all exceeding the scale midpoints (C1: Median 32, IQR 32-33, Midpoint 24, C2: Median 20, IQR 20-21, Midpoint 15, C3: Median 20, IQR 20-20, Midpoint 15) and all item median responses being 'Agree' (Table 4.9). There were; however, less positive responses in the items within Component 2 relating to determinants of behaviour around influences on practice in monitoring efficacy/toxicity of antimicrobials including items focused on the TDF domains: 'Environmental context and resources', 'Social influences', and 'Behavioural regulation'. The items with the lowest levels of positive responses were: 'Monitoring for efficacy/toxicity of antimicrobials according to the guidelines is encouraged by my peers' (agree/strongly agree *n=428*, 80%) and 'I have undertaken sufficient CPD to monitor for efficacy/toxicity of antimicrobials according to the guidelines' (agree/strongly agree *n=418*, 78.1%).

Inferential statistics showed that there was a statistically significant difference in component scores between doctors and pharmacists for each component (C1: P<0.001, C2: P<0.001, C3: P<0.001), with doctors generally having higher scores. Highest academic qualification showed a significant difference between categories (undergraduate, postgraduate taught or doctorate) for each component (C1: P<0.001, C2: P=0.027, C3: P=0.008), with post-hoc analysis showing that undergraduate respondents had lower scores than others. Lastly, for the 'Experience as health professional' categories (≤5 years, 6-10 years and ≥11 years) there was only a difference in C2 (P=0.005), with post-hoc analysis showing lower scores for less experienced respondents.

Table 4.9: Aspect 3: Monitoring for efficacy/toxicity of antimicrobials in relation to the TDF domains and PCA components (N=535, missing=16)

TDF domain	Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
With respect to appropriate and timely monitor for efficacy/toxicity of antimicrobials:		**% (n)**	**% (n)**	**% (n)**	**% (n)**	**% (n)**	**% (n)**
COMPONENT 1: GUIDELINES COMPLIANCE							
Beliefs of consequences	If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	9.2 (49)	84.1 (450)	1.7 (9)	1.9 (10)	0.2 (1)	0
	If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, I believe that patients will be treated more effectively	11.2 (60)	84.1 (450)	0.4 (2)	1.3 (7)	0	0
	If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	11.2 (60)	82.6 (442)	1.3 (7)	1.5 (8)	0.2 (1)	0.2 (1)
	If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, believe that patients will be treated more cost effectively	12.9 (69)	80.9 (433)	0.9 (5)	2.1 (11)	0.2 (1)	0
Goals	Monitoring for efficacy/toxicity of antimicrobials according to the guidelines is a high priority for me	10.7 (57)	83 (444)	1.9 (10)	1.3 (7)	0	0.2 (1)
	I have clear goals for monitoring efficacy/toxicity of antimicrobials according to the guidelines	10.1 (54)	84.5 (452)	0.7 (4)	1.5 (8)	0	0.2 (1)
Intentions	I intend to follow the guidelines on monitoring efficacy/toxicity of antimicrobials	8.8 (47)	82.1 (439)	4.5 (34)	1.5 (8)	0	0.2 (1)
	I intend to encourage others to follow the guidelines on monitoring efficacy/toxicity of antimicrobials	10.1 (54)	80.6 (431)	4.3 (23)	1.9 (10)	0	0.2 (1)
Component statistics: Cronbach's alpha 0.891, Range 8-40, Midpoint 24, Median 32, IQR 32-33							
COMPONENT 2: INFLUENCES ON PRACTICE							
Environmental context & resources	I have sufficient support from specialists to monitor for efficacy/toxicity of antimicrobials according to the guidelines	6 (32)	82.2 (440)	5.4 (29)	3.2 (17)	0	0.2 (1)
	I have undertaken sufficient CPD to monitor for efficacy/toxicity of antimicrobials according to the guidelines	18.5 (99)	59.6 (319)	8.2 (44)	10.3 (55)	0.4 (2)	0
Social influences	Members of the multidisciplinary team monitor for efficacy/toxicity of antimicrobials according to the guidelines	7.7 (41)	73.5 (393)	12.3 (66)	3.4 (18)	0	0.2 (1)
	Monitoring for efficacy/toxicity of antimicrobials according to the guidelines is encouraged by my peers	6 (32)	74 (396)	14.4 (77)	2.2 (12)	0	0.4 (2)
Behavioural regulation	I have ways of monitoring the quality of my monitoring for efficacy/toxicity of antimicrobials	2.2 (12)	79.4 (425)	11.8 (63)	2.2 (12)	0.6 (3)	0.7 (4)
Component statistics: Cronbach's alpha 0.789, Range 5-25 Midpoint 15, Median 20, IQR 20-21							
COMPONENT 3: SELF-EFFICACY							

TDF domain	Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
Knowledge	I have sufficient knowledge to monitor for efficacy/toxicity of antimicrobials according to the guidelines	5.2 (28)	87.3 (467)	3.2 (17)	1.3 (7)	0	0
Skills	I am sufficiently skilled to monitor for efficacy/toxicity of antimicrobials according to the guidelines	5 (27)	87.5 (468)	3.4 (18)	1.1 (6)	0	0
Social/ professional role & identity	It is my responsibility to monitor for efficacy/toxicity of antimicrobials according to the guidelines	9.5 (51)	79.8 (427)	6.2 (33)	1.1 (6)	0	0.4 (2)
Optimism	I am confident in my ability to monitor for efficacy/toxicity of antimicrobials according to the guidelines	7.3 (39)	85.6 (458)	2.8 (15)	1.3 (7)	0	0
Beliefs of capabilities	I am competent to monitor for efficacy/toxicity of antimicrobials according to the guidelines	6.7 (36)	79.8 (427)	8.6 (46)	1.9 (10)	0	0
Component statistics: Cronbach's alpha 0.890, Range 5-25 Midpoint 15, Median 20, IQR 20-20							
PCA, Principal Component analysis; TDF, Theoretical Domains Framework; Antimicrobials, all antimicrobial agents that act against all types of microbes including bacteria, viruses, fungi and parasites; IQR, interquartile range; CPD, continuing professional development							

4.4.3.4 Aspect 4: Managing antimicrobials

Again, the component scores all indicated generally positive responses with the median and IQR values all exceeding the scale midpoints (C1: Median 32, IQR 32-33, Midpoint 24, C2: Median 20, IQR 20-21, Midpoint 15, C3: Median 20, IQR 20-20, Midpoint 15) and all item median responses being 'Agree' (Table 4.10). There were; however, less positive responses in the items within Component 2 relating to determinants of behaviour around influences on practice in managing antimicrobials including items focused on the TDF domains: 'Environmental context and resources', 'Social influences', and 'Behavioural regulation'. The items with the lowest levels of positive responses were 'I have undertaken sufficient CPD to manage antimicrobials according to the guidelines (agree/strongly agree *n=423*, 79.1%) and 'Managing antimicrobials according to the guidelines is encouraged by my peers' (agree/strongly agree *n=422*, 78.8%).

Inferential statistics showed that there was a statistically significant difference in component scores between doctors and pharmacists for each component (C1: $P<0.001$, C2: $P<0.001$, C3: $P=0.014$), with doctors generally having higher scores on each component scale. Highest academic qualification showed a significant difference between categories (undergraduate, postgraduate taught or doctorate) in C1 ($P<0.001$) and C3 ($P=0.002$) only, with post-hoc analysis showing that undergraduate respondents had lower scores than others. Lastly, for the 'Experience as health professional' categories (≤5 years, 6-10 years and ≥11 years) there was only a difference in C2 ($P=0.049$) with post-hoc analysis showing lower scores for less experienced respondents.

Table 4.10: Aspect 4: Management of antimicrobials in relation to the TDF domains and PCA components (N=535, missing=16)

TDF domain	Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
With respect to appropriate and timely management of antimicrobials – for example medication errors and adverse drug reactions (i.e. drug allergy, side effects, etc.):		**% (n)**	**% (n)**	**% (n)**	**% (n)**	**% (n)**	**% (n)**
COMPONENT 1: GUIDELINES COMPLIANCE							
Beliefs of consequences	If I manage antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	9 (48)	86.5 (463)	0.4 (2)	1.1 (6)	0	0
	If I manage antimicrobials according to the guidelines, I believe that patients will be treated more effectively	10.5 (56)	85 (455)	0.4 (2)	1.1 (6)	0	0
	If I manage antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	9.5 (51)	85.2 (456)	0.9 (5)	1.3 (7)	0	0
	If I manage antimicrobials according to the guidelines, I believe that patients will be treated more cost effectively	9.5 (51)	84.3 (451)	1.5 (8)	1.5 (8)	0.2 (1)	0
Goals	I have clear goals for managing antimicrobials according to the guidelines	9.2 (49)	84.9 (454)	0.9 (5)	1.9 (10)	0	0.2 (1)
	Managing antimicrobials according to the guidelines is a high priority for me	12.7 (68)	81.9 (438)	0.9 (5)	1.3 (7)	0	0.2 (1)
Intentions	I intend to follow the guidelines on managing antimicrobials	9.7 (52)	82.1 (439)	3.9 (21)	1.3 (7)	0	0
	I intend to encourage others to follow the guidelines on managing antimicrobials	10.5 (56)	80.7 (432)	4.3 (23)	1.5 (8)	0	0
Component statistics: Cronbach's alpha 0.899, Range 8-40, Midpoint 24, Median 32, IQR 32-33							
COMPONENT 2: INFLUENCES ON PRACTICE							
Environmental context & resources	I have sufficient support from specialists to manage antimicrobials according to the guidelines	6.7 (36)	82.4 (441)	5 (27)	2.4 (13)	0.2 (1)	0.2 (1)
	I have undertaken sufficient CPD to manage antimicrobials according to the guidelines	20 (107)	59.1 (316)	8 (43)	9.9 (53)	0	0
Social influences	Members of the multidisciplinary team manage antimicrobials according to the guidelines	7.7 (41)	75.3 (403)	11.8 (63)	2.1 (11)	0	0.2 (1)
	Managing antimicrobials according to the guidelines is encouraged by my peers	5.2 (28)	73.6 (394)	15.3 (82)	2.2 (12)	0.2 (1)	0.4 (2)
Behavioural regulation	I have ways of monitoring the quality of my managing of antimicrobials	2.1 (11)	79.8 (427)	11.8 (63)	2.6 (14)	0.2 (1)	0.6 (3)
Component statistics: Cronbach's alpha 0.779, Range 5-25 Midpoint 15, Median 20, IQR 20-21							
COMPONENT 3: SELF-EFFICACY							

TDF domain	Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
Knowledge	I have sufficient knowledge to manage antimicrobials according to the guidelines	6.2 (33)	86.5 (463)	3.4 (18)	0.9 (5)	0	0
Skills	I am sufficiently skilled to manage antimicrobials according to the guidelines	5.6 (30)	86.7 (464)	3.7 (20)	0.9 (5)	0	0
Social/ professional role & identity	It is my responsibility to manage antimicrobials according to the guidelines	9.3 (50)	81.5 (436)	4.7 (25)	1.3 (7)	0	0.2 (1)
Optimism	I am confident in my ability to manage antimicrobials according to the guidelines	9.2 (49)	83.6 (447)	3.6 (19)	0.7 (4)	0	0
Beliefs of capabilities	I am competent to manage antimicrobials according to the guidelines	5.4 (29)	79.1 (423)	11.2 (60)	1.3 (7)	0	0
Component statistics: Cronbach's alpha 0.876, Range 5-25 Midpoint 15, Median 20, IQR 20-20							
PCA, Principal Component Analysis; TDF, Theoretical Domains Framework; Antimicrobials, all antimicrobial agents that act against all types of microbes including bacteria, viruses, fungi and parasites; IQR, interquartile range; CPD, continuing professional development							

4.4.3.5 Aspect 4: Thematic analysis

Few clinicians (18 out of 535) responded to the open questions, as outlined in Table 4.11. However, when they did, they often acknowledged the key role of ID doctors, clinical microbiologists and pharmacists in AMS practice, with the main limitations being the lack of guidelines regular updates and sufficient staff. Concerns were also expressed about interprofessional conflict and the need for further training relating to appropriate antimicrobial prescribing practice.

Table 4.11: Analysis of participants' free text comments in relation to PCA components

Component (C)	Illustrative quote
C1: Guidelines compliance	"We have a lot of old doctors who are not quite up to date with the HMC guidelines. They tend to prescribe broad-spectrum antibiotics frequently…" (Doctor)
	"The guidelines are strict and not updated. HMC is not ready for implementing the antimicrobial stewardship programme. A lot of sepsis cases are encountered because physicians don't want to go further and prescribe antibiotics for patients. What is needed: flexible and updated guidelines…" (Doctor)
	"…HMC guidelines are not frequently updated. This can be done by the ID doctors with consultation of clinical pharmacists…" (Pharmacist)
	"…the guidelines document is too long. I don't have time to read it. Also, I haven't been given any orientation." (Doctor)
	"Antimicrobials are powerful agents to kill organisms but only by following the local guidelines. These guidelines are tailored to our resistance patterns…" (Doctor)
	"Recommending antimicrobials according to the HMC guidelines is a high priority for me..." (Pharmacist)
C2: Influences on practice	"Poor documentation by doctors while changing or starting a new medication is an issue in my facility. Some of them even reject our recommendations and stick to their old-style practice…" (Pharmacist)
	"The [hospital name] should take the lead in collecting and analysing antimicrobial data instead of all facilities. Interventions to be done by all, but data collection should be done by only the ID pharmacists to minimise abusing staff..." (Pharmacist)
	"Antimicrobial stewardship data should only be collected by [hospital name] team, to avoid directing data collection to personal benefits..." (Pharmacist)
	"…what is needed is hiring more qualified people who are assigned for conducting research… not to waste doctors' precious time which can be spent on saving lives." (Doctor)
	"We need to keep an eye on the workload levels. I think it's really important to hire more staff. Please don't depend on the available staff as they are already overloaded. Staff shortage puts patients and health systems in danger, especially now in the pandemic..." (Pharmacist)
	"Antimicrobial stewardship training for pharmacists is very important and very much needed in this hospital." (Pharmacist)
	"…sometimes the senior doctors ask us to prescribe strong antibiotics to patients without an indication." (Doctor)
C3: Self-efficacy	"Clinical pharmacists have an important role to play in ensuring the right antibiotic when cultures are positive. For example, if a positive blood culture indicates the presence of an organism to which the prescribed antibiotic is unlikely to be effective, the doctors are contacted advising the need for change…" (Pharmacist)
	"The microbiology laboratory plays a crucial proactive but often overlooked role in timely review. This is by ensuring not only that results are available as soon as possible but also that units are telephoned immediately if there

Component (C)	Illustrative quote
	is a potential for de-escalation of antibiotics based on the antimicrobial susceptibility…" (Doctor)
	"The clinical microbiologists are an underutilised resource within HMC with regards to antimicrobial stewardship. A number of them have been fully trained and are competent to do all aspects of antimicrobial stewardship including ward rounds, in addition to providing a laboratory service, antibiotic data and membership of stewardship committees…" (Doctor)
	"Making interventions and guiding other physicians on appropriate antibiotic prescribing is an understood job. I am more confident now to say no if there is no need for an antibiotic…" (Doctor)
	"…I always consider patient factors in the prescribing/recommendation process, for example financial states, adverse drug reactions, renal/hepatic functions and allergies." (Pharmacist)
PCA, Principal Component Analysis; ID, infectious diseases	

4.5 Discussion

4.5.1 Key results

This survey captured quantitative data from experienced doctors and pharmacists across different HMC hospital settings, in relation to the potential determinants of antimicrobial prescribing behaviour. PCA of the TDF domains indicated three components of 'Guidelines compliance', 'Influences on practice' and 'Self-efficacy'. While component scores for 'Guidelines compliance' and 'Self-efficacy' indicated positive responses, that for the other component (i.e. Influences on practice) was much less positive. There were low levels of agreement for items relating to undertaking sufficient CPD (environmental context and resources) and peers' encouragement (social influences) to review/monitor/manage antimicrobials according to the guidelines. There were neutral responses around patients' pressure to prescribe/recommend antimicrobials outside the guidelines. Comparison of component scores across demographic characteristics identified that, in general, doctors, more qualified and those with greater experience were more likely to be positive in their responses ($P<0.05$). Scores, however, did not vary significantly between clinicians from different practice settings (i.e. secondary and tertiary care).

4.5.2 Strengths and limitations

This survey adds context to the limited literature on use of theory to inform BCIs to improve antimicrobial prescribing, as identified in a recently published systematic review (117). It is unique in its rigorous process of questionnaire development (a review of literature, expert consensus and piloting) and approach of using a framework of behavioural theories (i.e. TDF). Using the TDF

has resulted in findings that offer an original contribution to the evidence base around potential determinants of antimicrobial prescribing behaviour within hospitals. Further strength of this survey is that it is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidance (185).

There are, however, some limitations, hence, the findings should be interpreted with caution. The total number of those who prescribe/recommend antimicrobials as an integral part of their role in HMC was unknown, as a result, the response rate was indeterminate. Despite all strategies to encourage participation, the number of responses was considered to be low in view of the total number of clinicians at HMC. This may have introduced response bias with non-respondents having no or little interest in topic. To carry out a robust (i.e. theoretically-based) comprehensive study, the questionnaire had to be relatively long which may have affected engagement and completion. Nevertheless, it is worth noting that the survey was distributed during the COVID-19 pandemic when clinicians juggled significant priorities. Furthermore, there may have been an element of social desirability and acquiescence bias particularly in relation to Component 1 (i.e. Guidelines compliance). Another limitation is that the results are all based on self-reported data which could not be confirmed or validated. In addition, the study was carried out in HMC, Qatar only and so findings may lack generalisability. It should be noted, though, that the study could be replicated more widely in different practice settings and countries to achieve larger-scale generalisation.

4.5.3 Interpretation

This study has allowed the quantification of the potential theoretically-based behavioural determinants and comparison between respondents, which may support the development of an effective BCI to improve clinicians' antimicrobial prescribing in hospitals and, thereby, minimise AMR. Michie et al. (97) reported that BCIs are more likely to be effective if they are designed to target the causal determinants of behaviour.

Respondents scored items within the 'Guidelines compliance' component highly, suggesting a general acceptance of the local antimicrobial prescribing guidelines. This is in accordance to previous studies among hospital doctors in Belgium

(186), France and Scotland (187), and England (188) who had positive attitudes towards local guidelines. Likewise, respondents scored items in the 'Self-efficacy' component highly, demonstrating confidence in caring for patients with infection, consistent with an earlier multidisciplinary study with clinicians (i.e. nurses, doctors and pharmacist) who work in long-term care facilities in Ireland (189). In this study, clinicians conveyed confidence in providing a high quality of care for the patients due to their long work experience and their in-depth knowledge of the patient cases (189). Another study in the Democratic Republic of Congo revealed a similar result, in which nearly 90% of hospital doctors declared to feel confident about their antibiotic prescribing (190).

The lowest levels of positive scores were in relation to the items within the 'Influences on practice' component, with particular focus on the TDF domains: 'Environmental context and resources', and 'Social influences'. Analysis of the open comments also identified this as a significant issue in relation to appropriate antimicrobial prescribing practice. While other studies have also reported environmental context and resources, and social influences as potential influences on antimicrobial prescribing (42, 189, 191, 192), this is the first questionnaire-based survey which has used the TDF in the context of AMS and also quantified scale scores. Interventions to modify environmental context and resources, and social influences should be prioritised in an effort to improve antimicrobial prescribing behaviour and be targeted at pharmacists, particularly the less qualified and less experienced.

Although previous studies reported that clinicians are more likely to prescribe antimicrobials when they feel pressure from their patients (41, 44, 46, 193), in this study respondents generally held neutral views with regard to patients' pressure to prescribe/recommend antimicrobials. This could have been influenced by the fact that a high proportion of respondents were ≤5 years qualified and AMS topics are more likely now to be included in university curricula and practice-based training.

The finding that component scores did not vary significantly between practice settings is in line with previous research of doctors working in two UK hospitals (Location 1, England and Location 2, Scotland), which have found greater differences between specialities/wards than between hospital settings (194). As

such, this indicates that AMS interventions in one setting can be transferrable to similar specialities/wards in different settings.

As described in Chapters 1 and 2, once the TDF determinants are identified, they can be mapped to relevant BCTs which are the 'active ingredients' of an intervention (113). This can be done using the BCTTv1, which is a methodological tool used for specifying the potentially content of BCIs delivered to the individuals whose behaviour is targeted (see Chapter 2) (113). In agreement with expert consensus exercise that has mapped BCTs to TDF determinants for which they are most likely to be effective (114), the BCTs which could form part of an intervention to impact environmental context and resources, and social influences are outlined in Table 4.12 below. Each of these BCTs are presented with their own label and definition that can be used when developing and reporting interventions.

Table 4.12: Mapping the determinants of antimicrobial prescribing, identified in Phase 2, to relevant BCTs (113, 114)

TDF determinant	BCT	
	Label	Definition
Environmental context & resources	Information about environmental consequences	Record/provide information (e.g. written, verbal, visual) about environmental consequences of performing the behaviour
	Prompts/cues	Introduce or define environmental stimulus with the purpose of prompting or cueing the behaviour
	Restructuring the physical environment	Change the physical environment to facilitate, or create barriers to, the target behaviour
	Adding objects to the environment	Add objects to the environment in order to facilitate performance of the behaviour
Social influences	Social support (unspecified)	Advise on, arrange, or provide practical help (e.g. from colleagues, 'buddies' or staff) for performance of the behaviour
	Information about health consequences	Provide information (e.g. written, verbal, visual) about health consequences of performing the behaviour
	Social comparison	Draw attention to others' performance to allow comparison with the person's own performance
	Restructuring the social environment	Change the social environment to facilitate, or create barriers to, the target behaviour

BCTs, behaviour change techniques; TDF, Theoretical Domains Framework

Accordingly, interventions involving 'Information about environmental/health consequences', 'Prompts/cues', 'Restructuring the physical/social environment', 'Adding objects to the environment', 'Social support' and 'Social comparison' strategies are likely to improve antimicrobial prescribing. This is consistent with a recent systematic review of interventions to improve antibiotic prescribing in long-term care facilities, reporting the BCTs of interventions that were associated with improved outcomes (62). In this review, similar BCTs were identified, including adding objects to the environment, providing information about health consequences and restructuring the social environment.

4.6 Conclusion

This study has demonstrated that clinicians in HMC, Qatar perceive themselves to be compliant, confident and competent in relation to appropriate antimicrobial prescribing practice. There were, however, issues around influences on practice (patients, other clinicians), with particular focus on the behavioural determinants of environmental context and resources, and social influences among pharmacists and early career clinicians. A range of relevant BCTs, which could form part of BCIs to address these determinants, were identified. The findings may contribute to the development of effective BCIs to improve clinicians' antimicrobial prescribing practice in, as a result, combat AMR.

4.7 Implications for next research phase

Qualitative research exploring clinicians' prescribing behaviour in more depth is required prior to developing interventions designed to improve antimicrobial prescribing practice. This research is reported in Chapter 5.

Chapter 5: Qualitative interviews with clinicians in Qatar around antimicrobial prescribing

5.1 Introduction

As noted in the literature review presented in Chapter 1 (Section 1.2.3), few studies have explored determinants (including barriers and facilitators) of antimicrobial prescribing behaviour or made reference to behavioural theories. An understanding of these determinants is required for the successful development and implementation of BCIs in this area (97). This chapter (Phase 3) follows on from the cross-sectional survey (Phase 2), reported in Chapter 4.

5.2 Aim

The aim of this study was to explore the determinants of clinicians' antimicrobial prescribing behaviour in Qatar.

The detailed research questions were:

- how and why do specific behavioural determinants impact antimicrobial practice?
- are there any differences between health professions?
- what are the barriers and facilitators relating to appropriate antimicrobial practice?
- how could antimicrobial practice be improved and optimised?

5.3 Methods

5.3.1 Design

A constructivist, qualitative approach (phenomenological design) was selected, as discussed in Chapter 2, to explore clinicians' views and experiences in more depth. Semi-structured interviews, rather than focus groups, were chosen to allow a focus on individual rather than collective views and to provide participants with a more confidential situation to talk about their personal experiences of managing their patients' care.

Given the COVID-19 pandemic situation (e.g. physical distancing measures, national lockdowns and travel restrictions), online video interviews using a videoconferencing software programme, Zoom (139), were considered more

appropriate than other forms of data generation methods to virtually replicate the face-to-face interviews (see Chapter 2).

5.3.2 Setting

The research was conducted across all 12 hospital settings of HMC, Qatar, as described in Chapter 1.

5.3.3 Eligibility criteria

Those doctors (both physicians and surgeons) and pharmacists who completed the questionnaire (Chapter 4), expressed an interest in participating in the interviews phase, and provided their preferred contact details at the end of the questionnaire (Appendix 4B) were eligible to be included.

5.3.4 Sampling and sample size

A purposive sampling approach was adopted with strata of gender, profession, years of experience and area of practice/clinical speciality to ensure a representative sample of clinicians working in HMC, Qatar. Recruitment was progressed to the likely point of data saturation, following the four principles of Francis et al. (143) (see Chapter 2). The initial sample size was five from each health profession (doctors and pharmacists), with interviews continuing until no new themes were identified from three further consecutive interviews.

5.3.5 Development of interview schedule

A draft semi-structured interview schedule was developed from the research aim/questions, the literature presented in the systematic review (Phase 1) presented in Chapter 3 (117) and the main findings (the PCA results) of the survey (Phase 2) presented in Chapter 4. In addition, the TDF domains were incorporated in the design of the interview schedule to ensure comprehensive coverage of likely key determinants related to clinicians' antimicrobial prescribing behaviour (99). Further information, including barriers (with negative effects), facilitators (with positive effects) and potential BCIs was sought around these determinants. The draft schedule was reviewed by the six experts from the survey phase (see Chapter 4) to promote credibility (see Chapter 2) (148). Two pilot interviews were conducted (with one doctor and one pharmacist) prior to finalising the final interview schedule (Appendix 5A). No changes were made following the pilot interviews so these were included in the data analysis. An overview of the alignment of interview questions to the TDF domains and PCA

components (as previously identified in the survey) is presented in Table 5.1 below.

Table 5.1: Interview key questions in relation to the TDF domains and PCA components (104)

Area	Interview key question
DEMOGRAPHIC CHARACTERISTICS	
Introduction	Can I start by asking you to describe your current involvement in antimicrobial practice?
C1: GUIDELINES COMPLIANCE	
Goals	I wonder if you can tell me how you feel that guidelines help you in setting your goals in relation to your routine antimicrobial practice, that is prescribing/recommending, review/amendment, monitoring and management?
Intentions	Clinicians are encouraged to follow the guidelines in their routine antimicrobial practice. I wonder if you can comment on that in relation to your own practice?
Beliefs of consequences	What do you think the positive or negative consequences are, related to antimicrobial practice using the guidelines?
Barriers & facilitators	In relation to the guidelines, what do you feel are the barriers and facilitators to using them to help with your antimicrobial practice?
C2: INFLUENCES ON PRACTICE	
Environmental context & resources	Which factors within the hospital environment, or resources help or hinder your antimicrobial practice?
Social influences	Can you tell me about the influences of peers and other people that are important to you in relation to your antimicrobial practice?
Behavioural regulation	Thinking about your own antimicrobial practice, can you tell me whether and how you plan to ensure the best practice?
Barriers & facilitators	In relation to the influences on antimicrobial practice, what do you feel are the barriers and facilitators to your own practice?
C3: SELF-EFFICACY	
Knowledge/Skills	Apart from your academic qualifications - what sort of knowledge and skills do you have in relation to antimicrobial practice?
Beliefs of capabilities	How well do you feel you use your knowledge and skills in your antimicrobial practice?
Optimism	How confident you feel in relation to your antimicrobial practice?
Social/professional role & identity	What you feel are your roles and responsibilities in relation to antimicrobial practice?
Barriers & facilitators	In relation to your personal qualities and attributes, what do you feel are the barriers and facilitators to your antimicrobial practice?
REFLECTIONS ON HOW TO IMPROVE AMS PRACTICE	
Conclusion	Finally, I wonder if you can let me have your thoughts around what you feel works very well and what needs to improve regarding AMS practice in HMC, in general?
TDF, Theoretical Domains Framework; PCA, Principal Component Analysis; C, component; AMS, antimicrobial stewardship; HMC, Hamad Medical Corporation	

From December 2020 to February 2021, those clinicians sampled for interviews were contacted by the researcher via E-mail (Appendix 5B) which included a detailed participant information sheet (Appendix 5C) and a consent form (Appendix 5D). The consent form included an explicit statement consenting to interview via Zoom and to the video/audio recording of the conversation. Participants were able to ask any questions before providing consent prior to their interview. Upon completion and submission of the online consent form, the

researcher contacted the participant by their preferred method to arrange a convenient date and time for a Zoom interview.

Semi-structured, online interviews were conducted in English by the doctoral researcher who had pharmacy experience in hospital settings in Qatar, has an interest in AMS and has been trained in carrying out qualitative interviews (promoting dependability) (148). The researcher had no relationship to the hospitals or participants selected. Different probes, such as 'Can you give me more detail about that?', 'What did you mean when you said?' and 'Can you give me an example?' were used throughout the interviews to obtain further details and explanations. The interviews were both video- and audio-recorded through the propriety functionality in Zoom and local storage of recordings. In addition, a backup recoding was made using a stand-alone digital voice recorder (i.e. Sony ICD-UX570 Digital Voice Recorder, ICDUX570BLK) to a memory card. After each interview, recordings were transferred from the memory card to University based password protected secure storage and were deleted from the memory card. The audio transcripts for the recordings were automatically generated by Zoom's audio transcript feature, then checked/edited in full by the researcher using a naturalistic approach in which every utterance is transcribed in as much detail as possible (195). All participants were offered the opportunity to review their transcripts to promote credibility (148).

5.3.6 Data analysis

Thematic analysis was conducted using the Framework Approach which has been applied in a wide variety of qualitative research, as described in Chapter 2 (144, 145). NVivo® version 11 Software (147) was used by the researcher as a qualitative data management tool to support data analysis. The six stages of conducting the thematic analysis are presented in Table 5.2 below.

Table 5.2: Stages of thematic analysis using the Framework Approach (144, 145)

Stage	Description of the process
1. Data familiarisation	Immersion in the data by the doctoral researcher and her supervisory team via listening repeatedly to the recordings and reading the transcripts after each interview to generate ideas for the creation of codes and facilitate analysis
2. Generating initial codes	Generating initial codes using the TDF domains as headings and grouping into potential themes and sub themes by the researcher. Codes were then reviewed by the supervisory team with any disagreements resolved through discussion
3. Searching for themes	Looking for themes through the remaining transcripts and applying systematically to all related data
4. Reviewing themes	Reviewing themes to ensure reflection of associated quotes and the entire data set
5. Defining, naming and mapping themes	Defining and refining themes by attributing clear definitions and names for each key theme. A map was used to arrange data and explore interrelationships between themes (Appendix 5E)
6. Producing the report	Selecting the supported quotes for each theme (labelled by profession to protect anonymity) and producing the final narrative analysis, in relation to the research aim, questions and previous literature. The quotes were then reviewed, discussed and agreed by the supervisory team

The doctoral researcher prepared the initial coding frame using the TDF domains (104), followed by the identification of potential themes and subthemes under each domain. One additional theme emerged and was added to the coding frame: 'Interventions needed'. Figure 5.1 is a screenshot showing how the TDF domain 'Environmental context and resources' was divided into different themes and subthemes, each with associated text of transcript. Themes were then reviewed, defined and considered in relation to each other, allowing grouping themes/subthemes that were linked with one another into key themes. This leads the researchers to look for the complexity of participants' views rather than narrowing meanings. Given the constructivism philosophical paradigm that fits the qualitative approach taken for this work (see Chapter 2), a degree of preconception and subjectivity is inherent. In view of this, analysis was reviewed with supervisors (SC and TM together) and any disagreements resolved by discussion in an attempt to mitigate against this.

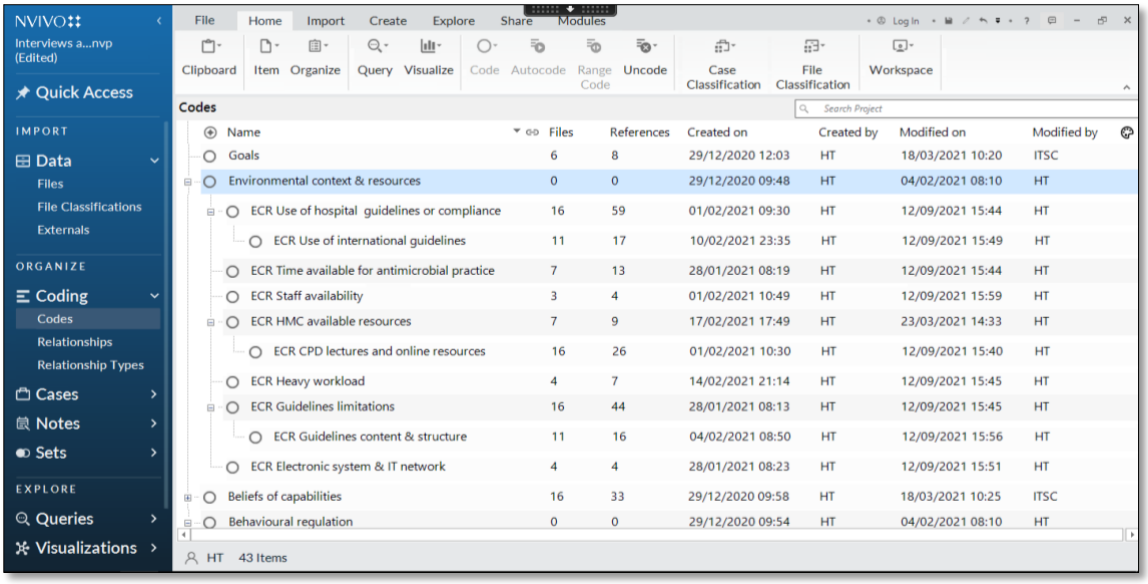


Figure 5.1: Screenshot showing coding of the TDF domain 'Environmental context and resources' in NVivo® version 11 Software (147)

5.3.7 Governance

Zoom was used with activation of maximum-security features, including password protected meetings, user authentication and locked meetings to maintain privacy and confidentiality.

Ethics approval was obtained from the ethics committees of RGU, QU and HMC, as described in Chapter 4, Section 4.3.7. Written, informed consent was received from all participants via E-mail before conducting the interviews. All transcripts were anonymised and individuals identified by the use of unique codes (i.e. participant's questionnaire number). In accordance with RGU's Research Governance and Research Ethics Policies (184), all consent forms, audio files and transcripts were stored on password protected, secure databases on secure University servers with a restricted access to the key research team members only.

5.4 Findings

5.4.1 Participant recruitment

Forty-five clinicians agreed to be interviewed, with data saturation achieved after interviewing eight doctors and eight pharmacists from a range of area of practices (see Chapter 2). The interviews lasted between 23 and 45 minutes. The demographics of the 16 participants are given in Table 5.3. Participant quotes are identified by profession, questionnaire number, job title and area of practice.

The job titles and areas of practice were as stated by the participants as part of the questionnaire (see Chapter 4).

Table 5.3: Demographic characteristics of participants

Participant*	Gender	Job title	Area of practice
Pharmacist 6	Female	Clinical pharmacist	Infectious diseases
Pharmacist 8	Female	Clinical pharmacist	Paediatrics
Pharmacist 9	Female	Junior pharmacist	Obstetrics and gynaecology
Pharmacist 469	Female	Clinical pharmacist	Otolaryngology
Pharmacist 470	Female	Staff pharmacist	Cardiology
Pharmacist 471	Male	Senior clinical pharmacist	Cardiology
Pharmacist 501	Male	Senior pharmacist	Obstetrics and gynaecology
Pharmacist 511	Female	Clinical pharmacist	Ambulatory care
Doctor 13	Male	Resident	Family medicine
Doctor 14	Male	Associate consultant	Infectious diseases
Doctor 17	Male	Resident	Internal medicine
Doctor 19	Male	Resident	Emergency medicine
Doctor 21	Female	Clinical fellow	Infectious diseases
Doctor 23	Female	Resident	Emergency medicine
Doctor 28	Female	Associate consultant	Internal medicine
Doctor 514	Female	Senior consultant	Microbiology
*This refers to participant's questionnaire number (see Chapter 4)			

5.4.2 Key determinants influencing antimicrobial prescribing

The key themes which emerged most strongly during analysis were identified as determinants influencing antimicrobial prescribing behaviour, and linked to the TDF domains and PCA components (see Chapter 4). These are presented in Table 5.4. Classification of themes into barriers and facilitators to appropriate antimicrobial prescribing are also given. The TDF domains: 'Emotion', 'Optimism' and 'Reinforcement' were not represented in the thematic analysis as not enough references to the relevant domains were made (i.e. only 2, 1 and 1 references were related to emotion, optimism and reinforcement respectively in comparison to 199 references related to environmental context and resources). One additional key theme was found to be influential: 'Interventions needed'.

Table 5.4: Summary of the TDF domains and key themes relating to clinicians' views and experiences of antimicrobial prescribing practice in Qatar

TDF domain	Key theme	Barrier or facilitator
C1: GUIDELINES COMPLIANCE		
Goals & Intentions	Following of the guidelines	Barrier
		Facilitator
	Continuing education and training	Barrier
		Facilitator
	Maintaining appropriate prescribing/dispensing practices	Facilitator
Beliefs of consequences	Impacting patient outcomes and AMR	Barrier
		Facilitator

TDF domain	Key theme		Barrier or facilitator
	Impacting the prescribing patterns of clinicians		Facilitator
	Consequences of COVID-19 on antimicrobial practice		Barrier
C2: INFLUENCES ON PRACTICE			
Environmental context & resources	Hospital guidelines and electronic system		Barrier
			Facilitator
	Staffing, workload and time pressure		Barrier
Social influences	Professional hierarchies		Barrier
	Multidisciplinary teamworking and relationships		Barrier
			Facilitator
	Patient pressure and perceived expectations		Barrier
Behavioural regulation	Restriction policies on antibiotics		Barrier
			Facilitator
	Monitoring, auditing and feedback activities		Barrier
			Facilitator
C3: SELF-EFFICACY			
Knowledge	Knowledge about the guidelines and AMS practice		Barrier
			Facilitator
Skills	Patient counselling skills		Facilitator
	Effective communication between clinicians		Barrier
			Facilitator
Beliefs of capabilities	Confidence and self-belief		Barrier
			Facilitator
Social/professional role & identity	Professional obligation to prescribe/dispense antimicrobials appropriately		Barrier
			Facilitator
	The role of the AMS Committee in the facility		Barrier
			Facilitator
ADDITIONAL DOMAINS AND THEMES			
Memory, attention & decision processes	Antimicrobial prescribing decisions		Barrier
			Facilitator
N/A	Interventions needed	Need for ongoing education and training	Facilitator
		Need for guidelines changes	Facilitator

TDF, Theoretical Domains Framework; PCA, Principal Component Analysis; C, component; AMS, antimicrobial stewardship

The findings below describe how interview data align within the PCA components (see Chapter 4) and TDF domains. In general, there were no obvious differences in responses across health professions.

5.4.2.1 Component 1: Guidelines compliance

Domain 1: Goals and Intentions (mental representations of outcomes that an individual wants to achieve) and (a conscious decision to perform a behaviour or a resolve to act in a certain way), respectively (104)

As Cane and colleagues (104) found, there was a clear overlap between the 'Goals' and 'Intentions' domains so these are considered together. In all cases, the participants placed their patients first and would do what they could to optimise their care and minimise harm caused by unnecessary antibiotic prescribing/use. Their key goals were following the local guidelines, undertaking

continuing education and training, and maintaining appropriate prescribing/dispensing practices. Development of the HMC guidelines according to the local susceptibility and resistance patterns was viewed positively as going some way to facilitating compliance with these.

a. Following of the guidelines

Local antimicrobial prescribing guidelines were considered very influential and most participants stated that they tended to use them to guide their prescribing practice. Keeping to the guidelines and best AMS practices, for example therapeutic drug monitoring of antimicrobial agents were considered as overarching goals for most participants who believed that the guidelines are tailored based on the local susceptibility and resistance patterns.

> "…ensuring that we follow the best AMS recommendations by using the hospital guidelines. This includes daily reviews of patient files, following up cultures, taking patient previous colonisation into account, dose optimisation and therapeutic drug monitoring for antibiotics. Also making sure that the antimicrobial treatment is appropriate for special care groups e.g. pregnancy, breastfeeding, renal diseases and obese patients…"
> (Clinical pharmacist 6, ID)

> "…following of the guidelines, actually, because it is based on our own antibiogram data… It's tailored according to our resistance patterns and to our common organisms."
> (Associate consultant doctor 28, Internal medicine)

Whereas some participants reported that they were more likely to follow the local guidelines, others indicated that in some circumstances they deviated from these and used broad-spectrum antibiotics. This was attributed to the perceived deficiencies in both the hospital guidelines and electronic system (see Domain 3: Environmental context and resources), and the antimicrobial prescribing habits of senior peers (see Domain 4: Social influences).

> "Whenever I prescribe antibiotics, usually I have two things in my mind. First, I want to make sure that whatever I'm giving the patient is enough to cover the organism. I try to keep the organism in my mind. What am I targeting and what exactly can be the source of infection. Second, I try my

best to avoid overprescribing. There are a lot of good antibiotics that we don't use just because of the usual practice of others and because most people do this in our department. I think this is something we should improve in ourselves. To be honest, sometimes I found that I and my colleagues are prescribing specific two or three strong antibiotics only for all patients. According to the guidelines, there are less stronger options which are very effective, but we are not using them..."
(Resident doctor 23, Emergency medicine)

b. Continuing education and training

Several participants considered that continuing education, keeping up to date with the most recent guidelines' recommendations, offering basic training to colleagues and raising awareness among patients/family members about optimal antimicrobial use were key goals. They explained that these could be attained through attending more CPD events and conferences, subscribing to major AMS journals, as well as using social media to connect with patients and to stay updated with new information/research. Some pharmacist participants, however, raised concern about the lack of CPD (similar to Chapter 4) and funded training courses for pharmacists on independent prescribing, for example the Pharmacist Independent Prescribing Practice Certificate (196) (see Interventions needed theme).

"Education, mainly residents and others like patients and patient's family. As well as trying to improve myself by learning about new antibiotics and resistance patterns to ensure that the quality of my antibiotic prescribing improves with time. I think the best antibiotic stewardship is where you train the clinicians to use the guidelines to embed good antibiotic stewardship in their day to day practice."
(Resident doctor 13, Family medicine)

"Trying to be up to date… with the most recent guidelines and antimicrobials journals to provide the best care to patients and to the institution at the same time. I have subscribed to major journals and I'm getting the updates to my E-mail… even like following them on Twitter. You know, nowadays, social media has a high impact on healthcare and clinical knowledge. Also attending more CPD events, conferences and independent

prescribing courses, like The Pharmacist Independent Prescribing Practice course which is quite expensive… Here, the funding for attending any external AMS course or prescribing certification has to come out of your own pocket."
(Senior clinical pharmacist 471, Cardiology)

c. Maintaining appropriate prescribing/dispensing practices

Appropriate and consistent antimicrobial prescribing/dispensing practices in line with the local guidelines were also a vital goal for several participants. In particular, this refers to reviewing the appropriateness of the agent prescribed for the patient served, with a preference for narrower-spectrum agents, indication, dose, duration, amendment (i.e. de-escalation or escalation) and discontinuation when indicated. Saving time and reducing the workload were motivators to promote appropriate practices.

"My goal is to make sure that patients are on the most appropriate antibiotic regimen. My responsibility is to ensure the appropriate choice, appropriate escalation or de-escalation when possible, appropriate dose and duration of antibiotics… Also, the therapeutic drug monitoring for some antibiotics..."
(Clinical pharmacist 8, Paediatrics)

"I think whatever I do, whether we are giving some initial clinical advice or whether it's releasing a report, it has to be consistent… that would be, you know, time saving or trying to reduce the workload as well… always make sure your practice is consistent with the organisation you work in."
(Senior consultant doctor 514, Microbiology)

Domain 2: Beliefs of consequences (acceptance of the reality about outcomes of a behaviour in a given situation) (104)

Most participants asserted that they were aware of the positive consequences of their appropriate antimicrobial prescribing, in agreement with the guidelines. They considered these consequences mainly in relation to their patients but also in relation to themselves and to their prescribing patterns. Notably, there was a prominent mention of COVID-19 as having had negative consequences on antimicrobial prescribing practice and guidelines compliance.

a. Impacting patient outcomes and AMR

Participants believed that prescribing antibiotics appropriately, in agreement with the guidelines, improves patient outcomes, including decreased morbidity, mortality and hospitalisation.

> "I think the guidelines are definitely a good foundation to have when it comes to dealing with patients… It sets a stable milestone with regards to what the latest updates are, what the best evidence-based practice would be… It's very important for patient safety specifically and dealing with microbes in the hospital setting… because the worst nightmare for us, obviously, is antimicrobial resistance…"
> (Resident doctor 17, Internal medicine)

> "…for sure, the patient will be treated more effectively, more cost effectively and the resistance among our patients will be reduced... It will be like an evidence-based practice… Infectious diseases can kill and using the guidelines will have some sort of positive patient outcomes like reduced morbidity, mortality and hospital length of stay."
> (Clinical pharmacist 469, Otolaryngology)

On the other hand, some participants admitted that inappropriate prescribing practice of antimicrobials that falls outside the guidelines, such as overprescribing, broad-spectrum use, unnecessary combination therapy and delayed administration from the time of prescription is common. They considered it as a leading driver for the emergence and increase in AMR in the region. These participants were concerned that if this problem persists, it would be life threatening and may increase the healthcare-associated infections, as well as the cost of treatment.

> "We encounter many patients who are resistant to the strongest antimicrobial treatment. When we check the patient medication history, we notice that there was overprescribing of broad-spectrum antibiotics by the doctor. This is a very dangerous issue. Some patients lose their lives because of AMR."
> (Staff pharmacist 470, Cardiology)

"The misuse of antibiotics is a challenge. Most of the time, the guidelines are not used. We see many hospitalised patients who are given a combination of ceftriaxone plus metronidazole, when not needed. This can delay the administration of antibiotics because we have to call the doctor and ask for changing the medication or even correcting the dose. Then, we need to prepare and send it to the ward…"
(Junior pharmacist 9, Obstetrics & gynaecology)

"Usually, if a patient is very sick we will prescribe meropenem plus vancomycin, then will sort it out later on. By default, for every patient comes to the ED with upper respiratory tract infection, we will prescribe ceftriaxone. Some of these antibiotics are very expensive for the patients but we still do prescribe them because we are worried about the patient."
(Resident doctor 23, Emergency medicine)

b. <u>Impacting the prescribing patterns of clinicians</u>

Participants were aware that appropriate antimicrobial prescribing patterns were a positive consequence of using the hospital guidelines. Building the best practice capacity of clinicians regarding the prescribing of antimicrobials was also considered as a good consequence of using the guidelines.

"These guidelines are helpful in limiting the misuse of the antibiotics. Consistent antimicrobial practice of clinicians is another good consequence of using the guidelines… Making the workflow more consistent according to a one, specific reference and having like an effective unified approach of treatment…"
(Junior pharmacist 9, Obstetrics & gynaecology)

"The guidelines help us, sometimes, in choosing which antibiotic we need to start the patient on and later, of course, in tailoring or narrowing the spectrum down according to the microbiology results… I have noticed that the prevalence of prescribing errors has decreased a lot after implementing the guidelines."
(Clinical fellow 21, ID)

c. Consequences of COVID-19 on antimicrobial practice

Several participants raised concerns about the consequences of the COVID-19 pandemic on guidelines compliance because of time constraints and increased work overload due increased numbers of patients. This is considered in Domain 3: Environmental context and resources. Several reported that COVID-19 was also driving increased patient demand for antibiotics as a prophylaxis for COVID-19 infections, which might result in serious issues including increased AMR.

> "AMS is very important especially now in this pandemic. I see many people come to the hospital asking doctors for antibiotics, although there's like no active bacterial infection. They think that antibiotics will prevent them from getting Coronavirus. The misuse of these antibiotics will create resistance among bacteria that normally exists in our bodies."
> (Clinical pharmacist 8, Paediatrics)

> "With the Coronavirus pandemic, there is no time at all to open the Internet, find the guidelines and search for information… We are too busy and overloaded with complicated patients' cases…"
> (Resident doctor 17, Internal medicine)

5.4.2.2 Component 2: Influences on practice

Domain 3: Environmental context and resources (any circumstances of a person's situation or environment that discourages or encourages the development) (104)

With regard to their environmental context and resources, most participants used the local guidelines, the hospital electronic health system (EHS): Cerner (197), and other international resources to support their prescribing practice. Some described that the local guidelines' accessibility, structure and content were significant barriers to compliance. In addition, poor Internet access, staffing, heavy workload and inadequate time were frequently regarded as barriers to appropriate practice.

a. Hospital guidelines and electronic system

Many participants acknowledged that having the hospital guidelines facilitated empirical treatment decisions based on the local resistance patterns and availability of antimicrobial agents in the facility. They also described the positive

influence of the Cerner (197) on their antimicrobial practice. They found it helpful in providing a source of information about patients' health at the place and time that it is needed, and suggested integrating the hospital antimicrobial prescribing guidelines to the Cerner to enable appropriate practice. Guidelines mobile application development was also suggested to facilitate appropriate practice (see Interventions needed theme).

> "The guidelines are really helpful in terms of providing guidance and advice to the empirical therapy because once you have the results, you rationalise the treatment according to the significant microbiology results… I think when patients come in, we want to give them the best choice of therapy without knowing what the organism is… so you know it's the best choice of empirical therapy, based on the prevailing local resistance patterns and what antimicrobial agents we have…"
> (Senior consultant doctor 514, Microbiology)

> "With the electronic health system, Cerner, we have access to all patients' health information, in relation to all HMC hospitals and primary care centres… Integrating the guidelines and hospital antibiogram to the Cerner is needed… Because you know in the busy daily practice people wouldn't go to search where is the guidelines or antibiogram… so by one click, it's going to pop up on computer screens to clinician. That's going to make it much easier for us to tailor the empirical regimen based on the local susceptibility data… It's not a matter of having guidelines for people who are not aware about where to find it."
> (Senior clinical pharmacist 471, Cardiology)

Missing details, such as cost information, traditional document layout, lack of frequent update, difficult access and lack of education/training sessions in relation to the guidelines negatively influenced participants' antimicrobial prescribing practice and were cited as obstacles (see Interventions needed theme). For example, some pharmacists mentioned the advantages of the Sanford Guide to Antimicrobial Therapy (198), which is widely used in their practice setting due to what they described as easier access and layout. These issues were also identified in the survey presented in Chapter 4.

> "No enough details. These guidelines don't give the priority for the cost and it would be great if the cost is actually loaded to give you a guidance about the options for saving purposes… Also, it's not updated regularly. More frequent updates probably will be helpful based on the local susceptibility date and the antibiogram for each site. I think the layout of the PDF document and the classic presentation of information make us not interested to go through it. We use the Sanford Guide frequently. It's easier to access and read…"
> (Senior clinical pharmacist 471, Cardiology)

The issue of poor Internet access within the hospitals was another significant challenge raised by several participants who felt this is needed to be addressed. An example given was the difficult access to the hospital online library using the hospital Wi-Fi network in personal devices.

> "Regarding the HMC online library, it is not easy to find a reference there. The first thing that I do when I arrive to the hospital is that switching off the Wi-Fi and use my 4G mobile data because it's almost impossible to work with the hospital Wi-Fi… There are many things you will not be able to reach when you use the Wi-Fi, especially for me dealing with a special population, paediatrics, which is an area where the evidence is already rare…"
> (Clinical pharmacist 8, Paediatrics)

b. <u>Staffing, workload and time pressure</u>

Staff shortages, a high load of patients and inadequate time were also reported as challenges while maintaining appropriate antimicrobial prescribing practice in line with the guidelines. Participants talked about how they were overwhelmed with the heavy workload and the number of patients, which prevented them from spending enough time in patient consultation with regards to antimicrobial use. Further to this, struggling with staff shortages was linked to more antimicrobial prescriptions. In this context, prescribing antimicrobial agents was seen as a way to deal with the clinicians' workload, and as an easier and quicker way of moving to the next patient rather than not prescribing.

> "…the time barrier is the main challenge that you can find here, especially when you are in a busy shift or when the doctor is calling the pharmacy for

a quick recommendation... we are overloaded with a huge number of patients. It is difficult to spend enough time with every patient explaining about the antibiotic and how they should take it. This is a real challenge for us…"
(Junior pharmacist 9, Obstetrics & gynaecology)

"We are deficient in number to run the AMS program in the current way. Physicians are still not following the restrictions and hardly stop antibiotics at 48 hours. Imagine one person is covering a whole hospital during the weekend and receiving like 30 calls for approvals of antibiotics… The easy way will be approving and letting the primary team follow the next day. Unfortunately, we come back next week and find the patients, who were seen over the weekend, prescribed broad-spectrum antibiotics unnecessarily. Yes, we can de-escalate but I don't think 24 hours will be enough for one person to discuss 30 new cases, convince the team, de-escalate, receive calls and see the necessary consultations. That's why there are a lot of inappropriate approvals done under pressure by the ID physician on call to not compromise patients' care."
(Associate consultant doctor 14, ID)

"Sometimes I don't have time to open the computer and access the guidelines… In internal medicine, it's very difficult to sit down, read the guidelines, make sure that you're following it properly and thoroughly, and see what the best possible options would be with every single patient… I think this is very hard…"
(Resident doctor 17, Internal medicine)

Domain 4: Social influences (the interpersonal processes that can cause individuals to change their thoughts, feelings or behaviours) (104)

As in Chapter 4, several social influences were also evident. These influences included clinicians' seniority, individual experience/preferences, prescribing habits of peers, as well as patient pressure/expectations. Despite some occasional disagreements with regard to prescribing decisions, most participants valued working as part of the multidisciplinary team and greatly appreciated the guidance and support afforded.

a. Professional hierarchies

Many participants reported the negative influence of senior doctors (i.e. consultants) on the antimicrobial prescribing practice of junior doctors. They explained that although prescribing is performed by juniors, it is the seniors who choose what is prescribed. Participants also mentioned that peers' habits, personal experience and preference for a particular course of action are sometimes the determinants of prescribing behaviour, despite the existence of local policies guiding appropriate antimicrobial prescribing.

> "Dealing with people who are higher up in the multidisciplinary team like consultants… sometimes it becomes a battle. They're very used to like an old style of prescribing of broad-spectrum antibiotics… I feel like that's wrong because that shouldn't be a factor that affects our prescribing. Unfortunately, sometimes, it is like a fight."
> (Resident doctor 17, Internal medicine)

> "…if I am working with a senior doctor, his opinion will affect my opinion, of course… The seniors here love to give the strongest antimicrobial agents as the first option for patients who are hospitalised. In my opinion, this is not right because of the AMR issue. Even though we talk with them about the rules, they are not going to adhere to that. Sometimes, the barrier would be the ego of senior doctors who refuse our evidence-based recommendations and just depend on their clinical judgement or experience gained over their years of practice."
> (Staff pharmacist 470, Cardiology)

b. Multidisciplinary teamworking and relationships

Most participants discussed the crucial role of multidisciplinary teamworking in influencing their prescribing practice in healthcare facilities. They reported that working with different healthcare professionals provides an opportunity for strong relationships, building trust, and interprofessional learning and education through case review and informal discussions. Juniors also reported that they would refer to their senior colleagues, such as experienced clinical pharmacists or ID doctors, for advice if they felt unsure about prescribing something.

"…what works well is the availability of a clinical pharmacists in every single inpatient team who help in taking decisions… I always prefer discussing my challenging cases with more senior clinical pharmacists who are very well educated and experienced. If you have a good discussion with someone senior, it will always be helpful. We meet new people, review cases and learn from each other. The availability of ID physicians is also helpful to take the right prescribing decisions at the right time. Dealing with people who are higher up in the multidisciplinary team, generally, is very beneficial."
(Clinical pharmacist 511, Ambulatory care)

Conversely, some participants reported that the multidisciplinary work occasionally lead to problems among healthcare professionals, especially when negotiations about the appropriateness of antibiotics arose and others made decisions that fell outside the guidelines (e.g. the interprofessional conflict between doctors and pharmacists). This is considered in further detail in Domain 10: Memory, attention and decision processes.

"It depends… Sometimes we find doctors who are very difficult to discuss interventions with. They prefer to go with their experience and they are over protective on their patients. They think that broad-spectrum antibiotics can really give better outcomes… we face this a lot."
(Clinical pharmacist 511, Ambulatory care)

"I think peer pressure does play a part… If someone just comes and says, 'That's what you need to do'… trying to impose things without actually having consultation and discussion. I think that would be quite off putting. It's just professional courtesy really… When you try to implement things that involve other stakeholders, as a professional courtesy you consult with them. The outcome may not change, but it's just about maintaining the etiquette. Some people can become passive aggressive when things are not managed or implemented in their own way."
(Senior consultant doctor 514, Microbiology)

c. Patient pressure and perceived expectations

A small number of participants identified that patient/family pressure and expectations for antibiotics were barriers to appropriate prescribing practice. They mentioned situations where some patients not only demand antibiotics but also argue about the antibiotic type or the route of administration. This was attributed to patients' previous experience of feeling better with specific antibiotics. A range of strategies to manage this were described, including patient reassurance and education on the need or otherwise for antibiotics.

> "In Paediatrics, the parents are coming and saying that 'I want antibiotic… I want antibiotic'. Many of them are used to get antibiotics immediately when they go to the private clinics. So, they come to us expecting the same… Especially if the patient had a viral infection before and improved with antibiotics… So, the parents believe that improvement was just because of the antibiotic… Many parents believe that antibiotic is a magical thing. Sometimes, this makes our life harder and more stressful, unfortunately."
> (Clinical pharmacist 8, Paediatrics)

> "In many cases, it might be a viral infection that doesn't really require antibiotics. However, the patients and the patient families usually think that they need to leave the hospital with antibiotics… Sometimes it's not just any antibiotic, they demand a specific broad-spectrum or IV antibiotic… Just because someone from their family or a relative got that antibiotic when they had an infection. I feel like it's very important to make sure that the patient understands and invest a lot of time in their education and reassurance."
> (Resident doctor 17, Internal medicine)

Domain 5: Behavioural regulation (anything aimed at manging or changing objectively observed or measured actions) (104)

Participants on the whole said that restricted prescribing of identified antibiotics, for example by means of pre-authorisation and automatic stop orders, had a positive influence on their antimicrobial prescribing practice, helping to reduce the rate of prescribing. Monitoring, auditing and feedback activities were also felt

to be facilitating appropriate practice. Some pharmacist participants, however, admitted having difficulty in auditing their own practice due the absence of training/education about antimicrobial auditing and any specific self-monitoring tools.

a. Restriction policies on antibiotics

Restrictive approaches in prescribing antimicrobial agents, such as pre-authorisation of targeted antibiotics on the hospital's formulary, substitution, and automatic stop orders for prophylaxis and treatment to ensure that antibiotics are continued no longer than necessary, were seen as playing into appropriate antimicrobial prescribing practice. For instance, some participants explained how non-ID doctors do not have the authority to prescribe specific antibiotics for more than 48 hours, because only ID doctors are allowed to prescribe such antibiotics for longer duration.

> "What goes very well is that we, as ID physicians, are reviewing all the patients who are started on restricted antibiotics and this of course limits the inappropriate prescribing of antimicrobial therapy… Especially prescribing broad-spectrum antibiotics."
> (Clinical fellow 21, ID)

> "One of the things that helped me in HMC is having a restricted antibiotics list… The primary prescribers can prescribe some strong antibiotics for two days only and then they have to consult ID physicians about either continuing or de-escalating… Now, we are managing things quite more well compared to not having all these restrictions."
> (Clinical pharmacist 511, Ambulatory care)

A few pharmacists reported that some doctors are not following these restrictive approaches in their prescribing practice, resulting in the need to alert the attending prescribers to modify the stopping date of the antibiotic. They explained that this requires dedicated pharmacist time that could potentially be devoted to other important tasks. They suggested increasing the number/methods of restrictions on antibiotics to reduce such inappropriate practices.

> "Many prescribers do prescribe restricted antibiotics for more than two days… This is a big challenge for us because any prescription for restricted antibiotics, prescribed by non-ID doctor, should be for two days only… Many doctors are still not aware of this. So, we in the hospital pharmacy need to call the prescriber to modify the stopping date of the antibiotic until an ID doctor assists the patient and decides if the patient should continue the antibiotic or not. This takes time… To avoid such issues, we need to increase the numbers and the methods of restrictions."
> (Junior pharmacist 9, Obstetrics & gynaecology)

b. Monitoring, auditing and feedback activities

Several participants described the influence of monitoring antibiotic susceptibility and resistance rates, auditing of antibiotics prescribed and the provision of timely feedback to individual prescribers during ward rounds on their antimicrobial prescribing practice. They found these activities valuable and linked them to reduced prescribing.

> "In the emergency department, we see a lot of sepsis and infections. We have a sepsis committee, which I'm a member of. We do audit records for all antibiotic prescriptions and make recommendations to prescribers on antibiotic treatment considered as inappropriate… This includes which antibiotic had been chosen, dose, frequency and duration plus clinical condition. I think this can lead to a more rational prescribing of antibiotics…"
> (Resident doctor 19, Emergency medicine)

Notably, a number of pharmacist participants complained that they have a limited role in relation to such activities and considered this as a barrier to their practice. They had not had any training on antimicrobial auditing and were not aware of any self-monitoring tools to audit their own performance (see Interventions needed theme).

> "In pharmacy, there is a lack of auditing antibiotic prescriptions and immediate action... It is important to audit prescribing to assess how compliant the practitioners are in relation to the local guidelines and take the necessary actions based on the findings. Also sharing data on

antibiotic prescribing and bacterial resistance with prescribers is really important in AMS. We don't do this…"
(Clinical pharmacist 511, Ambulatory care)

"...mostly the monitoring would be about the effectiveness of the medication in treating the infection. Also making sure it is not affecting any of the functionality of the patient or functionality of the organs. That's it. For my own antimicrobial practice, there is no definite monitoring tools for personal practices. Also, I am not sure about any training provided in relation to this."
(Staff pharmacist 470, Cardiology)

5.4.2.3 Component 3: Self-efficacy

Domain 6: Knowledge (an awareness of the existence of something) (104)

a. <u>Knowledge about the guidelines and AMS practice</u>

Influences on antimicrobial prescribing practice included knowledge of the current local prescribing guidelines. Participants asserted that they knew about the existence of the current local guidelines which are tailored to national antimicrobial susceptibility data and resistance patterns. They were also aware that inappropriate prescribing practice (i.e. outwith the guidelines) increases AMR and its negative consequences, including high healthcare costs due to longer hospital stays and drug usage.

"We use the guidelines because they are based on the local resistance patterns. For example, if you got a really sick patient coming in, you are giving them the best therapy based on the local resistance prevalence by using the guidelines…"
(Senior consultant doctor 514, Microbiology)

"You know the antimicrobial resistance rate varies from year to year… If the guidelines are not used and there is an overconsumption of certain antibiotics, for sure we will see a kind of a surge in the resistance rates to those antibiotics… As a result, more problems will be emerged, such as increased cost and length of treatments."
(Senior clinical pharmacist 471, Cardiology)

Several participants, however, were not aware of how to find the guidelines in the Intranet and, as a result, used other international resources or followed their peers' prescribing practices. In many instances, they reported a lack of educational/orientation sessions for clinicians, especially juniors, around the use of guidelines and AMS (see Domain 3: Environmental context and resources). This was perceived as a significant limitation in relation to self-efficacy and optimum practice, as described in Domain 8: Beliefs of capabilities.

> "To be honest, I do not know where are the HMC guidelines in the Intranet and I do not routinely use them. I usually use international guidelines such as the Sanford Guide, if I need to, or other resources… We didn't get any orientation or education about using the HMC guidelines. I heard about it from my peers by chance."
> (Resident doctor 13, Family medicine)

> "I feel many physicians are not aware about the presence of the guidelines, specially the new residents who joined the HMC recently. They don't know even how to reach it. So, I would highly recommend that they should get regular orientations or CPD events about the available guidelines or policies and how to reach them. Having a specific training about AMS practice, and the local antibiogram and resistance rates will also help in improving antibiotics prescribing and dispensing… This is the main barrier."
> (Clinical pharmacist 6, ID)

Domain 7: Skills (an ability or proficiency acquired through practice) (104)

Most participants identified a range of skills which they used during their antimicrobial prescribing practice, including counselling, and verbal and nonverbal communication skills. Competence in these skills was considered as important and enhancing self-efficacy.

a. <u>Patient counselling skills</u>

Participants highlighted that they exhibited good use of counselling skills and patient education when prescribing, resulting in increased self-efficacy through abilities to provide appropriate antimicrobial practice and help patients to achieve desired health outcomes. They spoke about several patient counselling

strategies, such as active listening, explaining about the potential consequences of non-adherence and providing additional teaching resources. Some pharmacists described having appropriate counselling skills gained from their academic education/training for example from QU, College of Pharmacy, and explained how they would use these when dispensing antibiotics.

> "I will not prescribe antibiotics irrationally when the patients demand them, even if thy fight with me… I would talk with them, listen, address their concerns and explain that antibiotics do not work on viruses. This can promote resistance and lead to higher medical costs, prolonged hospitalisation and increased adverse events."
> (Resident doctor 19, Emergency medicine)

> "I feel like I am having a good counselling skill, especially in outpatients when it comes to dispensing antibiotics. Also, I provide resources or video links to assist patients who may have further questions once they leave the pharmacy. These are important skills gained from our academic background back at Qatar University, College of Pharmacy."
> (Junior pharmacist 9, Obstetrics & gynaecology)

b. <u>Effective communication between clinicians</u>

Some participants articulated that effective communication skills, such as listening and negotiating skills between peers has a major influence on their antimicrobial prescribing practice. Competence in these skills was viewed as essential in facilitating self-efficacy in practice, for example in negotiating with other team members when deciding whether an antibiotic is needed or not.

> "…I think the communication and discussion with other peers in the multidisciplinary team is essential in developing the care plan for each patient's antimicrobial therapy… It is mainly through listening and responding, discussing the patients' cases together, and negotiations to reach an agreement."
> (Associate consultant doctor 28, Internal medicine)

Others felt that poor levels of interpersonal communication and networking sometimes exist with clinicians outside the facility due to different practice settings, and viewed this as a barrier to self-efficacy and effective practice. In

addition, communication issues, specifically between doctors and pharmacists in relation to prescribing decisions, were frequently reported (see Domain 9: Memory, intention and decision processes).

> "…communication skills are not perfect here. The problem is that we are stretched to specific hospitals. I think if we have a better coverage of other HMC hospitals, interpersonal communication will be improved. Personal relations and good communication with other prescribers are really helpful in AMS."
> (Resident doctor 13, Family medicine)

Domain 8: Beliefs of capabilities (acceptance of the truth, reality or validity about outcomes of behaviour) (104)

a. Confidence and self-belief

As in Chapter 4, participants believed themselves capable and were generally confident in their own abilities to prescribe/dispense antimicrobial therapy and care for patients with infection. This was due to experience in the clinical area and the availability of the hospital guidelines as a useful reference, including local antibiogram reports to guide empirical therapy.

> "…we have guidelines in place. We have our local antibiogram in place and we, you know, follow a kind of a structural clinical thought process… So, we feel like, really, we are good and feel confident at what we are doing."
> (Senior clinical pharmacist 471, Cardiology)

> "Well… I had many PharmD rotations e.g. in infectious diseases department so I have exposed to too many cases… this helped me to understand different infectious diseases and be more confident with regards to the antimicrobial choices."
> (Clinical pharmacist 469, Otolaryngology)

A minority of junior doctors and pharmacists had doubts about their clinical knowledge and capabilities (see Domain 6: Knowledge) in relation to antimicrobial prescribing practice and, hence, sought advice from their seniors. Again, this was attributed to the limited AMS training/education sessions offered by the institution (see Domain 3: Environmental context and resources).

"It is just the clinical practice that we are doing… I don't have a specific knowledge or training in relation to antimicrobial stewardship which I'm following or practising… Sometimes I just say 'sorry I am not sure' and refer to my seniors. This varies according to the clinical condition, the practice setting and the team we are dealing with."
(Clinical fellow 21, ID)

Domain 9: Social/professional role and identity (a coherent set of behaviours and personal qualities of an individual in a work setting) (104)

All participants displayed a strong sense of professional identity and were clear about their roles and scopes of practice within hospitals, due to their professional education and clinical expertise. They were also aware of the role of the AMS Committee in influencing antimicrobial prescribing practice, providing education about the dangers of inappropriate prescribing and raising awareness about AMR. Nevertheless, the limited roles of clinical microbiologists and pharmacists in AMS practice were seen as significant barriers. Expanding and enhancing these roles was seen as having the potential to make an important impact on self-efficacy, minimise inappropriate prescribing practice and ultimately improve patient outcomes.

a. <u>Professional obligation to prescribe/dispense antimicrobials appropriately</u>

Many participants saw themselves as professionally responsible or obligated to prescribe antimicrobial agents appropriately and described how this responsibility influenced their self-efficacy and prescribing practice. Key roles supporting appropriate practice included: using the local guidelines to guide antimicrobial prescribing and being an educator of other clinicians.

"Mainly prescribing antibiotics appropriately, using the guidelines and educating others… We have to educate other clinicians about the concept of antibiotic stewardship. This is one of the most important responsibilities of the prescribers… To ensure the good practice of other clinicians and if it is not optimum, education should be provided."
(Associate consultant doctor 28, Internal medicine)

"As a clinical pharmacist, I have to review my patients' list every day to see who is on antibiotic and make sure that antibiotic has been selected

> appropriately, right drug, right time, right dose and right duration based on the culture susceptibility. Also, check that there are no interactions with other medications and patients are able to cover the cost etc. Furthermore, my responsibility is to provide education if there is any mistake or malpractice."
> (Senior clinical pharmacist 471, Cardiology)

In contrast to this, two discrete barriers emerged. First, the underutilised role of clinical microbiologists to support appropriate antimicrobial prescribing practice, for example by attendance on daily multidisciplinary ward rounds to advise on therapy. This was attributed to limited collaborative practice between clinicians which could be enhanced through better networking and multidisciplinary teamworking (see Domain 4: Social influences). Participants felt that there was potential to utilise further the expertise of microbiologists and engage in more AMS activities, including education of clinicians about appropriate prescribing, production of an annual antibiogram reports and revision/update of local guidelines.

> "I think the barrier for me really would be that the microbiologist role in the antimicrobial prescribing process is very limited here. It's mostly laboratory and microbiology reports. There is a more proactive role can be done. I think it is a wasted opportunity really because microbiologists can offer a lot in AMS. They can certainly support the infectious diseases much more, go on the rounds and give sorts of clinical advice. They can also provide education, produce antibiogram reports for infection control purposes and review the guidelines. In this kind of setting, there are about four maybe five of us who got some UK training and background, we're not using our skills to the full extent because it's very much infectious diseases lead. There's no sort of joined up or collaborative approach."
> (Senior consultant doctor 514, Microbiology)

Second, the limited scope of pharmacists as an integral part of the AMS team and their under-recognised education/training capabilities. It was perceived that pharmacists are mainly involved in reviewing prescriptions and dispensing medications, rather than offering practical prescribing advice on appropriate antimicrobial prescribing decisions, for example in daily ward visits, educating

healthcare professionals, raising awareness about AMR and promoting adherence to guidelines. Participants emphasised the need to recognise the unique skills and expertise that pharmacists can provide to ensure the optimal prescribing/use of antimicrobial agents in all hospital specialities and departments (see Domain 9: Memory, attention and decision processes).

> "Pharmacists have to be more involved in AMS practice and help the doctors in choosing the best antimicrobial regimen. Also, raising awareness about AMR, providing education for other clinicians and developing hospital policies. This should be led by the pharmacists because they are drug experts, and they have specific knowledge about the pharmacology of medications and mechanisms of actions etc. They fully understand the complications of using inappropriate medications, wrong doses or durations. That is why I think pharmacists are underutilised and have to be more involved in AMS across HMC hospitals, not just dispensing medications or giving recommendations."
> (Senior pharmacist 501, Obstetrics & gynaecology)

b. <u>The role of the AMS Committee in the facility</u>

Most participants acknowledged the valuable role of the institution AMS Committee in promoting appropriate antimicrobial prescribing practice, including monitoring/evaluating antimicrobial consumption and resistance rates among hospitals, providing education and awareness related to AMS and updating the local guidelines. Some participants explained that most AMS meetings and educational events are restricted to committee members only which hindered their practice.

> "I'm a member of the AMS Committee and one of the important things that we do is generating an annual facility cumulative antimicrobial resistance report. This does inform our local prescribing guidelines… Whether it is still fit for purpose or whether anything does need changing."
> (Senior consultant doctor 514, Microbiology)

> "As a pharmacist member of the AMS Committee, I monitor the antibiotic consumptions using the defined daily dose method, participate in updating the guidelines and involved in some educational activities. Also,

> involvement in quality indicators on an annual basis and present that to the institution committee, and to the pharmacy and therapeutic committee at our site."
> (Senior clinical pharmacist 471, Cardiology)

> "…there are regular AMS Committee meetings, sponsored educational workshops and events… But they are restricted for the committee members only. Other clinicians can't attend these activities and depend on self-learning. So, I think if these AMS activities are available for free for every clinician to attend, this would be great."
> (Clinical pharmacist 6, ID)

5.4.2.4 Additional domains and themes

Analysis revealed further domains and themes unrelated to those identified in the PCA in Chapter 4.

Domain 10: Memory, attention and decision processes (retain information, focus selectively and choose between alternatives) (104)

a. <u>Antimicrobial prescribing decisions</u>

Many participants stated that antimicrobial prescribing decisions are made based on the local guidelines, patients' current clinical situation and any pre-existing morbidities. Some reported that the severity of illness (e.g. patients admitted to the emergency department) and perceived risk of disease progression (e.g. surgical patients receive antibiotic prophylaxis when not needed) could result in treating more readily with antibiotics to protect patients from future illness deterioration. Another issue reported was diagnostic uncertainty, sometimes due to the time taken to obtain culture results, when doctors have less information to assess a clinical situation compared to situations in which quick diagnostic information would be available, which in turn leads to the decision to prescribe antibiotics.

> "In every preparation, we have to see if the antibiotic is rightly prescribed, rightly indicated and rightly dosed, based on the patient clinical situation. Occasionally, we have patients who are not only cardiac, they are renal and hepatic too… So, we would dispense the antibiotic according to that… Mostly we use the guidelines to guide us or to find a specific information

needed. I think the guidelines make it easier for us to make a decision" (Staff pharmacist 470, Cardiology)

"Barrier is the overprescribing by some emergency department doctors who usually prefer to use broad-spectrum empiric antibiotics and insist on this, just because their patients are very ill and admitted by emergency care services. We are also struggling in implementing the guideline among the doctors in post-surgery. They are worried about patients' complications or illness deterioration. That's why they prescribe antibiotic prophylaxis when they are not needed. I feel like ashamed that we are not following the evidence-based practice appropriately with regards to antibiotics."
(Clinical pharmacist 469, Otolaryngology)

"Many times, we have a delay in having the microbiology lab results. For example, the respiratory pathogen panel may take three to five days to have the final results. During this time, I have difficulty to approve or disapprove the empiric antibiotics prescribed by the primary team… This is because I do not know what the patient exactly has."
(Associate consultant doctor 14, ID)

Whilst doctors had no comment on this, many of the pharmacists interviewed expressed concerns about the conflict between doctors (perceived as the writers of prescriptions) and pharmacists (perceived as drug experts), especially in making the final prescribing decisions and the difficulties in intervening once a prescription for an antibiotic was written. They felt that antimicrobial prescribing decisions are predominantly considered as a medical responsibility and controlled by doctors, with pharmacy only assisting, which deterred pharmacists' AMS practice. The dominance of the medical profession was seen as being due to the lack of pharmacists' legal authority to prescribe medication in Qatar. Talking about this issue, some stressed the importance of legislative changes to allow qualified pharmacists to train and practise as independent prescribers in Qatar, which in turn could enable more informed clinical decisions, and improve AMS practice and patient outcomes (see Interventions needed theme).

> "I'm not a prescriber… At the end of the day, doctors have the final prescribing decision or doctors insist on certain practices. Sometimes they tell us that 'I am the doctor here and you are the pharmacist, that is it'. With no disrespect to doctors, they think that antibiotic prescribing is only a medical responsibility. This is really challenging for us and it's hindering our practice. Personally, I think this needs to be changed in order to enhance AMS."
> (Junior pharmacist 9, Obstetrics & gynaecology)

> "One of the main barriers is basically that I'm not the final decision maker. I only take part in the prescribing decision-making process, but the final decision is made by the doctors. We don't have a privilege to prescribe here in Qatar, you know, we only recommend to the team during our review on the discharge, the admission process or even during the hospital rounds. I think if the certified pharmacist prescribers are legally entitled to prescribe medications, that would address a lot of the issues encountered every day in the hospital."
> (Clinical pharmacist 511, Ambulatory care)

Interventions needed (this emerged as a separate key theme, as well as being part in some other key themes)

Finally, the need for interventions to support AMS was identified particularly in the conclusion section of the interview which focused on this, but participants spoke about the need for specific interventions throughout the interviews. Different types of interventions were suggested as possibly being effective, including AMS educational/training activities (online and within the practice setting) and changes to local guidelines. There was a sense among participants that such interventions may provide an appropriate way to support AMS practice in the facility and reduce the emergence of AMR over time.

a. <u>Need for ongoing education and training</u>

Participants at all levels of seniority in medicine and pharmacy identified the need for more continuing educational activities, such as face-face workshops and e-learning resources for clinicians on conducting AMS research, using the local guidelines, and appropriate AMS practices such as prescription audits. They also

recommended organising regular national antibiotic awareness campaigns at patient/community level and distributing printed educational materials, such as brochures and leaflets to address the local AMR issues. In addition, there were some suggestions about the need for enhanced organisational support/funding for pharmacists to undertake independent prescribing courses to qualify as independent prescribers. This was seen as empowering pharmacists to contribute confidently to antimicrobial prescribing decisions and take prominent roles in AMS.

> "I think providing education about doing research and the different types of research methods is vital. We need more staff to conduct regional research on hospital AMS to answer the research questions arising from the local clinical practice and address any gaps in knowledge. This will definitely have some sort of positive impact on antibiotic use, patient outcomes and economic outcomes."
> (Staff pharmacist 470, Cardiology)

> "I hope that the institution encourages pharmacists to participate in accredited independent prescribing courses and provides the needed fund. These courses are taught mostly online, and focus on preparing pharmacists to play a key role as members in AMS and manage fully patients' medications as an independent prescribers. That is really important in order minimise the risk of prescribing errors."
> (Senior clinical pharmacist 471, Cardiology)

> "Personally, I would like to raise the point about the need of training doctors, especially juniors, on using the guidelines. It's not a matter of having guidelines and people are not aware about how to use it in the right way or where to find it. I think it's important that we, as doctors, get oriented on the available guidelines rather than just get thrown into the wards where we automatically learn with time. Also, we need to have more CPD lectures, e-resources and workshops, on a frequent basis, with regard to AMS and antibiotics mechanisms of action… hold bigger public campaigns… use leaflets and brochures to promote rational use of antibiotics, and improve patient understanding of AMR."
> (Resident doctor 17, Internal medicine)

b. Need for guidelines changes

Most participants who were familiar with the current hospital guidelines advised making what they considered necessary changes. These included frequent updates, additional details (e.g. monitoring parameters and IV to oral conversions), and an improved, attractive layout with coloured tables and diagrams to try to ensure that the guidelines are more widely used. In their accounts of difficulties with guidelines access, participants proposed making the guidelines available as a smart phone application like the Sanford Guide to Antimicrobial Therapy mobile app (198). It was felt that this would improve guidelines compliance. Tailored guidelines for each hospital/area of practice were also recommended to reduce inappropriate prescribing practice and improve guidelines compliance.

> "We need a guideline that is updated frequently, enriched with more details with regard to the monitoring parameters or changing from IV to PO, and tailored from site to site or hospital. Now, it's a kind of an HMC general policy. I recommend to have a sort of tailored guideline that includes the majority of infections per site, rather than, per institution or at the corporate level. This would be very helpful in guiding the choice of antibiotic therapy and decreasing the inappropriate prescribing behaviours."
> (Clinical pharmacist 6, ID)

> "The guidelines' PDF document has a traditional classic layout, around 30 to 40 pages. The layout should be like, let's say, more modern and attractive to look at, using coloured tables, diagrams, graphs or charts. These can be easier to read. The formal way in developing the guidelines makes people not interested to use it… No time."
> (Associate consultant doctor 14, ID)

> "I think the accessibility needs to be improved. We need to consider getting an antibiotic guidelines application which is downloaded to clinicians' mobile phones, like the Sanford because people can't always find the guidelines. When they do find them, you know, it is difficult to find a computer. The mobile application is handy, you can access it anytime even at the patient's bedside. This is something that we used in the

previous organisation that I worked with and it did improve compliance. So, I think that would go a long way in HMC."
(Senior consultant doctor 514, Microbiology)

5.4.3 Interrelationships between themes

A conceptual diagram display was created as a visual representation of relationships in interview data (Appendix 5E). Creating this display aided the doctoral researcher in comparing and relating different key themes, facilitated by using different colures to clarify relationships. In addition to providing a presentation tool, the development of a visual display promoted deeper thinking on how the various themes relate to each other, as described by Bazeley (199).

5.4.3.1 Links between Goals and Intentions; Environmental context and resources; Social influences; Beliefs of consequences; Knowledge; and Beliefs of capabilities (red text in Appendix 5E)

Use of the conceptual diagram helped to identify links between 'Following of the guidelines', 'Hospital guidelines and electronic system', and 'Professional hierarchies'. A clear association was also found between 'Consequences of COVID-19 on antimicrobial practice', and 'Staffing, workload and time pressure'. Similarly, there was a link between 'Knowledge about the guidelines and AMS practice', and 'Confidence and self-belief'.

Participants considered the guidelines as a useful reference, yet deviations were justified by perceived deficiencies in guidelines and electronic systems, lack of education/training in relation to the use of the guidelines and appropriate AMS practice, the prescribing habits of senior peers, and COVID-19-related workload.

5.4.3.2 Links between Memory, attention and decision processes; Social influences; Skills; and Social/professional role and identity (orange text in Appendix 5E)

The conceptual diagram also helped to identify that 'Multidisciplinary teamworking and relationships', 'Effective communication between clinicians', and 'Professional obligation to prescribe/dispense antimicrobials appropriately' are related to 'Antimicrobial prescribing decisions'.

For many participants, the decision whether or not to prescribe was attributed to the aforementioned influences. Participants also expressed views about the

limited roles of microbiologists and pharmacists in the prescribing decision processes, and suggestions were made for expanding these roles to support appropriate antimicrobial prescribing practice. In addition, legislative changes were recommended to allow pharmacist independent prescribing in Qatar.

5.4.3.3 Links between Interventions needed; Goals and Intentions; Environmental context and resources; Behavioural regulation; and Memory, attention and decision processes (green text in Appendix 5E)

This leads to the theme 'Interventions needed', which was clearly articulated throughout. Participants suggested the need for further education/training and guidelines changes to improve antimicrobial prescribing practice, and reduce AMR.

The need for interventions emerged as a separate theme, as well as being linked to others including 'Continuing education and training', 'Hospital guidelines and electronic system', 'Monitoring, auditing and feedback activities', and 'Antimicrobial prescribing decisions', again demonstrating complexity and inter-linking of influences.

5.5 Discussion

5.5.1 Statement of key findings

The aim of the qualitative Phase 3 of this research was to expand on and elucidate the quantitative findings of Phase 2 (Chapter 4), and specifically to explore the determinants of clinicians' antimicrobial prescribing behaviour in Qatar.

Semi-structured interviews with doctors and pharmacists in 12 secondary and tertiary care hospital settings in the State of Qatar showed that antimicrobial prescribing is a complex process, influenced by a broad range of behavioural determinants and that such determinants are interrelated. Ten TDF domains were identified as key determinants of prescribing behaviour: 'Goals and Intentions', 'Beliefs of consequences', 'Environmental context and resources', 'Social influences', 'Behavioural regulation', 'Knowledge', 'Skills', 'Beliefs of capabilities', 'Social/professional role and identity', and 'Memory, attention and decision processes'. One additional key theme unrelated to the TDF, was that of 'Interventions needed'.

In-depth analysis identified several barriers and facilitators that may result in inappropriate or appropriate antimicrobial prescribing behaviour. The main barriers identified were around hospital guidelines and electronic system deficiencies (environmental context and resources), gaps in knowledge in relation to guidelines and appropriate prescribing (knowledge), professional hierarchies and poor multidisciplinary teamworking/relationships (social influences), restricted roles/responsibilities of microbiologists and pharmacists in AMS (social/professional role and identity), and discomfort around antimicrobial prescribing decisions (memory, attention and decision processes). Key facilitators identified include guidelines compliance goals and intentions, as well as the beliefs of consequences of appropriate or inappropriate prescribing. Further education and training sessions, and some necessary changes to guidelines were considered crucial.

Analysis including the preparation of a conceptual diagram (Appendix 5E) also identified several interrelationships between themes, demonstrating and illustrating the complexity of prescribing behaviour in antimicrobial practice. To give one example, inappropriate decisions to prescribe antibiotics (memory, attention and decision processes) were linked to poor multidisciplinary teamworking/relationships (social influences), lack of effective communication between clinicians (skills), and restricted roles/responsibilities of microbiologists and pharmacists in AMS (social/professional role and identity).

The understanding of this complexity provided by this phase of research may contribute to the design and development of theoretically-based BCIs to improve clinicians' antimicrobial prescribing practice (see Chapter 6). Findings may also be used by clinicians to aid understanding of barriers and facilitators to enhancing their own appropriate prescribing practice.

5.5.2 Strengths and limitations

This study has a number of strengths. As highlighted in a recently published systematic review (Phase 1) presented in Chapter 3, only a few studies have used theory to study antimicrobial prescribing behaviour and none was carried out in the Middle East or targeted pharmacists (117). Therefore, this study has provided an original contribution to knowledge. By using the TDF to inform data collection, analysis and reporting, key behavioural determinants which may be

used as future intervention targets have been identified. In addition, this study is reported according to the COREQ guidance (153). Another strength of this study is the qualitative interview-based approach which allowed participants to share in detail their personal views of antimicrobial prescribing practice and others' performance. An additional strength is that prescribing practice was investigated from the perspective of both doctors and pharmacists who collaborate and depend on each other in daily practice. Interviewing these two key groups of stakeholders ensured that the findings provide a valuable insight into influences of antimicrobial prescribing in hospitals, as well as potentially informing the design and development of successful interventions in the future (see Chapter 6). Data saturation was achieved using a validated, evidence-based approach (143), thereby, enhancing credibility (see Chapter 2). Furthermore, a number of other strategies were taken to promote research trustworthiness as a measure of research quality, particularly credibility, confirmability and dependability and, therefore, rigour (145, 148). These included the following:

- offering participants in Phase 2 the opportunity to participate in Phase 3
- ensuring appropriate training of the interviewer by means of participation in research ethics and integrity, and qualitative data analysis training courses
- use of different sites (12 HMC hospitals)
- piloting the data generation tool prior to use
- allowing member checks of data collected
- independent data analysis by more than one research member
- mapping the analysis to the TDF domains and PCA components (Phase 2)
- describing in detail the research design, data gathering and analysis
- use of *verbatim* quotes to support themes described
- use of a reflexive and reflective approach including attention to the doctoral researcher's background and consideration of study limitations

There are, however, a few limitations to this study and, as such, findings should be interpreted with caution. First, the data were generated in the State of Qatar and the findings may not be transferable to other countries. Nevertheless, the research settings, methods and participants were described in detail to allow readers to consider transferability to their organisation (145, 148). Second, it is possible that those expressing interest to participate were not representative of

all clinicians (i.e. selection bias). This was mitigated by the broad sampling approach of different health professions, with a variety of experiences, working in a range of practice settings and in a wide range of medical conditions. There could also have been social desirability bias where participants give the answer they feel the researcher wants to hear (200), but participants appeared to speak freely and honestly about their own practice. Their reports that antimicrobial agents are often prescribed outwith the local guidelines, are testament to that. Although the views expressed were overall very open, the interviews were conducted during the COVID-19 lockdown and this may have affected participants' answers due to time constraints or workload, and may have resulted in participants feeling less able to reveal certain information. This may also have excluded some participants who did not feel comfortable with or have access to the technology required.

In addition, issues of reflexivity could have impacted on the conduct of all stages of the research. Participants knew that the doctoral researcher was a pharmacist trained in HMC and this knowledge may have influenced their answers (201). However, the doctoral researcher was aware that her clinical background/experience was likely to influence her research and, as a result, she explained her role as a researcher before each interview as well as maintained a position of neutrality throughout (202). For example, if participants seemed to seek her personal opinion or beliefs she would reply 'Let's talk about this later' or any similar neutral response.

5.5.3 Comparison with other studies

To our knowledge, this study is the first to use semi-structured interviews and the TDF to identify the determinants that influence clinicians' antimicrobial prescribing behaviour in the hospital setting and to explore, and to explore barriers and facilitators to appropriate practice. However, this approach has been used successfully in Australia and UK primary care (203, 204).

Further, this study was the qualitative part of a mixed-methods programme of research and, thus, extends the knowledge base beyond the quantitative findings (see Chapter 4). In particular, this study identified three additional key determinants of antimicrobial prescribing behaviour which appeared to act as barriers to appropriate practice. In addition to 'Environmental context and

resources' and 'Social influences', these were: 'Knowledge', 'Social/professional role and identity', and 'Memory, attention and decision processes'.

Overall, there are some similarities between the findings of this study and other qualitative studies of antimicrobial prescribing within hospitals, although these studies lacked a robust theoretical underpinning. Previous studies identified some similar barriers which were key issues in relation to appropriate antimicrobial prescribing practice. For example, a systematic review of 35 published qualitative studies exploring clinicians' antimicrobial prescribing behaviour in both primary and hospital care reported that the prescribing process is complex, based on a host of factors that affect the decision-making process. Dominant among these, according to the authors, are physicians' lack of knowledge, perceived risk of possible future complications, diagnostic uncertainty and patient pressure/expectation (43). A further systematic review of 10 qualitative and quantitative studies on antimicrobial prescribing behaviour in acute care highlighted the dominant influence of senior clinicians (recognised as 'opinion leaders') on antimicrobial prescribing practice of juniors, including on the use of guidelines. (40). These findings are consistent with more recent qualitative work conducted in UK hospitals (38). Similarly, poor multidisciplinary collaboration and communication were cited as barriers in previous studies (186, 205, 206).

Studies also highlighted some similar facilitators, including education and training on appropriate antimicrobial prescribing and AMR (207-209), and guidelines changes in relation to access and content (210-212).

It is important to note that, however, none of these studies had adopted the TDF or similar theoretical framework. The use of the TDF in this study identified additional barriers and facilitators which are crucial for the development of future interventions to improve antimicrobial prescribing, such as the restricted roles/responsibilities of microbiologists and pharmacists in AMS (social/professional role and identity). Within these barriers and facilitators, many interrelationships were also identified.

Several studies have found that interventions targeting factors/determinants influencing antimicrobial prescribing behaviour are likely to be more effective (see Chapter 1) (32, 50, 213). As described in Chapter 2, the determinants identified (i.e. TDF domains) in this study can be mapped to relevant evidence-

based BCTs, through use of the BCTTv1 (113, 114). The BCTs mapped to 'Environment context and resources' and 'Social influences' are as described in Chapter 4. Those relating to 'Knowledge', 'Social/professional role and identity', and 'Memory, attention and decision processes' are outlined in Table 5.5 below.

Table 5.5: Mapping the determinants of antimicrobial prescribing, identified in Phase 3, to relevant BCTs (113, 114)

TDF determinant	BCT	
	Label	Definition
Knowledge	Instruction on how to perform a behaviour	Advise or agree on how to perform the behaviour
	Feedback on behaviour	Monitor and provide informative or evaluative feedback on performance of the behaviour (e.g. form, frequency, duration or intensity)
	Information about health consequences	Provide information (e.g. written, verbal, visual) about health consequences of performing the behaviour
Social/professional role & identity	Identification of self as role model	Inform that one's own behaviour may be an example to others
	Valued self-identity	Advise the person to write or complete rating scales about a cherished value or personal strength as a means of affirming the person's identity as part of a behaviour change strategy
	Social comparison	Draw attention to others' performance to allow comparison with the person's own performance
Memory, attention & decision processes	Pros and cons	Advise the person to identify and compare reasons for wanting (pros) and not wanting to (cons) change the behaviour
	Problem solving	Analyse, or prompt the person to analyse, factors influencing the behaviour and generate or select strategies that include overcoming barriers and/or increasing facilitators
	Instruction on how to perform a behaviour	Advise or agree on how to perform the behaviour

BCTs, behaviour change techniques; TDF, Theoretical Domains Framework

Further research is warranted to identify which BCTs could be utilised to target the identified TDF determinants that influence clinicians' antimicrobial prescribing, and then to pilot/test the feasibility of theoretically-based interventions in Qatari healthcare practice (see Chapter 6).

5.6 Conclusion

This qualitative study, using a theoretically-based approach, has identified that antimicrobial prescribing in hospitals is influenced by a broad range of behavioural determinants, including specific barriers and facilitators. These determinants can be mapped to likely effective BCTs, facilitating the design and development of future BCIs to improve clinicians' antimicrobial prescribing. The issues of the environmental context and resources, social influences, knowledge, professional role and identity, and memory, attention and decision processes are significant challenges to address. The final chapter (Chapter 6) discusses these findings in relation to those of systematic review (Chapter 3) and cross-sectional survey (Chapter 4).

Chapter 6: Discussion and conclusion

This chapter provides an overview of key findings related to the overarching aim of the programme of research and the existing state of knowledge on the topic. It also provides an insight into the potential evidence-based BCTs that could be used as the basis for the development of future interventions in the area of this research. In addition, the chapter considers the originality of the research, potential impact and future research.

6.1 Aims and key findings

The overarching aim of this research was to identify, quantify and explore clinicians' behavioural determinants of antimicrobial prescribing in HMC, Qatar. The intention was to provide an evidence base that could inform a later programme of research on developing a theoretically-based intervention to improve antimicrobial prescribing behaviour of clinicians in Qatar, initially targeting the HMC hospitals. The research involved three phases, each based upon the findings of the earlier phase, informed by theory and guided by the UK MRC framework for developing and evaluating complex interventions (34). First, a systematic review of the literature (Phase 1) was carried out in preparation for next phases. This was followed by an explanatory sequential mixed-methods design of quantitative (Phase 2: Cross-sectional survey) and qualitative (Phase 3: Semi-structured interviews) approaches, underpinned by use of the TDF (104) and the peer-reviewed, published literature.

6.1.1 Phase 1: Systematic review of literature

Phase 1 aimed to systematically review, critically appraise, synthesise and present the existing evidence on the application and use of theory in the development and evaluation of BCIs designed to improve clinicians' antimicrobial prescribing (Chapter 3) (117). This PROSPERO registered systematic review provides a mapping of the existing antimicrobial prescribing interventions to the phases of the UK MRC framework (34). It also used the TCS (154) to evaluate the extent of the use of theory.

The review identified 10 peer-reviewed, published studies (five quantitative, three qualitative and two mixed methods) meeting all inclusion criteria. Studies were conducted in the UK *(n=8)*, Canada *(n=1)* and Sweden *(n=1).* Most were

carried out in primary care settings *(n=9),* targeting RTIs *(n=8)* and medical doctors, mainly GPs *(n=10)*. There was a notable absence of systematic application of the phases of the UK MRC framework. The most common theories used were: TPB *(n=7),* SCT *(n=5)* and OLT *(n=5).* The use of theory to inform the design and choice of intervention varied, with no optimal use as recommended in the TCS.

The systematic review phase, described above, identified gaps in literature given that few primary studies of interventions to improve antimicrobial prescribing have reported using theory in their development and evaluation. Most were suboptimal in the use of theory and the application of the UK MRC framework. None originated from the Middle East, and none targeted pharmacists. As a result, the findings from this systematic review supported the need for further theoretically-based primary research to be conducted in this area.

It should be noted that some additional primary research studies which match the review eligibility criteria have been published since conducting the systematic review. In 2019, Courtenay et al. (214) described the development of an online learning intervention (i.e. a consultation scenario) focusing on nurses' and pharmacists' determinants of antibiotic prescribing for RTIs in UK primary care, identified from previous research (204). In this work, a three-stage, eight-step method was applied to describe intervention content, intervention functions, mode of delivery and policy categories. A sister study (215) tested the feasibility of that intervention (i.e. recruitment, response, attrition and accessibility) in 2020 using a pre-post online survey and semi-structured telephone interviews with 15 prescribers who consented to be contacted after taking part in the previous research. It was found that although the information in the intervention was not new to prescribers, the intervention was acceptable and useful to them, for example in helping them refresh their memories on the topic, consolidate learning and enable self-reflection.

In 2020, Kronman et al. (216) reported the evaluation of an online, educational intervention (i.e. tutorials, webinars and booster video vignette sessions) on the overall antibiotic prescribing rates by 57 American primary care paediatricians for RTIs. Results indicated a 7% decrease in the probability of antibiotic prescribing

overall between the baseline and postintervention periods (adjusted rate ratios [aRR], 0.93; 95% confidence interval [CI], 0.90–0.96).

It is, however, unlikely that these more recent studies would significantly change the systematic review findings outlined in Chapter 3.

6.1.2 Phase 2: Cross-sectional survey

Phase 2 aimed to identify and quantify potential determinants of antimicrobial prescribing behaviour in HMC, Qatar, using the TDF (Chapter 4) (112). A cross-sectional survey methodology (i.e. a quantitative approach), using an online questionnaire data collection tool, elicited 535 responses from doctors and pharmacists working within HMC hospitals.

PCA showed a three component (C) solution with; 'Guidelines compliance' (C1), 'Influences on practice' (C2) and 'Self-efficacy' (C3). The scales derived for each of these components had high internal consistency (Cronbach's alpha all >0.7), indicating statistical appropriateness for developing scales. Respondents generally scored highly for 'Guidelines compliance' 'and 'Self-efficacy' components. The lowest levels of positive scores were in relation to the items within the 'Influences on practice' component, with particular focus on TDF domains of; 'Environmental context and resources', and 'Social influences'. Inferential analysis comparing component scores across demographic characteristics identified that, in general, doctors, more qualified and those with greater experience were more likely to be positive in their responses ($P<0.05$). This suggests that environmental context and resources, and social influences, with an emphasis on pharmacists and early career clinicians, may be useful targets for BCIs to improve clinicians' antimicrobial prescribing.

6.1.3 Phase 3: Qualitative semi-structured interviews

Phase 3 aimed to explore the determinants of clinicians' antimicrobial prescribing behaviour in HMC, Qatar (Chapter 5). This qualitative phenomenological approach provided more depth to and elucidated the quantitative findings presented in the previous phase. Semi-structured, online, video interviews were undertaken via Zoom with 16 doctors and pharmacists (a purposive sample of survey respondents) in relation to the determinants of antimicrobial prescribing. The interview schedule was developed based on the study aim/questions, the

literature presented in the systematic review (Chapter 3), the key findings of the survey (Chapter 4) and the TDF (104).

A number of themes, linked to ten TDF domains, were identified as determinants of antimicrobial prescribing and these determinants were interrelated. In-depth analysis identified several barriers and facilitators that may contribute to inappropriate or appropriate antimicrobial prescribing. The main barriers identified were around hospital guidelines and electronic system deficiencies (environmental context and resources), gaps in the knowledge in relation to guidelines and appropriate prescribing (knowledge), professional hierarchies and poor multidisciplinary teamworking/relationships (social influences), restricted roles/responsibilities of microbiologists and pharmacists in AMS (social/professional role and identity), and discomfort around antimicrobial prescribing decisions (memory, attention and decision processes). Key facilitators highlighted include guidelines compliance goals and intentions, and the beliefs of consequences of appropriate or inappropriate prescribing. The need for further education and training sessions, and some necessary changes to guidelines were considered crucial.

Taken together, the two research phases (Phases 2 and 3) described above have generated unique findings which extend the knowledge of the determinants (including the barriers and facilitators to appropriate practice) of clinicians' antimicrobial prescribing behaviour in HMC hospitals. The findings can then be used for the development of targeted, BCIs to improve antimicrobial prescribing (see Section 6.2.2).

In summary, Figure 6.1 provides an overview of the methods and key messages from this research. The strengths, limitations and interpretation of findings of each phase have been previously described in detail in their respective chapters. One additional key strength is that the phases are linked, with each conducted based on the findings of the earlier phases.

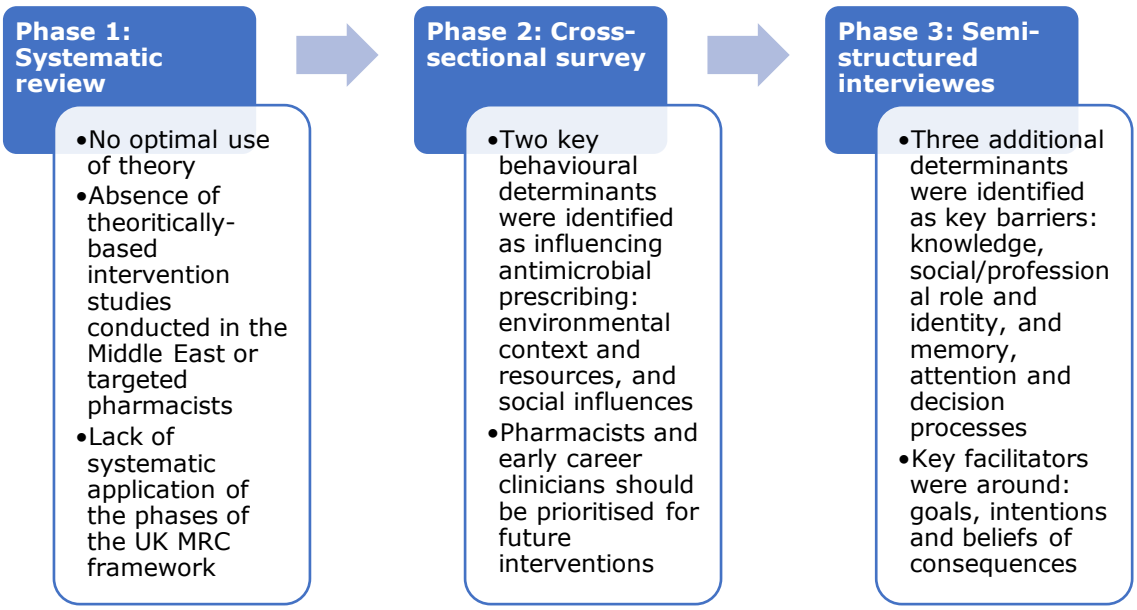


Figure 6.1: Summary of the methods and key messages from the programme of research

6.2 Implications for practice

This section discusses the key research findings in terms of the overall barriers, facilitators, BCTs and the wider literature. These findings have clear implications for practice in relation to the development of interventions to improve clinicians' antimicrobial prescribing behaviour.

6.2.1 Interpretation of key findings

As described in the initial literature review in Chapter 1 (Section 1.2.3), the majority of studies identified in previous systematic reviews of interventions to improve clinicians' antimicrobial prescribing behaviours failed to pay attention to the use of theory to inform the design and choice of their intervention. Authors of two of these systematic reviews recommend that future intervention research should use behavioural sciences to understand the key barriers and facilitators to behaviour change in the target population and tailor interventions to the populations in whom behaviour change is needed (32, 40). This is exactly the approach followed in this research.

The findings of the literature review presented in Chapter 1 taken together with the systematic review presented in Chapter 3 (Phase 1), similarly provide evidence to support using theory to investigate clinicians' antimicrobial prescribing behaviours.

The cross-sectional survey in Chapter 4 (Phase 2), together with qualitative semi-structured interviews in Chapter 5 (Phase 3), identified the determinants of clinicians' antimicrobial prescribing behaviour, which aligned with the TDF domains (104). Categorisation of these determinants into barriers and facilitators to appropriate antimicrobial prescribing is given in Table 6.1, illustrating that antimicrobial prescribing is influenced by a broad range of behavioural determinants.

Table 6.1: Barriers and facilitators to appropriate antimicrobial prescribing identified from Phases 2 and 3 (some were both barriers and facilitators)

Barriers and facilitators	**TDF determinants linked to PCA**	
	Phase 2: Cross-sectional survey	**Phase 3: Semi-structured interviews**
Barriers	C2: INFLUENCES ON PRACTICE ▪ environmental context & resources ▪ social influences ▪ behavioural regulation	C2: INFLUENCES ON PRACTICE ▪ environmental context & resources ▪ social influences C3: SELF-EFFICACY ▪ knowledge ▪ social/professional role & identity ADDITIONAL DOMAINS AND THEMES ▪ memory, attention & decision processes
Facilitators	C1: GUIDELINES COMPLIANCE ▪ goals ▪ intentions ▪ beliefs of consequences C3: SELF-EFFICACY ▪ knowledge ▪ skills ▪ social/professional role & identity ▪ optimism ▪ beliefs of capabilities	C1: GUIDELINES COMPLIANCE ▪ goals ▪ intentions ▪ beliefs of consequences C2: INFLUENCES ON PRACTICE ▪ behavioural regulation C3: SELF-EFFICACY ▪ knowledge ▪ skills ▪ social/professional role & identity ▪ beliefs of capabilities
TDF, Theoretical Domains Framework; PCA, Principal Component Analysis; C, component		

The TDF determinants identified in both phases were considered dominant and will be the focus of the proposed intervention (see Section 6.2.2). Overall, the determinants which were shown to dominate as barriers across Phases 2 and 3 were around environmental context and resources, and social influences, with memory, attention and decision processes also important. Knowledge, and social/professional role and identity were determinants which facilitated appropriate prescribing but they could also act as barriers to this. There is,

therefore, a need to consider these determinants for the development of future interventions to improve antimicrobial prescribing. Further to this, the quantitative data suggest that pharmacists and early career clinicians should be prioritised for future interventions and linked research.

6.2.2 An approach to intervention development

While accepting the limitations discussed in previous chapters, findings can be used to facilitate the development of BCIs to improve clinicians' antimicrobial prescribing.

As described earlier, any intervention developed and implemented with the aim of changing antimicrobial prescribing behaviour would be a complex and challenging intervention consisting of many interacting components (34), known as BCTs, that have the potential to change behaviour (217).

While the relevant BCTs were mapped to the TDF determinants identified in Chapters 4 and 5 separately using the BCTTv1 (113, 114), these are summarised in Table 6.2. These are prime, evidence-based BCTs to provide the basis for the development of a BCI around antimicrobial prescribing, which can then be examined through the feasibility/pilot testing phases of the UK MRC framework prior to evaluation and implementation (see Section 6.5).

Table 6.2: BCTs mapped to the determinants of antimicrobial prescribing, identified in Phases 2 and 3 (113, 114)

TDF determinant	BCT	
	Label	Definition
Environmental context & resources	Information about environmental consequences	Record/provide information (e.g. written, verbal, visual) about environmental consequences of performing the behaviour
	Prompts/cues	Introduce or define environmental stimulus with the purpose of prompting or cueing the behaviour
	Restructuring the physical environment	Change the physical environment to facilitate, or create barriers to, the target behaviour
	Adding objects to the environment	Add objects to the environment in order to facilitate performance of the behaviour
Social influences	Social support (unspecified)	Advise on, arrange, or provide practical help (e.g. from colleagues, 'buddies' or staff) for performance of the behaviour
	Information about health consequences	Provide information (e.g. written, verbal, visual) about health consequences of performing the behaviour

TDF determinant	BCT	
	Label	Definition
	Social comparison	Draw attention to others' performance to allow comparison with the person's own performance
	Restructuring the social environment	Change the social environment to facilitate, or create barriers to, the target behaviour
Memory, attention & decision processes	Pros and cons	Advise the person to identify and compare reasons for wanting (pros) and not wanting to (cons) change the behaviour
	Problem solving	Analyse, or prompt the person to analyse, factors influencing the behaviour and generate or select strategies that include overcoming barriers and/or increasing facilitators
	Instruction on how to perform a behaviour	Advise or agree on how to perform the behaviour
BCTs, behaviour change techniques; TDF, Theoretical Domains Framework		

Accordingly, the interventions which are most likely to be effective in relation to clinicians' antimicrobial prescribing in hospitals should consist of the following evidence-based BCTs:

- providing information via ward rounds, hospital wall posters, leaflets, E-mails, etc. about the consequences of inappropriate prescribing, such as healthcare costs and AMR
- introducing electronic decision support tools, such as computerised alerts and prompts at the point of care to guide with appropriate prescribing
- making some guidelines changes, for example frequent updates, easier access, attractive layout, site specific and mobile application development, supported by EHS, to facilitate compliance
- reducing hospital stock of non-first-line antimicrobial agents, in line with guidelines recommendations
- providing social support, encouragement and reassurance to junior clinicians around organisation-agreed approaches to prescribing including meetings and induction sessions, supported by seniors
- comparing peers' prescribing rates perhaps by showing the clinician the proportion of patients who were prescribed antimicrobials by others and compare with their own data, and using the data to identify underlying reasons for inappropriate prescribing (i.e. nudging)

- sharing local examples of good practice or actions taken by others as part of AMS and arranging regular multidisciplinary AMS learning activities
- standardising the AMS-related roles to avoid interprofessional conflict and ensure a consistent approach to antimicrobial decision-making processes
- deploying adequate number of ID doctors, microbiologists and pharmacists, as part of the AMS multidisciplinary team, in all settings to work more closely with practices and address AMS-related issues

These evidence-based BCTs should become a priority for researchers in order to achieve successful results in relation to AMS interventions.

6.3 Originality of the research

This research is a significant and novel contribution to the limited evidence base of BCIs around antimicrobial prescribing, as highlighted in Chapter 1. Its originality stems from its multimodal methodological approach underpinned by the use of theory to research this area of practice, and the unique insight into antimicrobial prescribing practice in the Middle East. These aspects of originality will be described separately.

6.3.1 The multimodal methodological approach underpinned by the use of behavioural theory

The research adopted both a systematic review of the published literature and an explanatory sequential mixed-method design of quantitative and qualitative approaches, underpinned by the use of behavioural theory (i.e. the TDF), to investigate clinicians' behavioural determinants of antimicrobial prescribing in HMC, Qatar. The research findings were mapped to relevant evidence-based BCTs in order to recommend possible intervention strategies for AMS (see Section 6.2.2). Two key stakeholder groups were targeted: doctors and pharmacists, and two levels of hospital care: secondary and tertiary care. This variation helped to increase the generalisability and transferability of findings to a certain extent, and allow for comparison between different groups (i.e. multi-disciplinary recruitment). As far as is known, this comprehensive, coherent and systematic investigation of antimicrobial prescribing practice, is the first of its kind and has not been investigated anywhere before.

The Phase 1 systematic review was conducted in line with the development phase of the UK MRC framework, which advises researchers to explore the existing evidence base related to the topic of interest and address any gaps (34). The review protocol was prospectively registered on PROSPERO (116), and the systematic review itself published in the Journal of Antimicrobial Chemotherapy (117), which provides clear evidence of originality. This is the first published systematic review focusing on the application and use of theory in AMS interventions. The approaches to data synthesis, using the TCS and mapping the interventions identified to the phases of the UK MRC framework, were also original. The findings from the systematic review added to the limited published studies investigating theoretically-based interventions around antimicrobial prescribing, identified a need for further primary research in this area, and informed and contextualised the focus of the following phases in this research. Aspects of this were: considering carefully how to use and report theory, employing mixed-method design to investigate the theoretical determinants of prescribing which need to be targeted by future interventions, focusing on hospital settings, and incorporating pharmacists.

Again, in line with the development phase of the UK MRC framework (34), Phase 2 and Phase 3 used the TDF as underpinning for a cross-sectional survey and qualitative semi-structured interviews to investigate the determinants of clinicians' antimicrobial prescribing behaviour. Although such behavioural determinants have been studied in previous research (203, 204), as far as is known, the determinants most relevant to hospital-based clinicians had not yet been elucidated using the TDF. The findings from these two phases led to the identification of a wide range of determinants, including barriers and facilitators influencing antimicrobial prescribing behaviour. At the time of writing the PhD thesis, a paper based on the survey has been accepted for publication at the Journal of Hospital Infection (112) and an additional publication focusing on the qualitative study is in development.

Chapter 2 (Section 2.4) identified the advantages of the use of theory in research and highlighted this as an integral step in the UK MRC framework. The TDF, a framework of 33 behavioural theories organised into 14 domains, was used to characterise the potential influences on or determinants of behaviours, throughout the primary research (i.e. in the design of data collection and

generation tools, analysis, and reporting of findings) (104). Using this in conjunction with the literature provided a robust, theoretically-based underpinning likely to strengthen the research (99). It also aided understanding of the complex nature of antimicrobial prescribing behaviour in great detail, identifying the barriers and facilitators to appropriate practice. It is hoped that this will inform the future development of BCIs to improve antimicrobial prescribing.

6.3.2 The unique insight into antimicrobial prescribing behaviours in the Middle East

Another facet of originality in this research is that it sheds light on a geographical setting not investigated in any depth in the literature reviewed to date. While none of the studies reported in Phase 1 originated from the Middle East, Phases 2 and 3 were conducted in the State of Qatar, hence generated original data in this geographical setting. This was important in identifying where Qatar can be placed for AMS and provides a robust and rigorous evidence base regarding the determinants of antimicrobial prescribing behaviour in Qatar, supporting the future development of targeted, theoretically-based interventions that are more likely to be successful (see Section 6.2.2).

While the results overall are limited to the context of Qatar and cannot be readily generalisable, they could be transferable to other countries in the Middle East. This is because the majority of the Middle Eastern countries share similar culture, ethnicity and work practices, as outlined in Chapter 1 (Section 1.3.1). Transferability of the methodological approach may also be applicable to other areas of prescribing practice (i.e. outwith AMS) and other health professions (e.g. nurses, dentists and veterinarians). This is possible as a sufficient description of the details around the research settings, methods and participants was provided to allow readers to consider transferability to their own proposed setting (145, 148).

6.4 Impact of the research

Research impact is 'the demonstrable contribution that excellent research makes to society and the economy through fostering global economic performance, increasing the effectiveness of public services and policy, and enhancing quality of life, health and creative output' (218). The Research Councils UK (RCUK) developed guidance 'Pathways to Impact' that can be tailored by researchers to ensure that potential beneficiaries have the opportunity to benefit from their research (Figure 6.2) (219). This guidance identifies two main levels of research impact: academic impact, and economic and societal impacts. While academic impact refers to contributions to academic advances in understanding theory, methods and application, the economic and societal impacts refer to a broader contribution to individuals, organisations and nations. In light of this, findings of this research will be considered in relation to these two levels of impact.

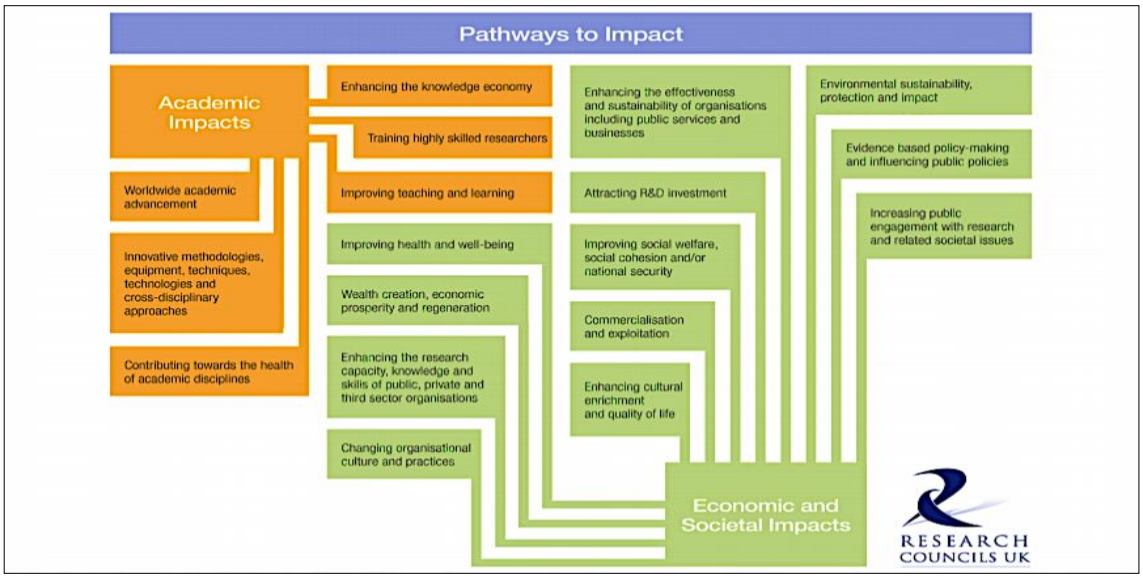


Figure 6.2: The Research Councils UK Pathways to Impact (219)

6.4.1 Academic impact

Conducting this research has impacted the professional development of the supervisory and advisory team members by improving their teaching, learning and research experience. Awareness of the importance and benefit of building research collaboration between and among different academic (i.e. RGU, QU) and non-academic (i.e. HMC) institutions was also enhanced. Presentation of the research findings at national (i.e. the Health Services Research and Pharmacy Practice Conference) and international conferences (i.e. the 5th International

Conference on Prevention and Infection Control), and publication in peer-reviewed journals (i.e. Journal of Antimicrobial Chemotherapy (117) and Journal of Hospital Infection (112)) have added to the body of knowledge around behavioural determinants of antimicrobial prescribing and theoretically-based intervention research. Furthermore, publication of this PhD thesis and additional papers planned will enlighten education, training and wider healthcare practice.

On a personal basis, the doctoral researcher has developed high level knowledge and research skills particularly in relation to different research philosophies, methodologies and methods, use of theory (i.e. the TCS, TDF, BCTTv1), along with communication skills through networking and interacting with other research team members, including clinicians and academic faculty members in RGU and Qatar. In addition, the research has contributed to the fulfilment of a PhD degree in the School of Pharmacy and Life Sciences, RGU.

6.4.2 Economic and societal impacts

The research has also impacted participants (i.e. doctors and pharmacists) involved in antimicrobial prescribing/dispensing in Qatar, through raising awareness of AMR and stimulating reflection on current practice. Doctors and pharmacists are key frontline healthcare professionals who have a vital role in AMS activities and make a crucial contribution to the appropriate prescribing of antimicrobials in a range of specialities, ultimately resulting in optimised patient outcomes. Investigation of the behavioural determinants of their prescribing, including potential barriers and facilitators, will support them in following best antimicrobial practice according to the hospital guidelines. Given that these guidelines are developed based on the local susceptibility and resistance patterns, enhanced compliance will result in safe, effective and cost-effective therapy, improving patient care. This in turn may help to slow the emergence and reduce the spread of AMR in Qatar's hospitals, which are particularly susceptible to harbouring MDR pathogens (12).

On a broader basis, this research has provided new insights to healthcare organisations within Qatar, primarily HMC hospitals, but through dissemination to others, with reference to wider reduction in inappropriate antimicrobial prescribing, combating AMR, saving unnecessary healthcare costs and conserving existing antimicrobial agents (see Chapter 1). It has the potential to improve

Qatar's healthcare system and health services efficiency around AMS, in line with Qatar's National Vision 2030 that recognises the importance of healthcare delivery in a professional and safe environment at appropriate level (75). Findings may also encourage policy makers and regulatory bodies, for example Qatar's MoPH, to reflect, review and develop policies, strategies, guidelines and campaigns in relation to antimicrobial prescribing and AMS programmes. The research may also promote future development of theoretically-based interventions to improve antimicrobial prescribing behaviour of clinicians in HMC, Qatar, which may be replicated more widely in other healthcare settings (e.g. primary care, dental or veterinary practice), and in countries in the Middle East and beyond.

6.5 Future research

It is hoped that the research findings will stimulate future research studies focusing on the key priority areas identified which may promote an improvement in antimicrobial prescribing behaviours and, hence, minimise the progression of AMR. All studies will be aligned to the phases of the UK MRC framework (34) and underpinned by the TDF (104), as described below.

6.5.1 Study 1: Development of intervention

In line with the UK MRC approach, the next step is to design and develop a theoretically-based intervention to improve clinicians' antimicrobial prescribing behaviour within HMC hospitals, in relation to the proposed evidence-based BCTs, mapped to the TDF determinants identified in this research (see Section 6.2.2). Suggestions for the detailed nature of the intervention i.e. content (what will be delivered), modes of delivery (how each selected BCT will be delivered) and targets (which people an intervention will target) should also be considered through the further application of research techniques within HMC. This is essential in order to develop interventions that are designed specifically for the context within Qatar and which will support the translation of the findings of this research into routine practice or policy (34).

By way of example of a BCI resulting from this programme of research, hospital guidelines could be a specific focus for future work. The intervention could relate to frequency of updates, attractive layout, site specific guidelines, and easier access through the development of a mobile application, supported by EHS, to

facilitate compliance. Offering educational/orientation sessions for clinicians around the use of guidelines could also be of benefit.

A consensus-based approach (e.g. nominal group technique) could be used to prioritise and explore these potential aspects of a guideline focussed intervention. This would help consider the key features of the intervention including focus, content, nature and mode of delivery, and target groups.

Although findings suggest that pharmacists and early career clinicians should be prioritised and targeted for any future intervention, it is important to include representation (i.e. purposive sampling) of all involved in antimicrobial practice (i.e. doctors, pharmacists and nurses) at all levels of qualification, experience and seniority. Health profession leaders and policy makers should also be included to allow the engagement of a broad range of individuals most likely to contribute to the achievement of the study aim and provide valuable insights from a wide range of perspectives. A snowball sampling method could also be considered to identify the most appropriate individuals to be included and make sure that no key individuals have been omitted.

Following intervention development, feasibility and pilot testing should be carried out to ensure that the intervention would be delivered as intended. This is important as it may detect any weaknesses and lead to modifications before embarking on an expensive or lengthy evaluation study (34).

6.5.2 Study 2: Feasibility testing

This study would test the feasibility of the intervention using a qualitative, phenomenological approach with clinicians to explore the likely feasibility. It would aim to explore clinicians' perspectives of the intervention which was designed to improve antimicrobial prescribing behaviour in HMC hospitals. While several methods may be appropriate, a focus group method is likely to be the most appropriate since such a method is central to providing an opportunity for participants to discuss issues between each other (93, 94). Sampling would be purposive to include a range of participants who are most likely contribute to data generation (i.e. excluding those involved in Study 1). Recruitment would continue to the point of data saturation when no new themes emerged from data analysis, as explained earlier (see Chapter 2) (143). Following transcribing,

analysis would be thematic using a Framework Approach, as described in Chapter 5.

The findings are likely to provide an in-depth understanding of the likely feasibility, accessibility, usability and usefulness of the intervention prior to pilot testing and larger scale evaluation studies. Additionally, insights into the major feasibility issues associated with implementation of the relevant BCTs would be elucidated. These could be used to reflect on the intervention and modify if required.

6.5.3 Study 3: Pilot testing

A pilot testing study should then be carried out, using a quantitative, uncontrolled before and after (also known as pre–post) approach. This is an external pilot with the data not being incorporated as part of future evaluation. Before and after studies are convenient, less expensive, relatively simple to conduct and superior to observational studies (220). The aim of the study would be to test the effectiveness of the intervention on a small scale prior to implementation, as well as identifying the likely effect sizes for a future full-scale RCT. Clinicians would complete an online questionnaire survey before and immediately after undertaking the intervention to assess their perceptions of the impact of the intervention, and the results pre-post intervention would be compared. Data would be gathered using a combination of closed questions, Likert scales and open questions, and analysed using both descriptive and inferential analysis, as well as a suitable method for qualitative data depending on the intervention being tested.

Following a successful pilot testing, an intervention evaluation should be considered to explain any discrepancies between predicted and observed outcomes, as well as providing insights for future implementation. The intervention could be evaluated using an RCT to provide the most reliable evidence of effectiveness of the intervention, given that randomisation reduces bias and allows examining the cause-effect relationships (221). It would be useful to publish the study protocol while the evaluation was being undertaken due to the length of time it could take to complete, as recommended by the UK MRC guidance (34).

6.6 Conclusion

In summary, this research has provided original, robust and rigorous findings in relation to the determinants of antimicrobial prescribing behaviour which can support the development of future BCIs. In line with guidance from the UK MRC (34), a systematic review of the literature (Phase 1) was conducted to address an identified evidence gap in relation to theoretically-based interventions designed to improve clinicians' antimicrobial prescribing. An explanatory sequential mixed-methods design of quantitative (Phase 2: Cross-sectional survey) and qualitative (Phase 3: Semi-structured interviews) approaches was then considered to identify determinants (including barriers and facilitators) influencing clinicians' behaviour, which are an integral to understanding antimicrobial prescribing in hospitals. Using the TDF combined with the peer-reviewed published literature, key determinants for targeting were selected and mapped to a number of proposed evidence-based BCTs which can be used as part of future interventions.

While a range of behavioural determinants were identified, the key determinants in both quantitative and qualitative phases were around environmental context and resources, social influences, and memory, attention and decision processes. Successful interventions are likely to take the form of BCTs focusing on providing information about environmental/health consequences of inappropriate prescribing, restructuring the physical/social environment, drawing attention to peers' prescribing rates and instructing on how to make appropriate antimicrobial prescribing decisions. Further work is required to translate these findings into practice. Future research should dedicate sufficient time to developing and testing the proposed intervention before embarking on a full-scale evaluation study to explore effectiveness. This should follow the phases of the UK MRC framework in terms of intervention development, feasibility/pilot testing, evaluation and implementation (34).

There is always room for improvement and it is hoped that this research will contribute to improvements in antimicrobial prescribing practice, patient outcomes and ultimately to addressing AMR, a global health concern.

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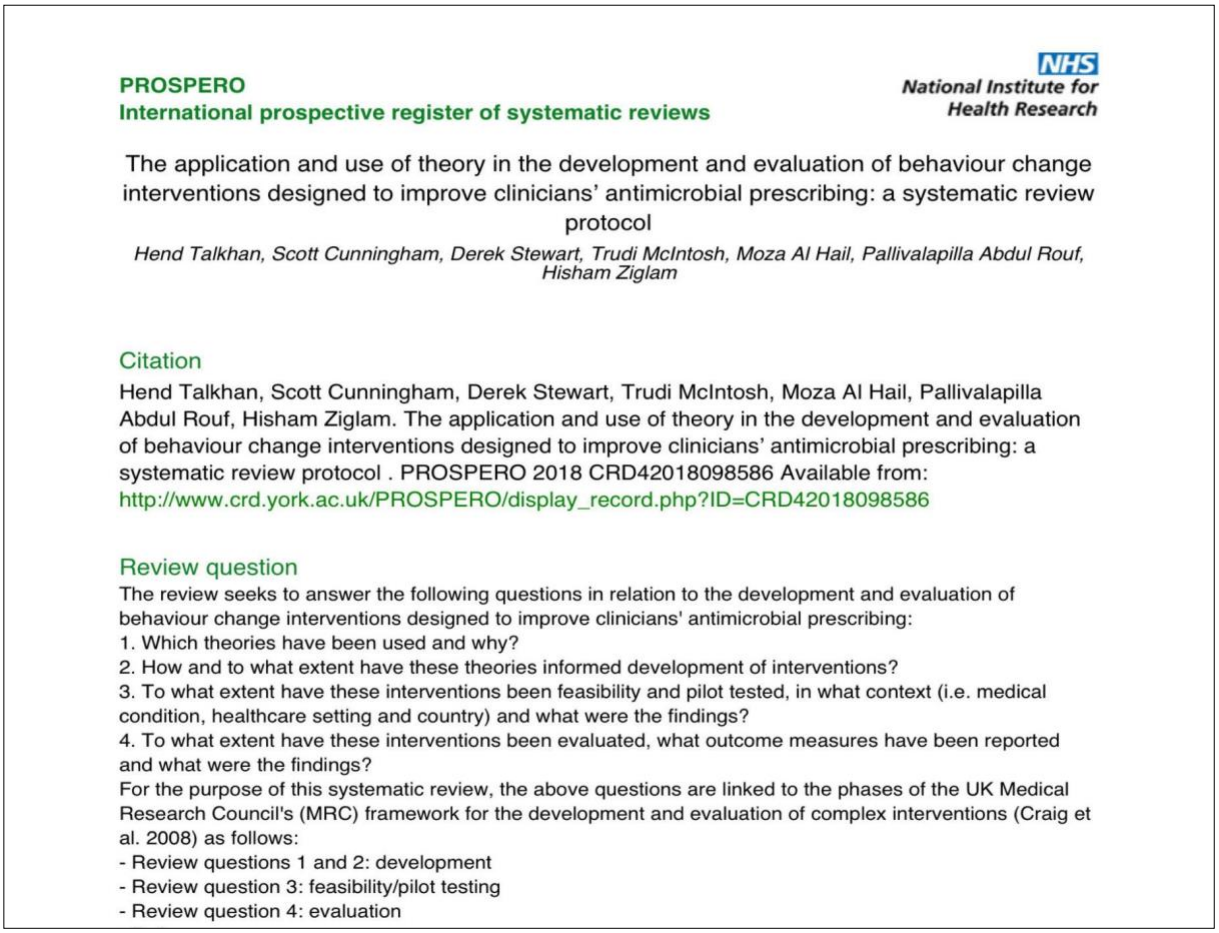
Appendices

Appendix 3A: PRISMA-P checklist for reporting systematic review protocols

Section and topic	No	Checklist item
ADMINISTRATIVE INFORMATION		
Title:		
Identification	1a	Identify the report as a protocol of a systematic review
Update	1b	If the protocol is for an update of a previous systematic review, identify as such
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number
Authors:		
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments
Support:		
Sources	5a	Indicate sources of financial or other support for the review
Sponsor	5b	Provide name for the review funder and/or sponsor
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol
INTRODUCTION		
Rationale	6	Describe the rationale for the review in the context of what is already known
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)
METHODS		
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review
Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated

Section and topic	No	Checklist item
Study records:		
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review
Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2, Kendall's τ)
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)

Appendix 3B: Screenshot of the published systematic review protocol



PROSPERO
International prospective register of systematic reviews

NHS
National Institute for Health Research

The application and use of theory in the development and evaluation of behaviour change interventions designed to improve clinicians' antimicrobial prescribing: a systematic review protocol

Hend Talkhan, Scott Cunningham, Derek Stewart, Trudi McIntosh, Moza Al Hail, Pallivalapilla Abdul Rouf, Hisham Ziglam

Citation

Hend Talkhan, Scott Cunningham, Derek Stewart, Trudi McIntosh, Moza Al Hail, Pallivalapilla Abdul Rouf, Hisham Ziglam. The application and use of theory in the development and evaluation of behaviour change interventions designed to improve clinicians' antimicrobial prescribing: a systematic review protocol . PROSPERO 2018 CRD42018098586 Available from: http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42018098586

Review question

The review seeks to answer the following questions in relation to the development and evaluation of behaviour change interventions designed to improve clinicians' antimicrobial prescribing:
1. Which theories have been used and why?
2. How and to what extent have these theories informed development of interventions?
3. To what extent have these interventions been feasibility and pilot tested, in what context (i.e. medical condition, healthcare setting and country) and what were the findings?
4. To what extent have these interventions been evaluated, what outcome measures have been reported and what were the findings?
For the purpose of this systematic review, the above questions are linked to the phases of the UK Medical Research Council's (MRC) framework for the development and evaluation of complex interventions (Craig et al. 2008) as follows:
- Review questions 1 and 2: development
- Review question 3: feasibility/pilot testing
- Review question 4: evaluation

Appendix 3C: CONSORT checklist for reporting randomised controlled trials

Section/Topic	No.	Checklist item	Reported on page No.
Title and abstract			
	1a	Identification as a randomised trial in the title	
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	
	2b	Specific objectives or hypotheses	
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	
Participants	4a	Eligibility criteria for participants	
	4b	Settings and locations where the data were collected	
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	
	6b	Any changes to trial outcomes after the trial commenced, with reasons	
Sample size	7a	How sample size was determined	
	7b	When applicable, explanation of any interim analyses and stopping guidelines	
Randomisation:			
Sequence	8a	Method used to generate the random allocation sequence	
generation	8b	Type of randomisation; details of any restriction (such as blocking and block size)	

Section/Topic	No.	Checklist item	Reported on page No.
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	
	11b	If relevant, description of the similarity of interventions	
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	
	13b	For each group, losses and exclusions after randomisation, together with reasons	
Recruitment	14a	Dates defining the periods of recruitment and follow-up	
	14b	Why the trial ended or was stopped	
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	

Section/Topic	No.	Checklist item	Reported on page No.
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	
Other information			
Registration	23	Registration number and name of trial registry	
Protocol	24	Where the full trial protocol can be accessed, if available	
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	

Appendix 3D: CONSORT checklist for reporting randomised feasibility/piloting trials

Section/Topic	No.	Checklist item	Reported on page No.
Title and abstract			
	1a	Identification as a pilot or feasibility randomised trial in the title	
	1b	Structured summary of pilot trial design, methods, results, and conclusions (for specific guidance see CONSORT abstract extension for pilot trials)	
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale for future definitive trial, and reasons for randomised pilot trial	
	2b	Specific objectives or research questions for pilot trial	
Methods			
Trial design	3a	Description of pilot trial design (such as parallel, factorial) including allocation ratio	
	3b	Important changes to methods after pilot trial commencement (such as eligibility criteria), with reasons	
Participants	4a	Eligibility criteria for participants	
	4b	Settings and locations where the data were collected	
	4c	How participants were identified and consented	
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	
Outcomes	6a	Completely defined prespecified assessments or measurements to address each pilot trial objective specified in 2b, including how and when they were assessed	
	6b	Any changes to pilot trial assessments or measurements after the pilot trial commenced, with reasons	
	6c	If applicable, prespecified criteria used to judge whether, or how, to proceed with future definitive trial	
Sample size	7a	Rationale for numbers in the pilot trial	
	7b	When applicable, explanation of any interim analyses and stopping guidelines	

Section/Topic	No.	Checklist item	Reported on page No.
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	
	8b	Type of randomisation(s); details of any restriction (such as blocking and block size)	
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	
	11b	If relevant, description of the similarity of interventions	
Statistical methods	12	Methods used to address each pilot trial objective whether qualitative or quantitative	
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were approached and/or assessed for eligibility, randomly assigned, received intended treatment, and were assessed for each objective	
	13b	For each group, losses and exclusions after randomisation, together with reasons	
Recruitment	14a	Dates defining the periods of recruitment and follow-up	
	14b	Why the pilot trial ended or was stopped	
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	
Numbers analysed	16	For each objective, number of participants (denominator) included in each analysis. If relevant, these numbers should be by randomised group	
Outcomes and estimation	17	For each objective, results including expressions of uncertainty (such as 95% confidence interval) for any estimates. If relevant, these results should be by randomised group	

Section/Topic	No.	Checklist item	Reported on page No.
Ancillary analyses	18	Results of any other analyses performed that could be used to inform the future definitive trial	
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	
	19a	If relevant, other important unintended consequences	
Discussion			
Limitations	20	Pilot trial limitations, addressing sources of potential bias and remaining uncertainty about feasibility	
Generalisability	21	Generalisability (applicability) of pilot trial methods and findings to future definitive trial and other studies	
Interpretation	22	Interpretation consistent with pilot trial objectives and findings, balancing potential benefits and harms, and considering other relevant evidence	
	22a	Implications for progression from pilot to future definitive trial, including any proposed amendments	
Other information			
Registration	23	Registration number for pilot trial and name of trial registry	
Protocol	24	Where the pilot trial protocol can be accessed, if available	
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	
Ethics	26	Ethical approval or approval by research review committee, confirmed with reference number	

Appendix 3E: COREQ checklist for reporting qualitative studies

Topic	Guide questions/description	Reported on page No.
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Inter viewer/facilitator	Which author/s conducted the inter view or focus group?	
2. Credentials	What were the researcher's credentials? E.g. PhD, MD	
3. Occupation	What was their occupation at the time of the study?	
4. Gender	Was the researcher male or female?	
5. Experience and training	What experience or training did the researcher have?	
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	
8. Interviewer characteristics	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	
Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	
Participant selection		
10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	
11. Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	
12. Sample size	How many participants were in the study?	
13. Non-participation	How many people refused to participate or dropped out? Reasons?	
Setting		
14. Setting of data collection	Where was the data collected? e.g. home, clinic, workplace	
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	
18. Repeat interviews	Were repeat inter views carried out? If yes, how many?	
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	
20. Field notes	Were field notes made during and/or after the interview or focus group?	
21. Duration	What was the duration of the inter views or focus group?	
22. Data saturation	Was data saturation discussed?	
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	

Topic	Guide questions/description	Reported on page No.
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	
25. Description of the coding tree	Did authors provide a description of the coding tree?	
26. Derivation of themes	Were themes identified in advance or derived from the data?	
27. Software	What software, if applicable, was used to manage the data?	
28. Participant checking	Did participants provide feedback on the findings?	
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	
30. Data and findings consistent	Was there consistency between the data presented and the findings?	
31. Clarity of major themes	Were major themes clearly presented in the findings?	
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	

Appendix 3F: The Theory Coding Scheme

Item	Description	Yes/No/Do not know	Page number
1. Theory/model of behaviour mentioned	Models/theories that specify relations among variables, in order to *explain or predict* behavior (e.g.,TPB, SCT, HBM) are mentioned, even if the intervention is not based on this theory.		
2. Targeted construct mentioned as predictor of behaviour	('Targeted' construct refers to a psychological construct that the study intervention is hypothesized to change). Evidence that the psychological construct relates to (correlates/predicts/causes) behavior should be presented within the introduction or method (rather than the Discussion).		
3. Intervention based on single theory	The intervention is based on a single theory (rather than a combination of theories or theory + predictors).		
4. Theory/predictors used to select intervention recipients	Participants were screened/selected based on achieving a particular score/level on a theory-relevant construct/predictor.		
5. Theory/predictors used to select/develop intervention techniques	The intervention is explicitly based on a theory or predictor or combination of theories or predictors.		
6. Theory/predictors used to tailor intervention techniques to recipients	The intervention differs for different sub-groups that vary on a psychological construct (e.g., stage of change) or predictor at baseline.		
7. All intervention techniques are explicitly linked to at least one theory relevant construct/predictor	Each intervention technique is explicitly linked to at least one theory-relevant construct/predictor.		
8. At least one, but not all, of the intervention techniques are explicitly linked to at least one theory-relevant construct/predictor	At least one, but not all, of the intervention techniques are explicitly linked to at least one theory-relevant construct/predictor.		
9. Group of techniques are linked to a group of constructs/predictors	A cluster of techniques is linked to a cluster of constructs/predictors.		
10. All theory-relevant constructs/predictors are explicitly linked to at least one intervention technique	Every theoretical construct within a stated theory, or every stated predictor (see item 5), is linked to at least one intervention technique.		
11. At least one, but not all, of the theory relevant constructs/predictors are explicitly linked to at least one intervention technique	At least one, but not all, of the theoretical constructs within a stated theory or at least one, but not all, of the stated predictors (see item 5) are linked to at least one intervention technique.		
12. Theory-relevant constructs/predictors are measured	a. At least one construct of theory (or predictor) mentioned in relation to the intervention is measured post-intervention. b. At least one construct of theory (or predictor) mentioned in relation to the intervention is measured pre- and post-intervention.		
13. Quality of measures	a. All of the measures of theory relevant constructs/predictors had some evidence for their reliability.		

Item	Description	Yes/No/Do not know	Page number
	b. At least one, but not all, of the measures of theory relevant constructs/predictors had some evidence for their reliability. c. All of the measures of theory relevant constructs/predictors have been previously validated. d. At least one, but not all, of the measures of theory relevant constructs/predictors have been previously validated. e. The behavior measure had some evidence for its reliability. f. The behavior measure has been previously validated.		
14. Randomization of participants to condition	a. Do the authors claim randomization? b. Is a method of random allocation to condition described (e.g., random number generator; coin toss). c. Was the success of randomization tested? d. Was the randomization successful (or baseline differences between intervention and control group statistically controlled)?		
15. Changes in measured theory-relevant constructs/predictor	The intervention leads to sig. change in at least one theory-relevant construct/predictor (vs. control group) in favour of the intervention.		
16. Mediational analysis of construct/s/predictors	In addition to 15, do the following effects emerge?: a. Mediator predicts DV? (or change in mediator leads to change in DV) b. Mediator predicts DV (when controlling for IV)? c. Intervention does not predict DV (when controlling for mediator)? d. Mediated effect statistically significant?		
17. Results discussed in relation to theory	Results are discussed in terms of the theoretical basis of the intervention.		
18. Appropriate support for theory	Support for the theory is based on appropriate mediation OR refutation of the theory is based on obtaining appropriate null effects (i.e. changing behavior without changing the theoryrelevant constructs).		
19. Results used to refine theory	The authors attempt to refine the theory upon which the intervention was based by either: a. adding or removing constructs to the theory, or b. specifying that the interrelationships between the theoretical constructs should be changed and spelling out which relationships should be changed		

Appendix 4A: Survey invitation E-mail

Subject: Antimicrobial Stewardship Study Invitation

Dear colleagues,

It gives us pleasure to invite you to participate in the completion of this questionnaire. This is being done collaboratively between Hamad Medical Corporation (HMC), Qatar University and Robert Gordon University, UK.

The aim of this questionnaire is to **investigate clinicians' behavioural determinants of antimicrobial prescribing in HMC, Qatar.** We hope to get information that will help us understand why antimicrobials are prescribed and what can be done to potentially improve the prescribing of antimicrobials. This in turn will help contribute to improvements in antimicrobial stewardship.

It will take approximately 20 minutes to complete the questionnaire.

Please click the link below to access the questionnaire:
ACCESS QUESTIONNAIRE [link]

If you have any questions or concerns, please contact:

- Dr Hisham Ziglam at 66734218 or email at HZiglam@hamad.qa
- HMC Institutional Review Board (HMC-IRB) Chair at 5554 6316
- HMC-IRB Office at 4025 6410 (from Sunday to Thursday between 7:00am-3:00pm) or email at irb@hamad.qa

Thank you very much for your support and help.

Kind regards,

The research team

PhD Candidate, Hend Talkhan	Dr Hisham Ziglam	Prof Derek Stewart
Prof Scott Cunningham	Dr PV Abdul Rouf	Dr Mohammad Diab
Dr Trudi McIntosh	Dr Moza Al-Hail	

Appendix 4B: A cross-sectional survey of clinicians in Qatar around antimicrobial prescribing

مؤسسة حمد الطبية
Hamad Medical Corporation
HEALTH · EDUCATION · RESEARCH صحة · تعليم · بحوث

A mixed methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviours among clinicians based in Hamad Medical Corporation, Qatar

Research Team
Hend Talkhan, PhD candidate, Prof Scott Cunningham, Dr Trudi McIntosh, School of Pharmacy and Life Sciences, Robert Gordon University, Scotland, UK
Prof Derek Stewart, Dr Mohammad Diab, College of Pharmacy, QU Health, Qatar University, Doha, Qatar
Dr Hisham Ziglam, Dr Abdullatif Al-Khal, Infectious Diseases Department, Hamad General Hospital, Hamad Medical Corporation, Doha, Qatar
Dr PV Abdul Rouf, Dr Moza Al-Hail, Pharmacy Department, Women's Wellness and Research Center, Hamad Medical Corporation, Doha, Qatar

Dear Participant,

You are invited to take part in an anonymous questionnaire. This should take around 20 minutes to complete. The overall aim of the study is to identify, quantify and explore clinicians' behavioural determinants of antimicrobial prescribing in Hamad Medical Corporation (HMC), Qatar. The findings will inform a programme of research on developing a theoretically based intervention to improve antimicrobial prescribing behaviour of clinicians in Qatar, initially targeting HMC. The study will include all doctors and pharmacists working in all settings of HMC.

HMC is conducting this research to investigate clinicians' behavioural determinants of antimicrobial prescribing in HMC, Qatar. Your participation in the questionnaire is completely voluntary. If you choose to complete the questionnaire then completion is considered as approval of participation. You can withdraw from the study at any time without having to supply reasons. All data referring to you will then be immediately destroyed. There are no risks associated with participating in this study. Your choice to participate or not will not affect your employment status; and your participation will remain confidential.

There are no direct benefits to you from taking part in the research. However, your participation may assist in informing a programme of research on developing a theoretically based intervention to improve antimicrobial prescribing behaviour in Qatar. There will not be any financial compensation for your participation.

This research has been funded by HMC. Your participation is anonymous, and all information will be kept confidential. You have the right to know the results of this study at the end of it. This is first stage of a programme of research which will take around 18 months in total. If you have questions or concerns, or if you think the research has hurt you, talk to the research team at HMC.

If you have questions about your rights as a volunteer, or you want to talk to someone outside the research team, please contact:

- Principal investigator: Dr Hisham Ziglam at 66734218 or email at HZiglam@hamad.qa
- HMC Institutional Review Board (HMC-IRB) Chair at 5554 6316
- HMC-IRB Office at 4025 6410 (from Sunday to Thursday between 7:00am-3:00pm) or email at irb@hamad.qa

Section A – includes questions about your demographics and your practice

What is your profession? ☐Doctor ☐Pharmacist

What is your job title?

What is your speciality, if any?

What is the highest level of academic qualification you hold?

☐PhD ☐MD ☐MSc ☐PharmD
☐Postgraduate Diploma ☐Postgraduate Certificate ☐MBChB ☐BSc
☐MPharm ☐Other – please specify

Which of the following is your main practice setting?

☐Hamad General Hospital ☐Heart Hospital ☐Rumailah Hospital ☐National Center for Cancer Care and Research
☐Women's Wellness and Research Center ☐Ambulatory Care Center ☐Qatar Rehabilitation Institute ☐Al Khor Hospital
☐The Cuban Hospital ☐Hazm Mebaireek General Hospital ☐Communicable Disease Center ☐Other – please specify

How many years have you worked as a health professional?

☐≤5 ☐6-10 ☐11-15 ☐16-20
☐21-25 ☐26-30 ☐≥31

What is your gender?

☐Male ☐Female ☐Prefer not to state

In relation to changes to your professional practice, please choose one phrase which best describes your approach:

☐I resist new ways of working
☐I am cautious in relation to new ways of working; I tend to change once
☐I think for some time before adopting new ways of working
☐I serve as a role model for others in relation to new ways of working
☐I am innovative with new ways of working

Section B – includes questions focusing on your current practice in the area of antimicrobials*

***The term "antimicrobials" refers to all antimicrobial agents that act against all types of microbes including bacteria, viruses, fungi and parasites (WHO).**

If you are a medical doctor, is prescribing/recommending of antimicrobials part of your practice?

☐ Yes ☐ No[+] ☐ Not applicable

[+] If no, please briefly describe why this is not, don't answer the remainder of the questionnaire and submit now

If you are a pharmacist, is reviewing/making recommendations to medical doctors on appropriate prescribing of antimicrobials part of your practice?

☐ Yes ☐ No[$] ☐ Not applicable

[$] If no, please briefly describe why this is not, don't answer the remainder of the questionnaire and submit now

Section C – includes questions about your current routine practice relating to antimicrobials with relevance to the HMC guidelines**

****The term "guidelines" refers to the HMC prescribing polices and clinical guidelines for antimicrobial treatment and prophylaxis within your clinical area(s) of practice.**

Note, the statements below are answered on a 5-point Likert scale (i.e. strongly agree, agree, unsure, disagree, strongly disagree) with an additional 'not applicable' option.
These statements are based on the Theoretical Domains Framework (TDF).

PART 1: APPROPRIATE PRESCRIBING/RECOMMENDATION OF ANTIMICROBIALS

With respect to appropriate and timely prescribing/recommending of antimicrobials (i.e. right medication, right dose, right patient, right time and right route):

	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
I have sufficient knowledge to prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am sufficiently skilled to prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I have undertaken sufficient continuing professional development (CPD) to prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
It is my responsibility to prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am confident in my ability to prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am competent to prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I feel anxious when prescribing/recommending antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
If I prescribe/recommend antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	☐	☐	☐	☐	☐	☐
If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will be treated more effectively	☐	☐	☐	☐	☐	☐
If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	☐	☐	☐	☐	☐	☐
If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will be treated more cost effectively	☐	☐	☐	☐	☐	☐
Cost is a deterrent to my prescribing/recommending of antimicrobials	☐	☐	☐	☐	☐	☐
I have clear goals for prescribing/recommending antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Prescribing/recommending antimicrobials according to the guidelines is a high priority for me	☐	☐	☐	☐	☐	☐
I intend to follow the guidelines on prescribing/recommending antimicrobials	☐	☐	☐	☐	☐	☐
I intend to encourage others to follow the guidelines on prescribing/recommending antimicrobials	☐	☐	☐	☐	☐	☐
Others have to remind me to prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I have sufficient support from specialists to enable me to prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Members of the multidisciplinary team prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Prescribing/recommending antimicrobials according to the guidelines is encouraged by my peers	☐	☐	☐	☐	☐	☐
Prescribing/recommending antimicrobials according to the guidelines is encouraged by superiors	☐	☐	☐	☐	☐	☐
Patients put me under pressure to prescribe/recommend antimicrobials outside the guidelines	☐	☐	☐	☐	☐	☐
I have ways of monitoring the quality of my prescribing/recommending of antimicrobials	☐	☐	☐	☐	☐	☐

Please add any comments you wish to make

PART 2: APPROPRIATE REVIEW/AMENDMENT OF ANTIMICROBIALS

With respect to appropriate and timely review/amendment of antimicrobials – for example from broad spectrum to narrow spectrum, parenteral to oral and/or discontinuation where appropriate:

	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
I have sufficient knowledge to review/amend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am sufficiently skilled to review/amend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I have undertaken sufficient CPD to review/amend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
It is my responsibility to review/amend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am confident in my ability to prescribe/recommend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am competent to review/amend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I feel anxious when prescribing/recommending antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
If I review/amend antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	☐	☐	☐	☐	☐	☐
If I review/amend antimicrobials according to the guidelines, I believe that patients will be treated more effectively	☐	☐	☐	☐	☐	☐
If I review/amend antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	☐	☐	☐	☐	☐	☐
If I review/amend antimicrobials according to the guidelines, I believe that patients will be treated more cost effectively	☐	☐	☐	☐	☐	☐
Cost is a deterrent to my reviewing/amending of antimicrobials	☐	☐	☐	☐	☐	☐
I have clear goals for reviewing/amending antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Reviewing/amending antimicrobials according to the guidelines is a high priority for me	☐	☐	☐	☐	☐	☐
I intend to follow the guidelines on reviewing/amending antimicrobials	☐	☐	☐	☐	☐	☐
I intend to encourage others to follow the guidelines on reviewing/amending antimicrobials	☐	☐	☐	☐	☐	☐
Others have to remind me to review/amend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I have sufficient support from specialists to enable me to review/amend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Members of the multidisciplinary team review/amend antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Reviewing/amending antimicrobials according to the guidelines is encouraged by my peers	☐	☐	☐	☐	☐	☐
Reviewing/amending antimicrobials according to the guidelines is encouraged by superiors	☐	☐	☐	☐	☐	☐
Patients put me under pressure to review/amend antimicrobials outside the guidelines	☐	☐	☐	☐	☐	☐
I have ways of monitoring the quality of my reviewing/amending of antimicrobials	☐	☐	☐	☐	☐	☐

Please add any comments you wish to make

PART 3: APPROPRIATE MONITORING FOR EFFICACY/TOXICITY OF ANTIMICROBIALS

With respect to appropriate and timely monitor for efficacy/toxicity of antimicrobials:

	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
I have sufficient knowledge to monitor for efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am sufficiently skilled to monitor for efficacy/toxicity of antimicrobials a ccording to the guidelines	☐	☐	☐	☐	☐	☐
I have undertaken sufficient CPD to monitor for efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
It is my responsibility to monitor for efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am confident in my ability to monitor for efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am competent to monitor for efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I feel anxious when monitoring efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	☐	☐	☐	☐	☐	☐
If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, I believe that patients will be treated more effectively	☐	☐	☐	☐	☐	☐
If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	☐	☐	☐	☐	☐	☐
If I monitor for efficacy/toxicity of antimicrobials according to the guidelines, believe that patients will be treated more cost effectively	☐	☐	☐	☐	☐	☐
Cost is a deterrent to my monitoring for efficacy/toxicity of antimicrobials	☐	☐	☐	☐	☐	☐
I have clear goals for monitoring efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Monitoring for efficacy/toxicity of antimicrobials according to the guidelines is a high priority for me	☐	☐	☐	☐	☐	☐
I intend to follow the guidelines on monitoring efficacy/toxicity of antimicrobials	☐	☐	☐	☐	☐	☐
I intend to encourage others to follow the guidelines on monitoring efficacy/toxicity of antimicrobials	☐	☐	☐	☐	☐	☐
Others have to remind me to monitor for efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I have sufficient support from specialists to monitor for efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Members of the multidisciplinary team monitor for efficacy/toxicity of antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Monitoring for efficacy/toxicity of antimicrobials according to the guidelines is encouraged by my peers	☐	☐	☐	☐	☐	☐
Monitoring for efficacy/toxicity of antimicrobials according to the guidelines is encouraged by superiors	☐	☐	☐	☐	☐	☐
Patients put me under pressure to monitor for efficacy/toxicity of antimicrobials outside the guidelines	☐	☐	☐	☐	☐	☐
I have ways of monitoring the quality of my monitoring for efficacy/toxicity of antimicrobials	☐	☐	☐	☐	☐	☐

Please add any comments you wish to make

PART 4: APPROPRIATE MANAGEMENT OF ANTIMICROBIALS

With respect to appropriate and timely management of antimicrobials – for example medication errors and adverse drug reactions (i.e. drug allergy, side effects, etc.):

	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	Not applicable
I have sufficient knowledge to manage antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am sufficiently skilled to manage antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I have undertaken sufficient CPD to manage antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
It is my responsibility to manage antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am confident in my ability to manage antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I am competent to manage antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I feel anxious when managing antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
If I manage antimicrobials according to the guidelines, I believe that there will be less antimicrobial resistance	☐	☐	☐	☐	☐	☐
If I manage antimicrobials according to the guidelines, I believe that patients will be treated more effectively	☐	☐	☐	☐	☐	☐
If I manage antimicrobials according to the guidelines, I believe that patients will have fewer adverse effects	☐	☐	☐	☐	☐	☐
If I prescribe/recommend antimicrobials according to the guidelines, I believe that patients will be treated more cost effectively	☐	☐	☐	☐	☐	☐
Cost is a deterrent to my managing of antimicrobials	☐	☐	☐	☐	☐	☐
I have clear goals for managing antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Managing antimicrobials according to the guidelines is a high priority for me	☐	☐	☐	☐	☐	☐
I intend to follow the guidelines on managing antimicrobials	☐	☐	☐	☐	☐	☐
I intend to encourage others to follow the guidelines on managing antimicrobials	☐	☐	☐	☐	☐	☐
Others have to remind me to manage antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
I have sufficient support from specialists to manage antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Members of the multidisciplinary team manage antimicrobials according to the guidelines	☐	☐	☐	☐	☐	☐
Managing antimicrobials according to the guidelines is encouraged by my peers	☐	☐	☐	☐	☐	☐
Managing antimicrobials according to the guidelines is encouraged by superiors	☐	☐	☐	☐	☐	☐
Patients put me under pressure to manage antimicrobials outside the guidelines	☐	☐	☐	☐	☐	☐
I have ways of monitoring the quality of my managing of antimicrobials	☐	☐	☐	☐	☐	☐

Please add any comments you wish to make

We would like to explore your perspectives on appropriate prescribing of antimicrobials in HMC in greater detail. If you are interested, please provide us with your contact details and we will contact you. These will not be used to match your questionnaire responses.

Name :

Gender:

Profession:

Practice setting:

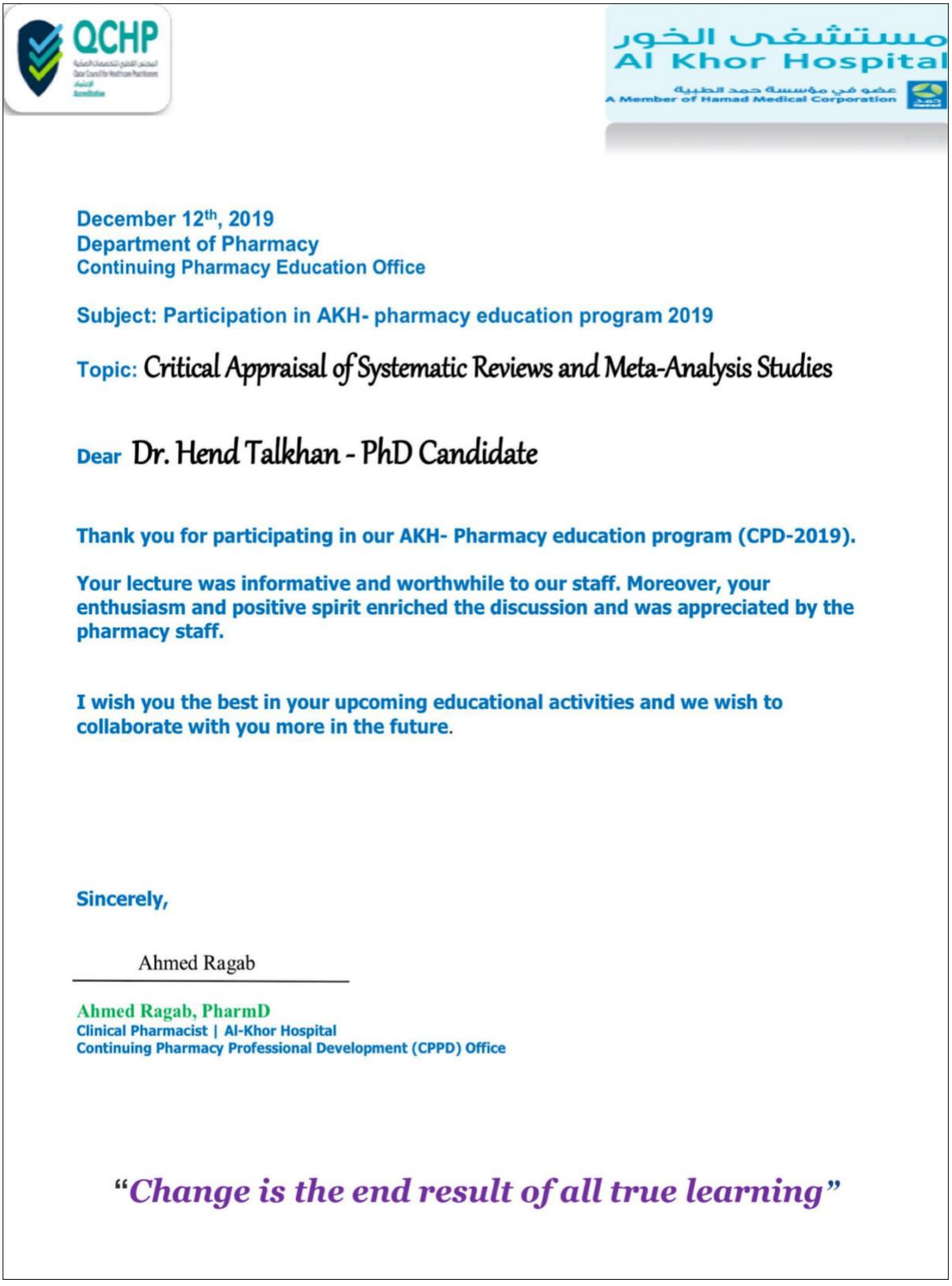
Grade:

Clinical speciality:

Phone number:

Email address:

Appendix 4C: Appreciation letter received from the CPPD Office, Hamad Medical Corporation



مستشفى الخور
Al Khor Hospital
عضو في مؤسسة حمد الطبية
A Member of Hamad Medical Corporation

December 12th, 2019
Department of Pharmacy
Continuing Pharmacy Education Office

Subject: Participation in AKH- pharmacy education program 2019

Topic: Critical Appraisal of Systematic Reviews and Meta-Analysis Studies

Dear Dr. Hend Talkhan - PhD Candidate

Thank you for participating in our AKH- Pharmacy education program (CPD-2019).

Your lecture was informative and worthwhile to our staff. Moreover, your enthusiasm and positive spirit enriched the discussion and was appreciated by the pharmacy staff.

I wish you the best in your upcoming educational activities and we wish to collaborate with you more in the future.

Sincerely,

Ahmed Ragab

Ahmed Ragab, PharmD
Clinical Pharmacist | Al-Khor Hospital
Continuing Pharmacy Professional Development (CPPD) Office

"Change is the end result of all true learning"

Appendix 4D: Robert Gordon University's ethics approval letter

ROBERT GORDON UNIVERSITY ABERDEEN

SCHOOL OF PHARMACY & LIFE SCIENCES
Robert Gordon University
Sir Ian Wood Building
Garthdee Road
Aberdeen
AB10 7GJ
United Kingdom
Tel: 01224 262500/2800
www.rgu.ac.uk

Date 13th February 2019

Dear Hend

Re: A mixed methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviours among clinicians based in Hamad Medical Corporation, Qatar

The School Research Ethics Committee has assessed your application and the overall decision is that there are no ethical issues with your project. However, they have provided some comments that you may find useful going forward.

I can now confirm that you are able to proceed with your research and any further ethics applications.

Should there be any amendments to this project during the research we would advise you to consult with the convener of the ethics committee as to whether a further ethical review would be required.

We wish you success with your project.

Regards

Dr Colin Thompson
Convener of the School Ethics Review Panel

Appendix 4E: Qatar University's ethics approval letter

جامعة قطر
QATAR UNIVERSITY

Qatar University Institutional Review Board
QU-IRB

November 13th, 2019

Dr. Derek Stewart
College of Pharmacy
Qatar University
Tel.: +974 4403 5562
Email: d.stewart@qu.edu.qa

Dear Dr. Derek Stewart,

Sub.: Research Ethics Expedited Approval
Project Title: "A mixed methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviors among clinicians based in Hamad Medical Corporation, Qatar"

We would like to inform you that your application along with the supporting documents provided for the above project, has been reviewed by the QU-IRB, and having met all the requirements, has been granted research ethics **Expedited Approval** based on the following category(ies) listed in the Policies, Regulations and Guidelines provided by MOPH for Research Involving Human Subjects. Your approval is for one year effective from November 13th, 2019 till November 12th, 2020.

1) present no more than minimal risk to human subject, and
2) involve only procedures listed in the following category(ies).
Category 6: collection of data from voice, video, digital, or image recording made for research purposes.
Category 7: Research on individual or group characteristics or behavior (including but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Documents Reviewed: QU-IRB Application Human Subject- Ver 2_Bilingual (1) D Stewart (H Talkhan) REVISION 2, QU-IRB Application Material Check List D Stewart (H Talkhan),ResearchProtocolFinalIRB, HMC INSTITUTIONAL REVIEW BOARD IRB letter, MRC final approval letter, RGU_Ethics_Decision, DraftInterviewTopicGuideIRB, DraftQuestionnaireFinalIRB, ResearchConsentFormFinalIRB revised, ResearchInfoSheetFinalIRB revised, QU-IRB Review Forms, responses to IRB queries and updated documents.

Please note that expedited approvals are valid for a period of **one year** and renewal should be sought one month prior to the expiry date to ensure timely processing and continuity. Moreover, any changes/modifications to the original submitted protocol should be reported to the committee to seek approval prior to continuation.

Your Research Ethics Expedited Approval Number is: **QU-IRB 1171-EA/19.** Kindly state this number in all your future correspondence to us pertaining to this project. In addition, please submit a closure report to the QU-IRB upon completion of the project.

Best wishes,

Dr. Ahmed Awaisu
Chairperson, QU-IRB

جامعة قطر
QATAR UNIVERSITY
Institutional Review Board
(IRB)
Office Of Academic Research

Appendix 4F: Hamad Medical Corporation's ethics approval letter

14/10/2019

مؤسسة حمد الطبية
Hamad Medical Corporation
HEALTH · EDUCATION · RESEARCH صحة · تعليم · بحوث

APPROVAL LETTER
MEDICAL RESEARCH CENTER
HMC, DOHA-QATAR

Dr. Hisham Ziglam **Sr. Consultant** **Department of Medicine** **HGH-HMC**	**Date: 13 October 2019**
Protocol No.	MRC-01-19-219
Study Title:	A mixed methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviours among clinicians based in Hamad Medical Corporation, Qatar
Hospitals/ Facilities Approved:	HMC Corporate
Team Member List:	Dr. Hisham Ziglam , Dr. Moza Sulaiman H Al Hail , Dr. Scott Cunningham , Dr. Trudi Carlyle McIntosh , Dr. mohammad Issam Diab , Mr. Palli Valappila Abdul Rouf , Mrs. Hend Talkhan , Ms. Eman Talkhan , Prof. Derek Stewart
Review Type:	Expedited
Decision:	Approved

The Medical Research Center has reviewed and approved the request for the above mentioned research study to be conducted in HMC on condition that continual approval from the HMC Institutional Review Board (IRB) is renewed as per the review board`s terms.

This study must be fully compliant with all the relevant sections of the `Rules and Regulations for Research` at HMC and the Medical Research Center should be notified immediately of any proposed changes to the study protocol. Wherever amendments to the initial protocol are deemed necessary, it is the responsibility of the Principal Investigator to ensure that appropriate reviews and renewed approvals are in place before the study will be allowed to proceed.

Please note that only official, stamped versions of the IRB approved documentation are to be utilized at any stage in the conduct of this study and follow the validity dates as mentioned in the IRB stamped documents. The research team must ensure that progress on the study is appropriately recorded in ABHATH, the online research system of the Medical Research Center.

We wish you success in this research and await the outcomes in due course.

Yours sincerely,

Ms. Emma Pendleton
Assistant Director Business Development and Research
Medical Research Center- Hamad Medical Corporation

Medical Research Centre
Hamad Medical Corporation - Doha - Qatar
حمد
Hamad

Date:13 October 2019

Appendix 4G: Screenshot of the Data Use Agreement

مؤسسة حمد الطبية
Hamad Medical Corporation
HEALTH · EDUCATION · RESEARCH صحة · تعليم · بحوث
حمد Hamad

مركز البحوث الطبية
Medical Research Center

DATA USE AGREEMENT

This Data Use Agreement (the 'Agreement'), effective as of the 2nd September 2019 (the "Effective Date"), between Hamad Medical Corporation, a public corporation existing and organized under Emiri Decree no 11/2016, with its head office located at Al Rayyan Rd, PO Box 3050 Doha, Qatar ('Institution') and The Robert Gordon University, a body corporate incorporated under The Robert Gordon University (Establishment) (Scotland) Order 2006, a Scottish Charity (Charity number SC013781) and having its principal administrative office at Garthdee House, Garthdee Road, ABERDEEN, AB10 7QB ('RGU'), and Hend Talkhan, PhD student, ID 1709108 (the 'Student'); (RGU and Student collectively referred to as the 'Recipient'), establishes the terms and conditions under which Recipient will access, copy, and use certain data described below (the 'Data'), which includes 'sensitive data'. Institution and Recipient are referred to in this Agreement singularly as a 'Party' and collectively as the 'Parties'.

WHEREAS, the purpose of this Agreement is so that Recipient, Principal Investigator (Dr Hisham Ziglam) and their Personnel can access data in accordance with the Research Protocol entitled "A mixed-methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviours among clinicians based in Hamad Medical Corporation, Qatar'.

WHEREAS, the Parties understand and acknowledge that all Data provided in accordance with this Agreement is Confidential and may be used only as set out in this Agreement.

1. **Description of Data.** Recipient may obtain from the Institution the Data described below which relates to the Study described below:

Study Title: A mixed-methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviours among clinicians based in Hamad Medical Corporation, Qatar

MRC No: MRC-01-19-219

Appendix 4H: Collaborative Institutional Training Initiative certificates

CITI PROGRAM

Completion Date 27-Jun-2019
Expiration Date 26-Jun-2022
Record ID 32173604

This is to certify that:

Hend Talkhan

Has completed the following CITI Program course:

HMC Biomedical Researchers (Basic Course) (Curriculum Group)
HMC Biomedical Researchers (Basic Course) (Course Learner Group)
1 - Stage 1 (Stage)

Under requirements set by:

Hamad Medical Corporation

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wdd2ea1c1-d40c-42e5-bb22-0ed2c2cce25e-32173604

CITI PROGRAM

Completion Date 27-Jun-2019
Expiration Date N/A
Record ID 32173605

This is to certify that:

Hend Talkhan

Has completed the following CITI Program course:

HMC Good Clinical Practice (Curriculum Group)
HMC Clinical Trials Investigators (GCP) (Course Learner Group)
1 - Stage 1 (Stage)

Under requirements set by:

Hamad Medical Corporation

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w6b12059d-8e3f-4b69-aff2-978c26f31430-32173605

CITI PROGRAM

Completion Date 27-Jun-2019
Expiration Date N/A
Record ID 32173606

This is to certify that:

Hend Talkhan

Has completed the following CITI Program course:

CITI Health Information Privacy and Security (HIPS) (Curriculum Group)
HMC Biomedical and Social Behavioral Researchers (HIPS) (Course Learner Group)
1 - Stage 1 (Stage)

Under requirements set by:

Hamad Medical Corporation

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w3ca20747-8184-41ee-9d8d-ee54453d7f48-32173606

Appendix 5A: Interview schedule

SEMI-STRUCTURED INTERVIEW SCHEDULE

INTRODUCTION

Hello, I'm Hend Talkhan, the doctoral student from Robert Gordon University calling to interview you about your antimicrobial practice in Hamad Medical Corporation (HMC).

Thank you for agreeing to take part in this interview. Please, can I check you have read the participant information sheet?

The purpose of this interview is to find out your views, experiences and perceptions of antimicrobial practice in HMC, Qatar. There are different aspects of this including:

- prescribing/recommending of antimicrobials
- review/amendment
- monitoring for efficacy/toxicity
- management e.g. medication errors and adverse drug reactions

Your participation is voluntary and you may withdraw at any point.

If you do not want to answer a specific question, then please let me know.

As you know from the information sheet and consent form, this interview is being video recorded and I want to emphasise that what you say will be kept strictly confidential. No personal identifiers such as your name or contact details will be disclosed.

The interview may take around 20 to 30 minutes. Are you ok to go ahead?

If yes: that's great, thank you.

If no: That's fine. When would be more convenient?

Thanks, I'll see you on day/date/time. Bye.

Write the new day/date/time here:

You kindly completed our survey and the results showed three broad areas in relation to clinicians' antimicrobial practice in HMC. These were: 'Guidelines compliance', 'Influences on practice' and 'Self-efficacy'.

1. Demographics: Can I start by asking you to describe your current involvement in antimicrobial practice?
   - what is your area(s) of antimicrobial practice?
   - which settings – inpatient/outpatient?
   - which medicines/patient groups do you routinely prescribe/recommend for?

SECTION 1: GUIDELINES COMPLIANCE

Now let's move on to the first section of this interview which is about the use of guidelines in antimicrobial practice. The term 'guidelines' refers to the HMC prescribing polices and clinical guidelines for antimicrobial treatment and prophylaxis within your clinical area(s) of practice.

2. Goals: I wonder if you can tell me how you feel that guidelines help you in setting your goals in relation to your routine antimicrobial practice, that is prescribing/recommending, review/amendment, monitoring and management?
   - when and how do you use the HMC guidelines?
   - what do you think about the guidelines generally? Are there any particular good points or bad points?
   - how useful are the guidelines and the level of evidence?
   - is there any way in which the guidelines could be improved?

3. Intentions: Clinicians are encouraged to follow the guidelines in their routine antimicrobial practice. I wonder if you can comment on that in relation to your own practice?
   - can you tell me about any situations where you didn't follow the guidelines?
   - do you use any other antimicrobial guidelines? Which ones? Why do you use them?
   - do you encourage others to follow the guidelines?

4. Beliefs of consequences: What do think the positive or negative consequences are, related to antimicrobial practice using the guidelines?
   - will patients be treated more effectively when guidelines are used compared to not?
   - what about the cost effectiveness of the treatment?
   - would there be any impact on the number of adverse effects?
   - and any impact on antimicrobial resistance?

5. Barriers & facilitators: In relation to the guidelines, what do you feel are the barriers and facilitators to using them to help with your antimicrobial practice?

SECTION 2: INFLUENCES ON PRACTICE

Next, I'd like to move on to Section 2. This section is about the influences that may affect your practice in relation to antimicrobials.

6. Environmental context & resources: Which factors within the hospital environment, or resources help or hinder your antimicrobial practice?
   - if needed: can you identify any resources or ways of working that affect your own antimicrobial practice e.g. available information resources – as paper copies or online?
   - what CPD or training have you had in this area? How has this helped?

7. Social influences: Can you tell me about the influences of peers and other people that are important to you in relation to your antimicrobial practice?
   - what about specialists and other members of the multidisciplinary team?
   - what about your superiors/managers/directors?
   - does any external body or organisation influence your practice?
   - what about patients/patients' families?
   - is there anyone else affecting your practice?

8. Behavioural regulation: Thinking about your own antimicrobial practice, can you tell me whether and how you plan to ensure the best practice?
   - are you aware of any ways of monitoring the quality of your practice either by yourself or by someone else? If needed: in relation to safety, effectiveness, cost effectiveness.

- e.g. peer review, analysis of prescribing data, audits, feedback, any research, etc.

9. Barriers & facilitators: In relation to the influences on antimicrobial practice, what do you feel are the barriers and facilitators to your own practice?

SECTION 3: SELF-EFFICACY

Well, that brings us to the final section which is about your personal qualities and attributes in relation to antimicrobial practice.

10. Knowledge/skills: Apart from your academic qualifications - what sort of knowledge and skills do you have in relation to antimicrobial practice?
    - do you feel they are sufficient or do they need to be improved? What are the gaps?
    - how could you improve your knowledge and skills in relation to antimicrobial practice?

11. Beliefs of capabilities: How well do you feel you use your knowledge and skills in your antimicrobial practice?
    - do you feel you are competent? Please explain further – give examples of situations where you showed competence?

12. Optimism: How confident you feel in relation to your antimicrobial practice?
    - does this vary sometimes?
    - can you tell me more about that or give examples?

13. Social/professional role & identity: What you feel are your roles and responsibilities in relation to antimicrobial practice?
    - how do these relate to your role as a doctor/pharmacist?

14. Barriers & facilitators: In relation to your personal qualities and attributes, what do you feel are the barriers and facilitators to your antimicrobial practice?

REFLECTIONS ON HOW TO IMPROVE AMS PRACTICE

15. Finally, I wonder if you can let me have your thoughts around what you feel works very well and what needs to improve regarding AMS practice in HMC, in general?

- what more could your organisation or employer do to help enhance your antimicrobial practice?
- is there any specific CPD or training you feel you need?
- can you identify any future interventions needed?

CONCLUSION

16. Is there anything else you would like to add about your antimicrobial prescribing practice, generally?

Well that's all of my questions. Thank you for your participation. Goodbye!

Appendix 5B: Interview invitation E-mail

Subject: Antimicrobial Stewardship Study Invitation

Dear [potential participant's name],

Many thanks for completing a questionnaire for this study previously. You kindly agreed to help further with this study by indicating you would be prepared to be interviewed.

It gives me pleasure to invite you to participate in an online interview using the Zoom web-based video meeting system. This research is part of my PhD and is being done collaboratively between Hamad Medical Corporation (HMC), Qatar University and Robert Gordon University, UK. HMC collaborators are Dr Hisham Ziglam, Dr Moza Al Hail and Dr Abdulrouf Palli Valappila.

The aim of this interview is to **explore the behavioural determinants of clinicians' antimicrobial prescribing in HMC, Qatar.** This in turn will help contribute to improvements in antimicrobial stewardship.

If you agree to take part in the research, it would be great if you could kindly read the information sheet, complete the consent form attached and return it to me directly. Within this form there is a section for you to give me some dates and times that would be best for an online Zoom interview as per your convenience over the next 2 weeks.

If you have any questions or concerns, please contact:

- Dr Hisham Ziglam at 66734218 or email at HZiglam@hamad.qa
- HMC Institutional Review Board (HMC-IRB) Chair at 5554 6316
- HMC-IRB Office at 4025 6410 (from Sunday to Thursday between 7:00am-3:00pm) or email at irb@hamad.qa

Thank you very much for your support and help.

Kind regards,

The research team

PhD Candidate, Hend Talkhan	Dr Hisham Ziglam	Prof Derek Stewart
Prof Scott Cunningham	Dr PV Abdul Rouf	Dr Mohammad Diab
Dr Trudi McIntosh	Dr Moza Al-Hail	

Appendix 5C: Interview information sheet

PARTICIPANT INFORMATION SHEET

Dear participant,

You are invited to participate in project title: A mixed-methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviours among clinicians based in Hamad Medical Corporation (HMC), Qatar.

HMC is conducting this research to investigate clinicians' behavioural determinants of antimicrobial prescribing in HMC, Qatar. The study will include a sample of those who returned the questionnaire and stated that they were interested in taking part in the interviews.

You are invited to take part in an anonymous online interview using the Zoom web-based application (Zoom Video Communications, USA. www.zoom.us) which is a videoconferencing software programme. Each interview will last around 20-30 minutes, will be video-recorded through the propriety functionality in Zoom and local storage of recordings. The aim of this interview is to explore clinicians' behavioural determinants of antimicrobial prescribing in HMC, Qatar.

Your participation in the interviews is completely voluntary. You can withdraw from the study at any time without having to supply reasons. All data referring to you will then be immediately destroyed. There are no risks associated with participating in this study. Your choice to participate or not will not affect your employment status; and your participation will remain confidential.

There are no direct benefits to you from taking part in the research. However, your participation may assist in informing a programme of research on developing a theoretically-based intervention to improve antimicrobial prescribing behaviour in Qatar, initially targeting HMC. There will not be any financial compensation for your participation.

This research has been funded by HMC. You have the right to know the results of this study at the end of it. This is second stage of a programme of research

which takes around 18 months in total. If you have questions or concerns, or if you think the research has hurt you, please contact the research team.

If you have questions about your rights as a volunteer, please contact:

- Dr Hisham Ziglam at 66734218 or email at HZiglam@hamad.qa
- HMC Institutional Review Board (HMC-IRB) Chair at 5554 6316
- HMC-IRB Office at 4025 6410 (from Sunday to Thursday between 7:00am-3:00pm) or email at irb@hamad.qa

The research team

PhD Candidate, Hend Talkhan	Dr Hisham Ziglam	Prof Derek Stewart
Prof Scott Cunningham	Dr PV Abdul Rouf	Dr Mohammad Diab
Dr Trudi McIntosh	Dr Moza Al-Hail	

Appendix 5D: Interview consent form

1. Research team		
PhD Candidate, Hend Talkhan Prof Scott Cunningham Dr Trudi McIntosh	Dr Hisham Ziglam Dr PV Abdul Rouf Dr Moza Al-Hail	Prof Derek Stewart Dr Mohammad Diab
2. Title of research		
A mixed-methods study to identify, quantify and explore determinants of antimicrobial prescribing behaviours among clinicians based in Hamad Medical Corporation, Qatar.		
3. Why are we inviting you to join this research?		
We are inviting you to join this research because you completed and returned a questionnaire indicating that you were interested in participating in an interview.		
4. What should you know about this research?		
▪ we will explain the research to you ▪ whether or not you join is your decision (you can accept or refuse no matter who is inviting you to participate) ▪ please feel free to ask questions or mention concerns before, during or after the research ▪ you can say yes but change your mind later ▪ we will not hold your decision against you		
5. Who can you talk to?		
If you have questions or concerns, or if you think the research has hurt you, talk to the research team. If you have questions about your rights as a volunteer, please contact: ▪ Dr Hisham Ziglam at 66734218 or email at HZiglam@hamad.qa ▪ HMC Institutional Review Board (HMC-IRB) Chair at 5554 6316 ▪ HMC-IRB Office at 4025 6410 (from Sunday to Thursday between 7:00am-3:00pm) or email at irb@hamad.qa		
6. Why are we doing the research?		
Concern due to increasing AMR and the need for a more coordinated effort to tackle this have resulted in the articulation of initiatives and guidance at global levels. Many countries, including Qatar, have developed antimicrobial stewardship programmes which consist of interventions designed to improve antimicrobial prescribing and utilisation, minimise AMR and improve clinical as well as economic outcomes. However, there remains a need for a theoretically-based behaviour change intervention directed toward modifying the current behaviour of clinicians with the aim of improving appropriate antimicrobial prescribing practices. This could positively impact patient care, professional practice and the economy. We would like to explore your perspectives on appropriate prescribing of antimicrobials in HMC in greater detail.		

7. How long will the research take?

The interview will last around 20-30 minutes.

8. How many people will take part?

We plan to engage with a sample of those who returned the questionnaire and stated that they were interested in taking part in the interviews. We hope to carry out an initial set of ten interviews; these will be analysed thematically and further interviews carried out until no new themes are identified, and data saturation appears to have been reached. We anticipate that no more than 20 interviews will be required to reach the point of data saturation.

9. What happens if you take part?

If you agree to join, we will ask you to do the following:

- attend a Zoom web-based interview, date and time of which will be determined to be most convenient to those participating
- answer questions
- agree to interview being video-recorded
- agree to maintain confidentiality of interview

10. Could the research be bad for you?

No, there are no risks to you from taking part in the interviews.

11. Could the research be good for you?

There are no benefits to you from joining this research. However, your participation may assist in informing a programme of research on developing a theoretically-based intervention to improve antimicrobial prescribing behaviour of clinicians in Qatar, initially targeting HMC.

12. What happens to information about you?

We will make efforts to secure information about you. This includes using a code to identify you in our records instead of using your name. We will not identify you personally in any reports or publications about this research. We cannot guarantee complete secrecy, but we will limit access to information about you. Only people who have a need to review information will have access. These people might include:

- members of the research team
- representatives of the Ministry of Public Health, Qatar and HMC who make sure the study is done properly and that your rights and safety are protected

13. What if you don't want to join?

You can say no and we will not hold it against you.

14. What if you join but change your mind?

You can stop participating at any time and we will not hold it against you. All data referring to you will then be immediately destroyed.

15. What else should you know?

This research is funded by HMC.

Volunteer
I voluntarily agree to join the research described in this form.
Printed Name of Volunteer
Signature of Volunteer Date
Person obtaining consent
I document that: ▪ *I (or another member of the research team) have fully explained this research to the volunteer* ▪ *I have personally evaluated the volunteer's understanding of the research and obtained their voluntary agreement*
Printed Name of Person Obtaining Consent
Signature of Person Obtaining Consent Date
Witness (if applicable)
I document that the information in this form (and any other written information) was accurately explained to the volunteer, who appears to have understood and freely given Consent to join the research.
Printed Name of Witness
Signature of Witness Date

Arranging interview: Please give the best days/times to speak over the coming 2 weeks

Best Day	**Morning**	**Afternoon**	**Evening**
Saturday			
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			

Appendix 5E: A conceptual diagram of interview findings in relation to the PCA components (Phase 2) and TDF determinants (Phase 3), using colours to show interrelationships between themes