A theoretical exploration of the implementation of antimicrobial stewardship programmes in the United Arab Emirates.

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A theoretical exploration of the implementation of Antimicrobial Stewardship Programmes in the United Arab Emirates

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Abstract

Antimicrobial resistance (AMR) is considered a global health threat and one of the most pressing public health issues. The World Health Organization (WHO) outlined actions to combat the AMR risk including optimising the use of antimicrobials through the introduction of Antimicrobial Stewardship Programmes (ASP). Many collaborative groups have produced bundles of actions that can guide ASP implementation. The Center for Disease Prevention and Control (CDC) have produced a framework of seven core elements driven from key ASP studies demonstrating effectiveness in antimicrobial use.

The Gulf Cooperation Council (GCC) states responded to the global health threat of AMR by issuing a five pillars strategic plan. In United Arab Emirates (UAE), local healthcare authorities detected the increased prevalence of resistant microbial strains and responded by issuing mandates demanding hospitals to establish ASP teams and actions tailored to their available resources. The overall aim of the doctoral research was to explore ASP implementation in acute care hospitals in UAE.

A number of systematic reviews have been published providing evidence on the effectiveness of ASP interventions and its impact on patient and microbiological outcomes, yet none have explored ASP implementation in relation to international standards. Since it is well recognised that ASP interventions can vary greatly across geographical regions, the need for a systematic review exploring ASP implementation in the GCC region has emerged.

The first phase of this doctoral research was a systematic review of 17 studies that aimed to critically appraise and synthesise the evidence of ASP implementation in GCC hospitals in comparison to the CDC framework and identify key facilitators and barriers. The CDC framework was the international standard of choice given its value as a reference point for many GCC hospitals and based on multiple effectiveness studies that used it to identify gaps in ASP implementation in acute care hospitals. Mapping to the CDC framework identified key areas of strengths and weaknesses in reporting implementation where infrastructure elements reporting was heterogeneous and insufficient. It also identified the need for rigorous qualitative in-depth research that utilises implementation frameworks to facilitate identification and understanding of factors that influence the translation of ASP research findings into practice within the healthcare sector in GCC states.

The second phase of this doctoral research aimed to explore key stakeholders' perspectives of ASP implementation in UAE hospitals, with a focus on facilitators and barriers. A qualitative study was conducted underpinned by the Consolidated Framework for Implementation Research (CFIR) and involving semi-structured interviews with ASP key stakeholders from UAE hospitals. Data saturation was achieved at the completion of 31 interviews. Multiple CFIR constructs emerged as facilitators (such as stakeholders' engagement and effective communication) or barriers (such as perceived ASP complexity and blame culture) for ASP implementation, which highlighted the value of employing theory as an underpinning in comparison to studies without any theoretical underpinning.

Coronavirus Disease 2019 (COVID-19) highly impacted data collection during phase two. Participants' perspectives on the impact of COVID-19 on ASP implementation were separately analysed and presented. The study identified the complexity of ASP implementation which led to initial disruption of the service, yet successful evolvement and restoration of ASP services reflects the high value and adaptability of ASP implementation in UAE hospitals.

Future research should focus on obtaining consensus agreement of ASP key stakeholders on recommendations for ASP implementation based on findings of the systematic review and the qualitative study.

Key words: Antimicrobial Stewardship, Consolidated Framework for Implementation Research, Implementation, Qualitative, Theory, United Arab Emirates

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This PhD journey has facilitated my development as an academic. In addition to my academic development, I have learnt the need to be patient, appreciating the value of excellent supervision. As I apply these learnings to the work with my students, I am very proud today that many of my undergraduate pharmacy students now approach me requesting that I supervise their graduation project.

This could not have been possible without the patience, guidance and support from my principal supervisor, Dr. Antonella Tonna. She was there at every step, pushing me to explore and grow as an independent researcher. Not only did she push me to complete my PhD, but she also helped build my self-confidence and trust in my capabilities.

My PhD journey would not have started without my second supervisor, Prof. Derek Stewart. I am forever in his debt for him accepting to be my principal supervisor early in 2017 then handing over to Dr. Antonella in 2019 when it was time for him to relocate from Robert Gordon University to Qatar University. Yet, he never left my side, he has always been there with right to the point feedback and quick responses to all my queries.

I would like to offer my heartfelt thanks and appreciation for my third supervisor, Prof Dhayaneethie Perumal. She was Head of Pharmacy during my work at Fatima College of Health Science in Abu Dhabi, UAE, before she accepted her new position as higher education expert in Commission for Academic Accreditation (CAA) in Ministry of Education, UAE. Prof Dhaya also aided my personal and professional development. She inspired me to continue my academic and research journey. Her emotional support for me during the difficult times of COVID-19 pandemic, will always remain in my heart.

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External output

Peer-reviewed publications:

1. Hashad N, Tonna AP, Perumal D and Stewart D. *Antimicrobial stewardship program implementation in the Middle East: a systematic review protocol*. [homepage on the internet]. London: PROSPERO CRD42017079597; 2017. [updated 2020 October 1; cited 2023 April 12]. Available at: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42017079597

2. Hashad N, Perumal D, Stewart D and Tonna AP. Mapping hospital antimicrobial stewardship programmes in the Gulf Cooperation Council states against international standards: a systematic review. *Journal of Hospital Infection*. 2020; 106(3).

3. Hashad N, Stewart D, Perumal D, Abdulrazzaq N and Tonna AP. The impact of COVID-19 on antimicrobial stewardship programme implementation in hospitals - an exploration informed by the Consolidated Framework for Implementation Research. *Journal of Hospital Infection*. 2022; 129.

4. Hashad N, Stewart D, Perumal D, Abdulrazzaq N and Tonna AP. Antimicrobial stewardship programme implementation in the UAE: perspectives of key stakeholders using Consolidated Framework for Implementation Research. *Journal of Hospital Infection*. 2023; 137.

Peer reviewed published conference abstracts:

1. Hashad N, Perumal D, Tonna A and Stewart D. Antimicrobial stewardship programs implementation in Gulf Co-operation Council states: A systematic review. *European Journal of Hospital Pharmacy*. 2019; 26.

2. Hashad N, Stewart D, Perumal D, Abdulrazzaq NM, Tonna A. Theoretical exploration of development and implementation of antimicrobial stewardship programmes in hospitals in the United Arab Emirates: A qualitative study of the perspectives of key stakeholders and health professionals. *International Journal of Clinical Pharmacy*. 2021; 43.

3. Hashad N, Stewart D, Perumal D, Abdulrazzaq NM, Tonna AP. The impact of COVID-19 on antimicrobial stewardship implementation in United Arab Emirates hospitals—an exploration informed by the Consolidated Framework for Implementation Research. *International Journal of Clinical Pharmacy*. 2022; 44.

Oral communications:

1. Hashad N, Stewart D, Perumal D, Abdulrazzaq NM, Tonna AP. The impact of COVID-19 on antimicrobial stewardship implementation in United Arab Emirates hospitals—an exploration informed by the Consolidated Framework for Implementation Research. *Dubai International Pharmaceutical and Technologies Conference and Exhibition (DUPHAT)*. United Arab Emirates: 22-25 February 2022.

2. Hashad N, Stewart D, Perumal D, Abdulrazzaq NM, Tonna AP. The impact of COVID-19 on antimicrobial stewardship implementation in United Arab Emirates hospitals—an exploration informed by the Consolidated Framework for Implementation Research. *50th European Society of Clinical Pharmacy Symposium on Clinical Pharmacy, polypharmacy and ageing - highly individualised, interprofessional, person-centered care*. Czech Republic: 19-20 October.

3. Hashad N, Stewart D, Perumal D, Abdulrazzaq NM, Tonna AP. A theoretical exploration of the implementation of antimicrobial stewardship programmes: perspectives of key stakeholders, underpinned by the Consolidated Framework for Implementation Research. *Dubai International Pharmaceutical and Technologies Conference and Exhibition (DUPHAT).* United Arab Emirates: 10-12 January 2023.

Poster presentations:

1. Hashad N, Tonna AP, Perumal D, Stewart D. Antimicrobial Stewardship Programs implementation and reported outcomes: An umbrella review approach. *10th Medication Safety Conference*. United Arab Emirates: October 2017.

2. Hashad N, Tonna AP, Perumal D, Stewart D. Antimicrobial stewardship programme implementation in the Gulf Cooperation Council states: A systematic review. Paper: 4CPS-276. In: *24th European Association of Hospital Pharmacist Congress*. Spain: 27-29 March.

3. Hashad N, Tonna AP, Perumal D, Stewart D. Antimicrobial stewardship programme implementation in the Gulf Cooperation Council states: A systematic review. *31st International Congress of Antimicrobial Chemotherapy ICC) / 4th Gulf Congress of Clinical Microbiology and Infectious Diseases (GCCMID)*. United Arab Emirates: 7-9 November 2019.

4. Hashad N, Stewart D, Perumal D, Abdulrazzaq NM, Tonna AP. Theoretical exploration of development and implementation of antimicrobial stewardship programmes in hospitals in the United Arab Emirates: A qualitative study of the perspectives of key stakeholders and health professionals. Paper: PP099. In: *49th European Society of Clinical Pharmacy European Society of Clinical Pharmacy Virtual Symposium on Clinical Pharmacy - Clinical pharmacy, working collaboratively in mental health care*. 19-21 October 2021.

5. Hashad N, Stewart D, Perumal D, Abdulrazzaq NM, Tonna AP. The impact of COVID-19 on antimicrobial stewardship implementation in United Arab Emirates hospitals—an exploration informed by the Consolidated Framework for Implementation Research. *5th UAE International Conference on Antimicrobial Resistance (ICAMR)*. United Arab Emirates: 25-26 March 2022. **Third Winner best poster award**.

6. Hashad N, Stewart D, Perumal D, Abdulrazzaq NM, Tonna AP. The impact of COVID-19 on antimicrobial stewardship implementation in United Arab Emirates hospitals—an exploration informed by the Consolidated Framework for Implementation Research. *Higher Colleges of Technology (HCT) International Conference on Advancements in Health Sciences (ICAHS)*. United Arab Emirates: 8-9 March 2023. **Third place, faculty poster presentation awards**.

7. Hashad N, Stewart D, Perumal D, Abdulrazzaq NM, Tonna AP. A theoretical exploration of the implementation of antimicrobial stewardship programmes: perspectives of key stakeholders, underpinned by the Consolidated Framework for Implementation Research. *6th UAE International Conference on Antimicrobial Resistance (ICAMR).* United Arab Emirates: 17-18 March 2023. **Second Winner best poster award**.

Workshop moderation:

1. Introduction to NVivo use in qualitative research. Workshop for teaching academic faculty. Higher Colleges of Technology, January 2022, Dubai, United Arab Emirates.
2. Theoretically Informed Implementation Research in Health Sciences. Workshop presented during HCT International Conference on Advancement in Health Sciences, March 2023, Dubai, United Arab Emirates.
3. An application of theoretically informed implementation research in pharmacy. Workshop presented during 51st European Society of Clinical Pharmacist (ESCP) Aberdeen symposium, November 2023, Aberdeen, United Kingdom.

Forward

This thesis describes the doctoral research undertaken in pursuit of my PhD on a part-time basis, from Robert Gordon University (RGU), Aberdeen, United Kingdom (UK). The doctoral degree was initiated in February 2017 and completed in August 2023. During the past six years, I explored Antimicrobial Stewardship Programme (ASP) implementation in United Arab Emirates (UAE) acute care hospitals with emphasis on facilitators and barriers to implementation.

In 2004, I obtained my Bachelor in Pharmaceutical Sciences from Faculty of Pharmacy, Alexandria University, Egypt. Soon after graduation, I joined the university hospital as a hospital pharmacist, where I worked for five years (2005 – 2010). During my years of practice in Egypt, I noticed the limited role of pharmacist to medication dispensing, counselling and pharmacy administrative tasks. Since I was eager to expand my knowledge in clinical pharmacy to maximise pharmacist involvement in clinical care where I am practicing, I joined Doctor in Pharmacy degree (PharmD) in Faculty of Pharmacy, Alexandria University in 2007. That was a two years post graduate programme equivalent to Master in Clinical Pharmacy where enrolled students study a variety of courses such as therapeutics, pharmacokinetics, Pharmacoeconomics and pharmacoepidemiology in addition to clinical rotations across all medical and surgical specialities in the university hospital. In May 2010, I accepted a hospital pharmacist job in the Military hospital in Abu Dhabi, UAE, where I had an exposure to pharmacy practice in UAE.

In 2014, I started my academic career by joining Pharmacy programme as a Lecturer in Fatima College of Health Sciences, Abu Dhabi, UAE. Here I felt the need to complement my pharmacy practice and clinical experience with academic research skills through enrolment in a PhD degree.

During 2016 and early 2017, the term Antimicrobial Stewardship Programme (ASP) was gaining the momentum in all medical and pharmaceutical conferences in UAE, especially with the release of mandates by local health authorities to implement ASP in all UAE hospitals as well as inclusion of ASP standard in medication management standards required by Joint Commission for international Accreditation (JCIA) in January 2017. Accordingly, majority of UAE hospitals sought formation of ASP teams and bundles of activities addressing antimicrobial use. Yet, very limited data was available about the implementation context in UAE hospitals and what factors could foster success or failure of ASP implementation which identified the need for this doctoral research.

The doctoral research involved two phases: a systematic review and a qualitative study. In March 2020, COVID-19 pandemic "swept" the world impacting every aspect of our life. Qualitative study participants were significantly impacted by COVID-19 and that was evident in their quotes. Accordingly, the impact of COVID-19 on ASP implementation was separately presented in this doctoral research.

This thesis is formed of six chapters:

Chapter 1 provides a brief overview of Gulf Cooperation Council (GCC) states with specific focus on UAE profile being the site of data generation. It then extends to introduce the issue of antimicrobial resistance (AMR) and its global burden along with the definition of ASP, different types of ASP interventions and outcomes. Also, the need for ASP implementation studies and an introduction to COVID-19 pandemic is presented.

Chapter 2 is a theoretical basis for the adopted research methodology with justification for the selection of paradigm, methodology and method. The theoretical underpinning and choice of Consolidated Framework for Implementation Research (CFIR) is further explained.

Chapter 3 describes the aim, method and findings of the systematic review that mapped ASP implementation studies in GCC states to international standards specifically to Centre for Disease Control and Prevention (CDC) core elements.

Chapter 4 provides a detailed description of the primary research conducted in this doctoral degree where a qualitative study was conducted based on CFIR, exploring ASP stakeholders' perspective regarding ASP implementation with focus on facilitators and barriers to implementation.

Chapter 5 presents the impact of COVID-19 on ASP implementation according to the perspective of ASP key stakeholder who were interviewed at the peak of the pandemic and were understandably highly impacted by the pandemic.

Chapter 6 provides an overview of the doctoral research aims and objectives with focus on its originality, impact and future research.

Abbreviations

ASP	Antimicrobial Stewardship Programme
AD ARS	Abu Dhabi Antimicrobial Resistance Surveillance
AMR	Antimicrobial resistance
APIC	Association for Professionals in Infection Control and Epidemiology
BOS	Bristol online survey
CAQDAS	Computer aided qualitative data analysis software
CDC	Center for Disease Prevention and Control
CDI	*Clostridioides difficile* infection
CDSR	Cochrane Database of Systematic Reviews
CFIR	Consolidated Framework for Implementation Research
CIDRAP	Center for Infectious Diseases Research and Policy
CINAHL	Cumulative Index of Nursing and Allied Health Literature
COM-B model	Capability, Opportunity, Motivation and Behaviour model
COREQ	Consolidated Criteria for Reporting Qualitative Research
COVID-19	Coronavirus disease 2019
CP	Clinical pharmacist
CQUIN	Commissioning for Quality and Innovation
CRD	Centre for Reviews and Dissemination
CRE	Carbapenem-resistant Enterobacteriaceae
DAHC	Dubai Academic Health Corporation
DDD	Defined daily dose
DHA	Dubai Health Authority
DHQP	Division of Healthcare Quality Promotion
DoH	Department of Health
DOT	Days of therapy
EBP	Evidence-based practice
EHS	Emirates Health Services
EC	Emergency Committee
ESBL	Extended Spectrum Beta-Lactamase

FAO	Food and Agriculture Organization
FRAME-IS	Framework for Reporting Adaptations and Modifications to Evidence-based Implementation Strategies
GAHS	General Authority of Health Services
GAP	Global Action Plan
GCC	Gulf Cooperation Council
GCC-IC	GCC Centre for Infection Control
GCP	Good Clinical Practice
GLASS	Global Antimicrobial Resistance and Use Surveillance System
Global PPL	Global priority pathogens list
HAAD	Health Authority of Abu Dhabi
HCT	Higher Colleges of Technology
ICU	Intensive care units
ID	Infectious diseases
IDSA	Infectious Diseases Society of America
IPA	International Pharmaceutical Abstracts
IPC	Infection prevention and control
IT	Information technology
IV	Intravenous
JCIA	Joint Commission for International Accreditation
JHI	Journal of Hospital Infection
JPIAR	Joint Programming Initiative on Antimicrobial Resistance
KPI	Key performance indicators
KSA	Kingdom of Saudi Arabia
MDR	Multi-drug resistant
MDR-M	Multi-Drug Resistant Microorganisms
MENA	Middle East/North Africa
MMS	Medication management standard
MOHAP	Ministry of Health and Prevention
MRC	Medical Research Council
MRSA	Methicillin Resistant *staphylococcus aureus*

NAP	National action plan
NAP-AMR	National Action Plan on Antimicrobial Resistance
NDAT-CTN	National Drug Abuse Treatment – Clinical Trials Network
NDM-1	New Delhi metallo-beta lactamase
NFP-AMR	National Focal Point for Antimicrobial Resistance
NHLBI	National Heart, Lung and Blood Institute
NHS	National Health Services
NICE	National Institute for Health and Care Excellence
NIHR	National Institute for Health Research
OPAT	Outpatient parenteral antimicrobial therapy
PARiHS	Promoting Action on Research Implementation in Health Services
PHEIC	Public Health Emergency of International Concern
PO	Per os (Oral)
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
PRISMA-P	Preferred Reporting Items for Systematic Reviews and Meta-analysis for Protocols
RCT	Randomised controlled trial
REF2014	Research Excellence Framework 2014
RGU	Robert Gordon University
SAP	Surgical antimicrobial prophylaxis
SEHA	Abu Dhabi Health Services company
SHEA	Society for Healthcare Epidemiology of America
TDF	Theoretical Domains Framework
UAE	United Arab Emirates
UK	United Kingdom
US	United States
USA	United States of America
WAAW	World Antimicrobial Awareness Week
WHA	World Health Assemblies
WHO	World Health Organization
WHO-EMRO	World Health Organization Eastern Mediterranean Regional Office

WOAH	World Organisation for Animal Health
ZMH	Zayed Military Hospital

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Chapter 1

Introduction

Chapter 1 Introduction

The overall aim of this doctoral research was to explore the implementation of Antimicrobial Stewardship Programmes (ASP) in United Arab Emirates (UAE). This introductory chapter starts with a brief overview of the Gulf Cooperation Council (GCC) States, with specific focus on UAE which was the site for data generation and place of residence of the doctoral student. The chapter then progresses to describe the phenomenon of continuously progressing antimicrobial resistance (AMR) burden and associated problems. There is an introduction to ASP as one of the crucial pillars in the fight to combat AMR. Since the Coronavirus disease 2019 (COVID-19) pandemic emerged during the process of data generation and heavily influenced the direction of the doctoral research, a section of this chapter introduces the burden of the COVID-19 pandemic on healthcare system, with special focus on UAE.

1.1. Research project setting

This doctoral research was conducted in UAE which is one of the six GCC states. As such, a brief overview of the GCC development and healthcare related challenges followed by the origin of UAE, population, healthcare system and major health imperatives of pressing importance to public health is provided.

1.1.1. Gulf Cooperation Council States

Development of the union

States of the Persian Gulf have long recognised their political, economic, and cultural commonalities. In May 1981, a charter was signed by six states namely: Kingdom of Saudi Arabia (KSA), Bahrain, Oman, United Arab Emirates (UAE), Kuwait and Qatar for the formation of 'The Gulf Cooperation Council (GCC) States' with its headquarters in Riyadh, KSA (See map in Figure 1.1). The GCC is now a continuously developing political and economic union. The basic objectives of the charter are to enhance coordination, integration, and inter-connection between member states in various fields such as: economy, finance, trade, tourism, legislation, administration as well as health and scientific research (1).

Figure 1.1: Map of the Gulf Cooperation Council member states. Adopted from Encyclopaedia Britannica (2)

The nature of the union has expanded to cover healthcare aspects exemplified in the development of 'The Council of the GCC Health Ministers' which identified a set of health affairs' objectives (see Figure 1.2) (3)

Objective one

Development of coordination and cooperation among member states in the preventive, therapeutic and rehabilitative health fields.

Objective two

Identifying the concepts of the various health affairs and the endeavour to unify them, arrange their priorities and adopt common programmes.

Objective three

Opening new channels of convergence with the international experience and enhancing cooperation with the Arab and international health organisations.

Objective four

Procurement of high quality, safe and effective medicaments at appropriate prices through the programme of group purchasing of medicaments and medical supplies.

Figure 1.2: Objectives for GCC cooperation in the field of health (3)

Challenges facing healthcare system in GCC states

The demand on the healthcare system in GCC states is continuously expanding because of several factors. The changing demographic and epidemiologic structure is a major contributor to inflating healthcare expenditure. The GCC population is one of the fastest growing populations, evidenced by data from GCC statistics centre (Figure 1.3), with the highest population numbers in KSA followed by UAE (4). This rapid population growth is a result of several factors such as: increased life expectancy, enhanced healthcare services, industrial growth, and high migrants' population influx to the region. The industrial growth and enhanced healthcare services have led to increase in life expectancy from 62 years in 1970 to 78 years in 2012 (5).

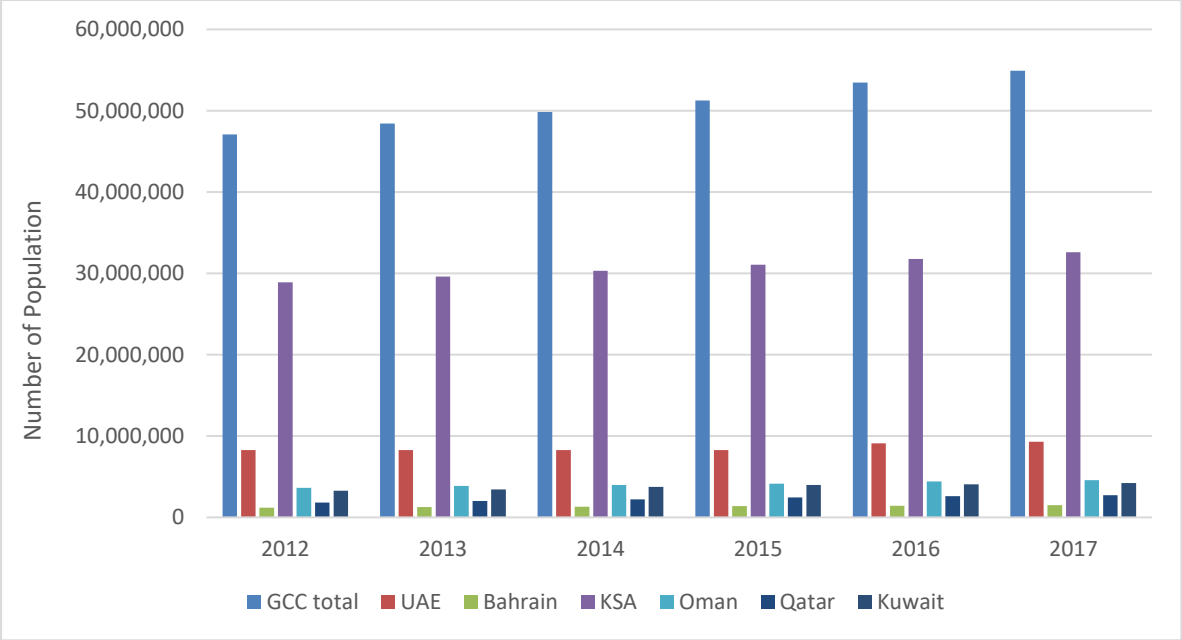


Figure 1.3: Total population of GCC states - Extracted from GCC statistics centre (4)

1.1.2. Profile of United Arab Emirates

Origin, geography, and climate

UAE is a constitutional federation of seven Emirates**:** Abu Dhabi, Dubai, Sharjah, Ras Al-Khaimah, Fujairah, Umm Al-Quwain, and Ajman. It is located at the South-East end of the Arabian Peninsula in Western Asia (see map in Figure 1.4) (6), comprises a total area of 83,000 square kilometres, of which Abu Dhabi, the largest Emirate, and the capital, constitutes about 87% of the total area (7).

Figure 1.4: UAE map and its bordering countries (8)

The federal constitution was developed by the founder of the nation on the 2nd of December 1971, His Highness Sheikh Zayed Bin Sultan Al Nahyan, known as the "Father of the Nation." Prior to this, the Emirates and the surrounding region were a vast desert named the Arabian Peninsula. The community was formed of tribes with the most influential families being the hereditary rulers (Sheikhs). Due to the British interest in the area, agreements were signed with the Sheikhs of the Emirates to form what was then known as the Trucial States. By the year 1971, the British declared their intention to leave, and the Emirates was subsequently formed by the endeavours of Sheikh Zayed (see Figure 1.5) (9).

Figure 1.5: Rulers of Emirates after the flag-hoisting in 1971 (10)

UAE has a desert climate with mild pleasant winter, temperature dropping down to 18 °C (64 °F), and an extremely hot sunny summer, temperature goes up to 49 °C (120 °F) or more (7).

Population demographics

Currently the UAE population is approximately 10.36 million (11). According to the latest population estimates (2020), 87% of the population are expatriates (12). Most of the population are middle aged males, largely due to the influx of male migrants from other countries mainly India, Bangladesh, Pakistan, Egypt, and Philippines (13).

Healthcare system

The health care system in UAE has experienced several revolutionary changes, starting from traditional remedies in the pre-oil era to missionary physicians and limited medical dispensaries and then initiation of the modern medical services by the British government (14). Table 1.1 illustrates the key milestones in the development of the current structure of healthcare system in UAE.

Table 1.1: Key milestones in the development of the structure of healthcare system in UAE (13, 15, 16)

Year	Key milestone	Description
1972	Establishment of Ministry of Health and Prevention (MOHAP)	Established to act as a federal regulatory body responsible for regulation, management, and licensure of health care facilities across the seven Emirates.
2001	Establishment of General Authority of Health Services (GAHS)	GAHS was established by Abu Dhabi government as a separate entity from MOHAP to oversee all the public health facilities in Abu Dhabi Emirate.
2007	GAHS restructuring and establishment of Health Authority of Abu Dhabi (HAAD)	The regulatory authority responsibility was apportioned to Health Authority of Abu Dhabi (HAAD) and the management of governmental health care facilities in the Emirate became the responsibility of Abu Dhabi Health Services Company (SEHA)
	Establishment of Dubai Health Authority (DHA)	DHA was established in Dubai as a separate entity from MOHAP for provision of licensing and regulation of health services in the Emirate of Dubai as well as management of governmental hospitals and clinics. MOHAP focus shifted to Northern Emirates only for both health regulation and management of governmental healthcare facilities.
2016	Establishment of Emirates Health Services (EHS)	EHS was established to take over the management of governmental healthcare facilities in Northern Emirates.
2018	Establishment of Department of Health (DoH)	DoH was established in Abu Dhabi Emirate to take over the responsibilities of HAAD.
2021	Establishment of Dubai Academic Health Corporation (DAHC)	DAHC was tasked to operate all governmental healthcare facilities in Dubai, instead of DHA. The two entities are currently going through a transitional phase where strategic plans and regulations are being concluded.

Abbreviations: DAHC; Dubai Academic Health Corporation, DHA; Dubai Health Authority, DoH; Department of Health, EHS; Emirates Health Services, GHAS; General Authority of Health Services, HAAD; Health Authority of Abu Dhabi, MOHAP; Ministry of Health and Prevention.

Currently the healthcare system in UAE is overseen by three health regulatory bodies, each with its separate jurisdiction. These are the Department of Health (DoH) in Abu Dhabi Emirate, Dubai Health authority (DHA) in Dubai Emirate and Ministry of Health and Prevention (MOHAP) in the Northern Emirates (Ras Al-Khaimah, Sharjah, Ajman, Fujairah, and Umm Al-Quwain). As shown in Table 1.1, the three regulatory authorities in UAE currently do not operate any healthcare facilities, instead they only oversee regulatory issues such as licensing of healthcare providers, facilities, and inspections. The operator role for governmental healthcare facilities has been transferred to other entities to improve and upgrade delivery of services (17). Despite the presence of different health regulatory bodies, partnerships among these authorities have been established to ensure successful achievement of sustainable healthcare goals (18). Figure 1.6 gives the jurisdiction for each health regulatory authority in UAE.

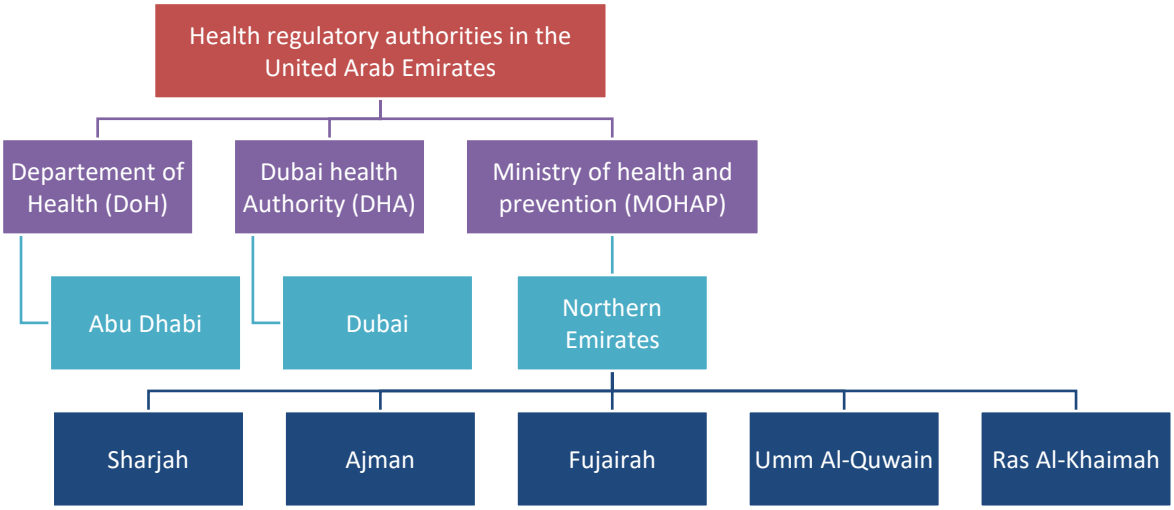


Figure 1.6: Summary of structure of health regulatory authorities in UAE

According to UAE statistical annual report for 2020 issued by Statistics and Research Centre, Ministry of Health and Community, there is a total of 157 hospitals distributed across the seven Emirates representing both governmental and private sectors (19). Distribution of hospitals and beds divided by Emirate and sector is presented in Table 1.2.

Table 1.2: Summary of number of hospitals and beds divided by sector and Emirate (Adopted from UAE statistical annual report 2020) (19)

Emirate	Sector	Number of hospitals	Number of beds
Abu Dhabi	Governmental	24	4185
	Private	40	3504
	Total	**64**	**7689**
Dubai	Governmental	6	2336
	Private	39	3592
	Total	**45**	**5928**
Sharjah	Governmental	8	1089
	Private	16	526
	Total	**24**	**1615**
Ajman	Governmental	4	274
	Private	4	512
	Total	**8**	**786**
Umm al-Quwain	Governmental	2	348
	Private	0	0
	Total	**2**	**348**
Ras al-Khaimah	Governmental	6	1036
	Private	3	84
	Total	**9**	**1120**
Fujairah	Governmental	3	381
	Private	2	138
	Total	**5**	**519**
Total	**Governmental**	**53**	**9649**
	Private	**104**	**8356**
	Total	**157**	**18005**

In 2014, His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice-President and Prime Minister of UAE and Ruler of Dubai, announced a National Innovation Strategy, which prioritises seven sectors to set UAE among the most innovative nations. The seven sectors are: renewable energy, transport, education, health, technology, water, and space (20). Based on that, UAE vision 2021 was established identifying six national priority areas: world-class healthcare, first-rate education system, competitive knowledge economy, safe public and fair judiciary, cohesive society and preserved identity, sustainable environment, and infrastructure. Each priority area has a set of key performance indicators (KPI) which are periodically monitored to measure performance outcomes and achievement of intended goals. World-class healthcare priority area is under sponsor of MOHAP. Table 1.3 gives KPI in the healthcare system along with the most recent scores as announced on UAE vision 2021 official website (21).

Table 1.3: UAE vision 2021 Key performance indicators of healthcare priority area and recently reported scores (21)

Key performance indicator	Definition	UAE vision Target score	2012 score	Most recent score (2019 onwards)
Number of Deaths from Cardiovascular Diseases per 100,000 Population	An indicator that measures the deaths from cardiovascular disease per 100,000 population.	158.2 deaths per 100,000 population.	297.6 deaths per 100,000 population.	84 deaths per 100,000 population.
Prevalence of Diabetes	An indicator that measures the number of people between the age of 20 and 79 with diabetes in UAE, as a proportion of the total population. This age group is aligned with the age group used by the International Diabetes Federation.	16.28%	19.3%	11.809%
Prevalence of Obesity amongst Children	An indicator that measures the proportion of children between the ages of 5 and 17 who are considered obese out of the total children of the same age group. The definition of obesity in children is where BMI is > +2 Standard Deviations with reference to the relevant Z-score chart regarding BMI-for-age.	12%	11.68%	17.35%
Average Healthy Life Expectancy	An indicator that measures the average number of years that a person can expect to live in full health.	73 years.	67.9 years.	66 years.
Prevalence of Smoking any Tobacco Product	An indicator that measures the daily consumption of cigarettes and tobacco products among different segments of society of different ages.	Male - 15.7% Female – 1.66%	Male - 21.6% Female – 1.9%	Male – 15.671% Female – 2.404%
Number of Deaths from Cancer per 100,000 Population	An indicator that measures the deaths from malignant tumours per 100,000 population.	64.2 deaths per 100, 000 population.	99 deaths per 100, 000 population.	26.8 deaths per 100, 000 population.

Key performance indicator	Definition	UAE vision Target score	2012 score	Most recent score (2019 onwards)
Percentage of Accredited Health Facilities	An indicator that measures the share of public and private hospitals adhering to national or internationally recognised standards.	100%	54.7%	91.27%
Healthcare Quality Index	An indicator that measures the quality of healthcare from three perspectives: basic health outcomes, health infrastructure and preventative care, and physical and mental health satisfaction.	Rank 20.	Rank 28.	Rank 36.
Number of Physicians per 1,000 Population	An indicator that measures the average number of physicians per 1,000 population (including general practitioners and all specialties except dentistry).	2.9 physicians per 1000 population.	2.53 physicians per 1000 population.	2.82 physicians per 1000 population.
Number of Nurses per 1,000 Population	An indicator that measures the average number of nurses per 1,000 population.	6 nurses per 1000 population.	3.16 nurses per 1000 population.	6.05 nurses per 1000 population.

Abbreviations: BMI, Body mass index; NKPI, National key performance indicator.

Improvement in recent scores compared to 2012 scores was observed in seven out of ten KPI as illustrated in Table 1.3, which reflects the improvement in healthcare sector in UAE. Notably, 91% of healthcare facilities are accredited by international accreditation bodies. According to the World Health Organization (WHO), accreditation of healthcare facilities is a form of external assessment and evaluation using qualitative and quantitative metrics, to publicly endorse that the healthcare facility meets specific pre-established criteria for clinical and organisational practices placing the facility at an optimum level which allows improvement of performance (22).

Major health imperatives

The top priority health care conditions in UAE are cardiovascular diseases, road traffic accidents, cancer, and respiratory conditions. Respiratory infections represent 16.8% of the total episodes received by health care settings as a principal diagnosis. This might be due to the increased risk of pollution, urbanisation and tobacco smoking especially water pipes smoking devices (Shisha) (13). On referring to the Abu Dhabi capacity master plan issued in 2020, immunology and infectious diseases are on top of the highly required specialty outpatient clinics reflecting a clear health care system demand and shortage in the supply for the infectious diseases specialty (23).

Recently in 2019, Abu Dhabi Emirate established the first Public Health Centre in the region to ensure the presence of a system which oversees the health of the population and ensures safety of workers through the promotion for critical public and preventive health concepts (24). The control of infectious diseases has been prioritised, among others, as strategic functions for the centre. See Table 1.4 for a summary of strategic functions.

Table 1.4: Strategic functions for Abu Dhabi Public Health Centre (24)

Strategic function	Specific aims
1. Governance and management of the Public and Preventive Health System	- Develop and maintain Abu Dhabi Public and Preventive Health System. - Ensure implementing the requirements of the system in an integrated manner, within both Government & Private Sectors. - Develop a system for registering technical service providers and individual working in the field of public and preventive health to ensure the efficiency of related services.
2. Encourage the community to practise a healthy lifestyle	- Raise the level of health awareness among members of community. - Encourage community participation in public and preventive health programmes.
3. Health and safety of workers and environmental health	- Develop and implement worker's health programmes, prevent occupational diseases, injuries, and health conditions related to environmental factors.
4. Improve the quality of life and reduce the financial burden	- Activate early detection programmes for chronic illnesses. - Reduce death rate due to chronic diseases. - Reduce the high rate of obesity in children and adults.
5. Implement an effective system for the prevention and control of infectious diseases	- Develop and improve mechanisms for early detection and control of infectious and emerging diseases.
6. Build and develop sustainable national capacities in public health	- Support and build an integrated system for Emirati national public health researchers.
7. Develop decision making with early warning, innovation, and artificial intelligence	- Develop an integrated smart electronic system for public health information. - Develop an integrated system of investigation and early warning to prevent public health risks. - Develop the disease registry within the artificial intelligence software and systems for early detection of diseases. - Develop medical statistics in innovative ways to enhance public health.

1.2. Antimicrobial resistance

1.2.1. Development and consequences of antimicrobial resistance

Although the terms 'antibiotic' and 'antimicrobial' are commonly used interchangeably, the World Health Organization Eastern Mediterranean Regional Office (WHO-EMRO) has defined antibiotics as those medicines that can prevent and treat bacterial infections. 'Antimicrobial' is a broader term which encompasses bacteria, parasites, viruses, and fungi (25).

According to World Health Organization (WHO), antimicrobial resistance (AMR) is defined as the ability of microorganisms (bacteria, fungus, parasite, or virus) to undergo changes, adapt and continue to grow in the presence of an antimicrobial (26). Microorganisms can naturally adapt to environmental changes, despite their small size and simple structure, through a normal evolutionary process (27). In bacteria this property is achieved through several molecular mechanisms and eventually leads to antimicrobial destruction, modification, alteration in target or reduced antibiotic accumulation (28). WHO has identified the following factors as the main causes of antibiotic resistance: overuse of antibiotics, lack of completion of a prescribed antibiotic course, use of antibiotics in healthy livestock and fishing farms, poor infection prevention and control measures in healthcare facilities, poor hygiene and sanitation and lack of development of new antibiotics (see Figure 1.7) (29). The misuse and overuse of antibiotics is of special focus since it can exert selective pressure leading to the development and acceleration of novel resistance mechanisms (30).

Figure 1.7: Causes of antimicrobial resistance - WHO infographics *(29)*

Increased human population and subsequently increased antibiotic use is another factor, given that in the recent years, the human population has increased to above 7.8 billion. Adding to this, increased urbanisation, living in groups, heavy populated geographical areas, and increased ability to travel all around the globe, are all factors which make it easier to pass new infections to distant communities (31).

AMR is not a recent phenomenon, having developed soon after the revolutionary discovery of penicillin in 1928. Alexander Fleming, known for the discovery of penicillin, warned the communities of bacterial resistance when he received the Nobel Prize for his discovery in 1945 (32). Since then, AMR has been developing against each antimicrobial in varying degrees. Over the past two decades, WHO has been calling for increasing efforts to combat the AMR threat, a recognised global health threat that can lead to serious consequences and challenge medicine practice (33). For example, in many parts of the world especially low- and middle-income countries, treatment of infections such as urinary tract infections, tuberculosis, sepsis, gonorrhoea and foodborne diseases are increasingly challenging due to the development of resistance against commonly used antimicrobials (27). Advances in medical practice which encompass immunosuppressed patients at increased risk of acquiring infections such as cancer chemotherapy, organ transplantation, abdominal surgeries and preterm labour can be threatened by the lack of effective antimicrobials. Notably, the economic burden of AMR affects both the healthcare system and individuals, since treating resistant infections will increase days of hospitalisation, cost of treatment and adds to morbidity and mortality in addition to loss of productivity and income (27, 34). Data from the European Union estimated about 25,000 annual deaths due to multidrug resistant bacteria with an estimated associated cost of 1.5 billion Euros (35). According to the United Kingdom (UK) review of antimicrobials report, around 700,000 deaths due to resistant infections every year are currently reported globally and estimated to reach 10 million annual deaths with 100 trillion United States (US) dollars of economic output by 2050 in case of lack of proactive response to the global threat of AMR (34).

1.2.2. World Health Organization initiatives

The national and global response to combatting antimicrobial resistance has been slow and inadequate according to WHO resources (35), although the essential strategic interventions have been publicised long before through World Health Assemblies' (WHA) issued resolutions (see

Figure 1.8 for summary of resolutions) (36). In 2012, during the conference "Combating AMR: time for action" (Copenhagen, Denmark), the Director General of the WHO, Dr. Margaret Chan stated "*If current trends continue unabated, the future is easy to predict … This will be a post-antibiotic era*". According to WHO, the risk of AMR can lead to life threatening infections that cannot be treated by the currently available antimicrobials, especially that the rate of discovery of new antimicrobials is very low and "*the pipeline is virtually dry*" (37).

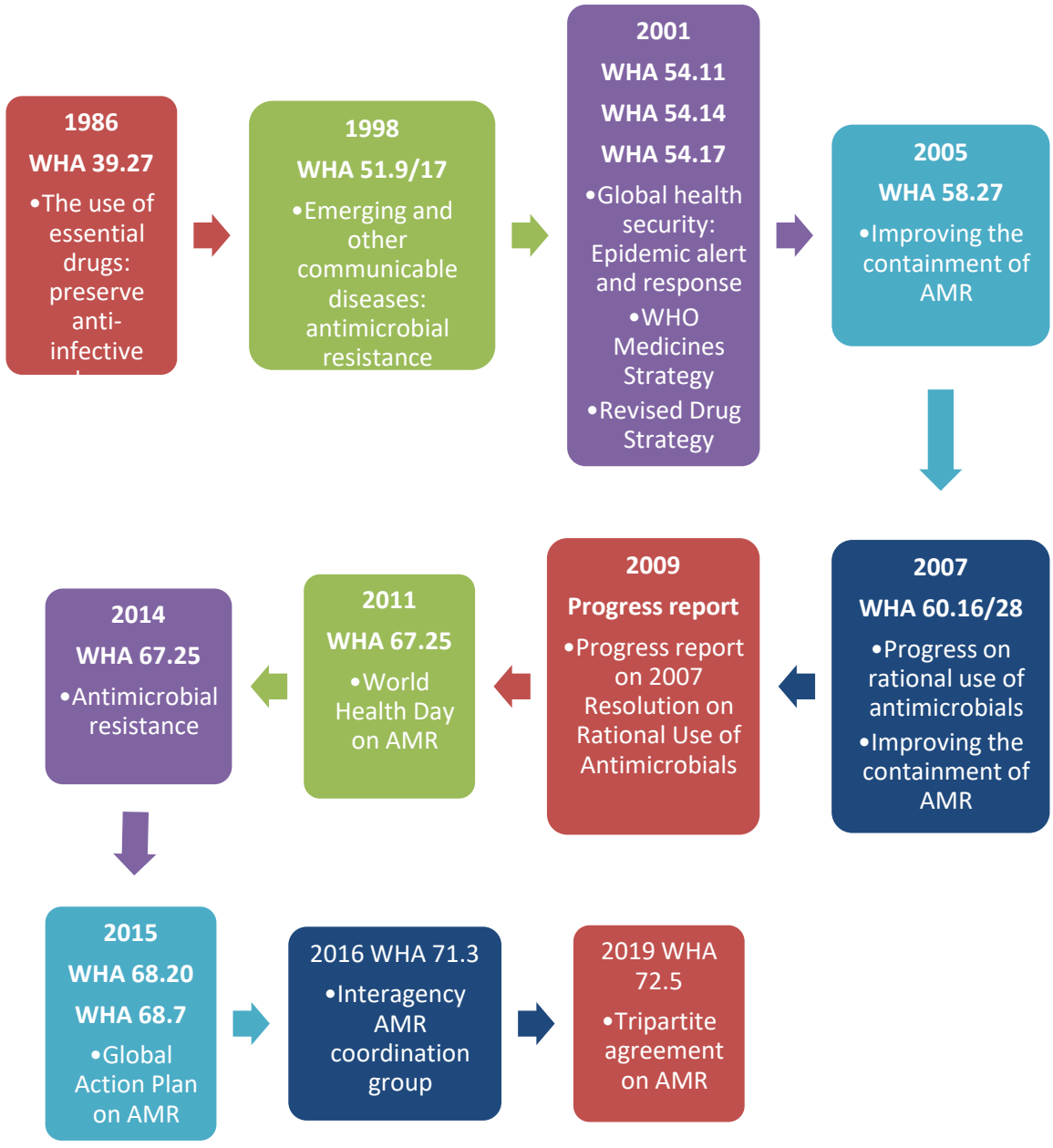


Figure 1.8: Timeline for World Health Assembly resolutions on antimicrobial resistance (36)

In 2009, the WHO identified the core components for infection prevention and control (IPC) to strengthen the capacity of prevention in different AMR national programmes. Since then, AMR has become an evident top priority of action for national health agendas. In 2016, WHO superseded the 2009 document with new guidelines on the core components of IPC which are now considered the cornerstone of all WHO strategies to combat AMR threat and to facilitate development of national action plans to support IPC and fighting AMR (38).

Currently, AMR is presented by the WHO as a discrete programme with strategies to fulfil each core component, as described in the Global Action Plan (GAP) on AMR report issued in 2015 (33). These are summarised in Table 1.5. Notably, WHO have separately presented the coordinated actions for optimising the use of antimicrobials (objective four of GAP), through the implementation of Antimicrobial Stewardship Programmes (ASP). Detailed discussion of ASP will be provided in the following sections.

Table 1.5: Summary of the WHO objectives for the Global Action Plan on antimicrobial resistance (33, 39)

Objective	Description of activities	Applications
1. Improve awareness and understanding of antimicrobial resistance through effective communication, education, and training.	• Raising awareness of AMR not only on a professional level but also on a public level. • For professionals, AMR is a core component in education, training, certification, and continuous education across different sectors of health, agriculture and veterinary practices. • For public audience, promoting behavioural change and including AMR in school curricula to enhance understanding at an early age.	**World Antimicrobial Awareness Week (WAAW)** Global campaign celebrated annually to enhance awareness and understanding of AMR and encourage best practices among the public, One Health stakeholders and policymakers.
2. Strengthen the knowledge and evidence base through surveillance and research	• There is a significant gap in knowledge about development and global economic implications of AMR. Therefore, a global action to emphasis on surveillance and evidence-based research will help to understand patterns and key drivers of AMR. • Information about AMR incidence, prevalence and trends must be gathered.	**Global Antimicrobial Resistance and Use Surveillance System (GLASS)** GLASS has been launched in support of standardising the approach for data collection, analysis and sharing at a global level. The aim is to collect clinical, laboratory and epidemiological data about pathogens that impose highest level of threat on global health. All countries are invited to participate in GLASS and a manual of implementation, documents and tools are provided by WHO.
3. Reduce the incidence of infection through effective sanitation, hygiene, and infection prevention measures.	• Infection prevention can help decrease the spread of resistant microorganisms through effective hand hygiene, sanitation, food and water safety, and vaccination. • Sustainable animal husbandry can reduce the risk of spreading resistant bacteria across the food chain to human.	Multiple applications related to patient safety, infection prevention and control in health care facilities, immunisation, vaccines, and biologicals.

Objective	Description of activities	Applications
4. Optimise the use of antimicrobial medicines in human and animal health.	• Elimination of unnecessary dispensary of antimicrobials in clinical, pharmacy and veterinary practices can help increase their longevity. • Setting the foundation for antimicrobial stewardship through evidence-based prescribing practices and adjusting patient unregulated use of antimicrobials.	**Antimicrobial Stewardship Programme** Through improving antimicrobial use is through evidence-based prescribing, ensuring appropriate use and compliance, discouraging indiscriminate use of antimicrobials besides the educational and regulatory strategies for guidance of patients, healthcare professionals and national authorities. **Surveillance of Antimicrobial Use** Surveillance is essential to track how and why antimicrobials are used by healthcare professionals or patients which can provide future insights and tools that support decision making.
5. Develop the economic case for sustainable investment that takes account of the needs of all countries, and increase investment in new medicines, diagnostic tools, vaccines, and other interventions.	• Most pharmaceutical companies are no longer researching new antimicrobial entities. The pipeline of antibiotic discovery has been dry for years. The global community must encourage research and development of new antimicrobials, diagnostic tools, and vaccines.	**Global Priority Pathogens List** WHO developed a global priority pathogens list (global PPL) of resistant pathogens to help in prioritising the research and development of new antimicrobials.

Since the introduction of the GAP on AMR in 2015 (33), several countries produced their own national action plan (NAP) for combating AMR. The WHO, in collaboration with Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (WOAH), has developed several tools to assist countries in developing a NAP, such as: a manual for developing NAP, several templates and samples for a national plan, a checklist and terms of reference. The site also provides a library of all action plans produced by different countries around the world to consult while developing a NAP (40). The global tripartite (WHO, FAO and WOAH) also produced a database to monitor the progress of individual countries in NAP implementation (39) as presented in Figure 1.9.

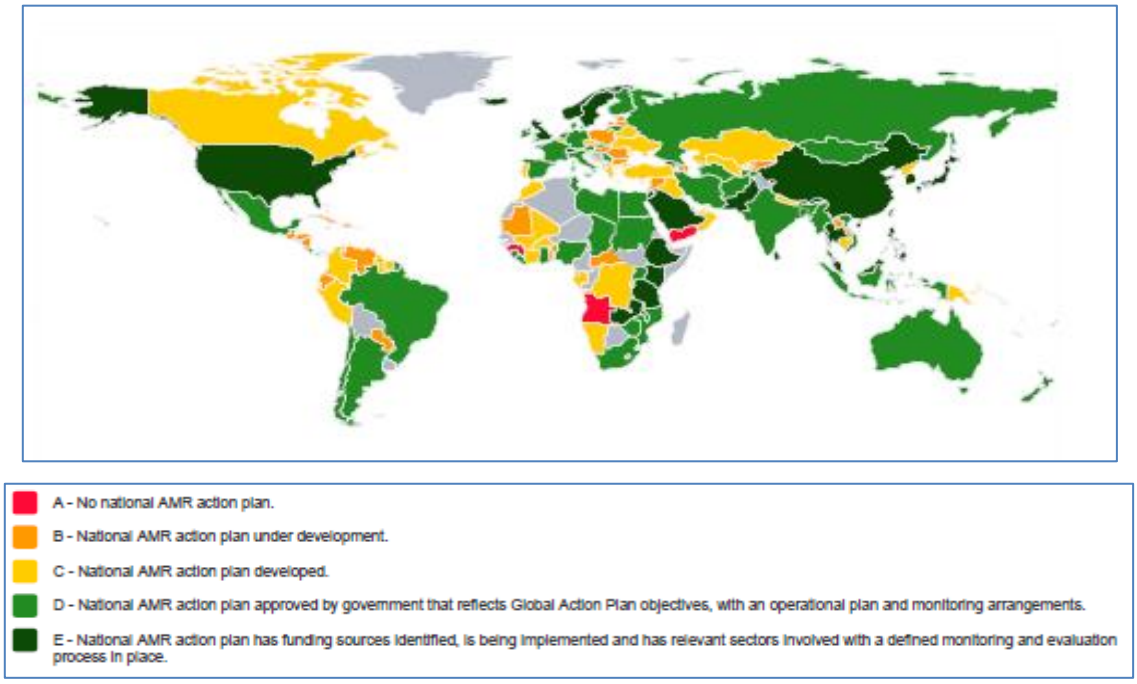


Figure 1.9: Country progress with development of a national action plan on AMR based on 2018-2019 survey responses (39)

1.2.3. Gulf Cooperation Council centre for infection control

As in other parts of the world, the evolving threat of AMR was recognised in the GCC region. Surveillance studies increasingly reported a significant AMR burden including novel and rare resistance mechanisms such as: Extended Spectrum Beta-Lactamase (ESBL) producing bacteria, fluoroquinolone resistant clinical strains, New Delhi metallo-beta lactamase (NDM-1) carrying resistant bacteria and Carbapenemase-producing bacteria (41, 42, 43).

Early reports identified different reasons for resistance development in GCC healthcare systems including: high burden of broad spectrum antimicrobial prescribing, outdated hospital architectural design, lack of robust infection control programmes, lack of trained staff and lack of integrated computerised hospital systems and information technologists (41, 42, 43).

Recognition of the growing burden of AMR led to the establishment of the GCC Centre for Infection Control (GCC-IC) in 2005, which plays a crucial role in infection control in the region and thus complements the efforts of western and other regions in this global initiative. The GCC-IC has been appointed by Ministers of Health of GCC states to include all health care facilities in the Gulf region in its scope of practice. A framework comprising representatives from hospital infection control and public and occupational health has been constructed, collaborating for the prevention and control of infection and infectious diseases (44).

AMR was on top of priorities for GCC-IC meeting in 2013, during which experiences were shared and discussed to define gaps and challenges. By 2015, the centre produced the first GCC strategic plan for combating AMR, which identified five strategic pillars (Figure 1.10) and addressed several aspects (healthcare systems, agriculture, and research) with the major strategic aim being to preserve antimicrobials from increasing resistance development (42).

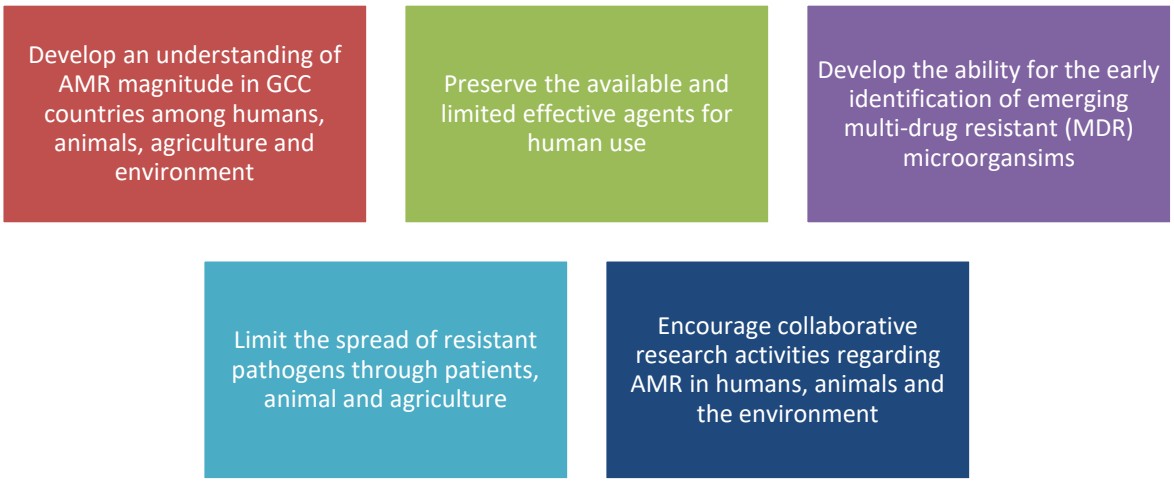


Figure 1.10: GCC strategic plan for combating AMR *(42)*

This was a high-level plan which included general recommendations rather than specific actions to implement ASP and aimed to complement the Global Action Plan issued by WHO. The task of implementation was then handed over to each individual country. There is however a paucity of data on the success or otherwise of the actual implementation of the plan in each of the countries. According to the strategic plan, each of the GCC States is encouraged to adopt a One Health approach and develop their own operational national action plan, which is aligned with WHO recommendations for combating AMR (40, 42)

1.3. Introduction to Antimicrobial Stewardship Programmes

The term 'Antimicrobial stewardship programme' (ASP) has been increasingly used recently to refer to the responsible actions in managing the use of antimicrobials. The term 'stewardship' is defined by Mariam-Webster Dictionary as careful responsible management of something entrusted to someone (45). ASP was introduced for the first time in 1996 by John E. McGowan Jr and Dale N. Gerding in USA to reflect the importance of antimicrobials as a precious non-renewable resource (46). This term evolved differently in different settings; therefore varying definitions have been produced by several organisations concerned with infectious diseases. Variations of definitions span the level of adoption (global, national, healthcare system and individual), context (human health, animal health and environment) and target (antibiotics only or all antimicrobials). Table 1.6 provides a summary of variable definitions for antimicrobial stewardship (programme) by several organisations.

Table 1.6: Definitions of antimicrobial stewardship (programme) by several organisations

Organisation	Definition
World Health Organization (WHO) (47)	**Antimicrobial stewardship:** A coherent set of actions which promote the responsible use of antimicrobials. This definition can be applied to actions at the individual level as well as the national and global level, and across human health, animal health and the environment. **Antimicrobial stewardship programme:** An organisational or system-wide health-care strategy to promote appropriate use of antimicrobials through the implementation of evidence-based interventions.
Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America (IDSA/SHEA) (48)	**Antimicrobial stewardship programme:** Coordinated interventions designed to improve and measure the appropriate use of [antibiotic] agents by promoting the selection of the optimal [antibiotic] drug regimen including dosing, duration of therapy, and route of administration.
Center for Disease Prevention and Control (CDC) (49)	**Antimicrobial stewardship programme:** Hospital based programmes dedicated to improving antibiotic use, can both optimise the treatment of infections and reduce adverse events associated with antibiotic use.
National Institute for Health and Care Excellence (NICE) (50)	The term **'antimicrobial stewardship'** is defined as 'an organisational or healthcare-system-wide approach to promoting and monitoring judicious use of antimicrobials (antiviral, antifungal, antibacterial and antiparasitic medicines) to preserve their future effectiveness'.
Association for Professionals in Infection Control and Epidemiology (APIC) (51)	**Antimicrobial stewardship** is a coordinated programme that promotes the appropriate use of antimicrobials (including antibiotics), improves patient outcomes, reduces microbial resistance, and decreases the spread of infections caused by multidrug-resistant organisms.
Center for Infectious Diseases Research and Policy (CIDRAP) (52)	**Antimicrobial stewardship** encompasses any activity that promotes the judicious use of antimicrobial agents in human medicine, veterinary medicine, and animal agriculture around the globe to help combat antimicrobial resistance and preserve drug effectiveness. In clinical practice, stewardship focuses on coordinated interventions designed to improve and measure the appropriate use of antibiotic agents by promoting the timely selection of the optimal antimicrobial regimen of dose, duration of therapy, and route of administration.

To facilitate successful ASP implementation, several national and international collaborative groups have developed consensus-based interventions (53, 54). Literature indicates that such grouped interventions, in the form of a toolkit, guidelines or framework, have been used in planning, developing, implementing, and measuring the impact of ASPs (54) and in guiding audit (55). Examples of such grouped interventions include: “Start Smart then Focus toolkit” in English hospitals (56) , European Union guidelines for the prudent use of antimicrobials in human health (57), Centers for Disease Control and Prevention (CDC) in United States of America (USA) hospitals (49), and the WHO practical toolkit for ASP in health care facilities in low- and middle-income countries (47). Further details about the importance of CDC core elements will be discussed in Chapter 3.

Given the increased concern about public health issues, in 1946 USA sought to establish a centre for communicable disease, which became an integral component of US Department of Health and Human Services. This centre is now named the Centre of Disease Control and Prevention (CDC) (58). CDC has produced one of the most widely cited frameworks for hospital ASP, grouped into seven core elements: hospital leadership, commitment, accountability, pharmacist expertise, actions, tracking, reporting and education. This was initially published in 2014 (49), then updated in November 2019 reflecting new evidence and experiences gained in the preceding years (59). The current guidance published by the CDC recommends implementing these seven core elements, extracted from several studies and of proven value in optimising antibiotic use. Definitions of the seven core elements and a summary of updates introduced in 2019 version are presented in Table 1.7.

Table 1.7: Definition of ASP core elements by CDC and major updates in 2019 version (59)

Core element	Definition	Major updates for 2019 version
Hospital leadership commitment	Leadership support in the form of human, financial and information technology resources.	Prioritised hospital leadership commitments to place dedicated necessary human, financial and information technology resources on top of their duties.
Accountability	The multidisciplinary team leader and co-leader is a physician and a pharmacist. The two of them are the core of the team and responsible for management and outcomes.	Appoint a co-leadership of physician and pharmacist, reflecting the effectiveness of such co-leadership.
Pharmacy expertise	A pharmacist (co-leader), ideally with infectious disease expertise.	Renamed from 'Drug expertise' to 'Pharmacy expertise' reflecting the importance of pharmacist involvement in stewardship activities.
Action	Implementing at least one of the recommended actions.	Stratified multiple interventions described within the Action core element according to their priority. Also incorporating a section for nurse related actions, reflecting the importance of their involvement.
Tracking	By monitoring antibiotic prescribing trends and pattern of resistance.	Stratify multiple measures within the Tracking core element according to their priority.
Reporting	Regular reports on antibiotic use and resistance patterns to health care professionals.	Emphasise on reporting information related to antibiotic use and antimicrobial resistance to physicians, pharmacists, and nurses.
Education	Education of prescribers is crucial to change prescribing habits and as a motivating tool.	Education through prospective audit and feedback and preauthorisation are highly effective.

The CDC also published core elements for the outpatient setting, which supports the increasing evidence of the value of ASP, not only in the inpatient setting where patients are in critical vulnerable conditions and the possibility of developing multidrug resistance is high, but also in outpatient settings where the indiscriminate antibiotic prescribing trend is high. The core elements for outpatient setting are only four: (1) commitment, (2) action for policy and practice, (3) tracking and reporting, and (4) education and expertise (60)

Different interventions have been identified to implement ASP and choice should be based on facility, resources, and expertise. CDC grouped interventions into: (1) high priority interventions, (2) infection-based interventions, and (3) healthcare professional interventions (provider, nurse, pharmacist, and microbiologist) (59). A summary of ASP interventions as presented in CDC 2019 version is given in Table 1.8.

Table 1.8: Summary of ASP interventions according to CDC 2019 version (59)

CDC core element four: Action	
A. High priority interventions	
Prospective audit and feedback	External review of antibiotic therapy by an expert in antibiotic use who are members of ASP team, accompanied by suggestions to optimise use, at some point after the agent has been prescribed.
Pre-authorisation	Specific antibiotics require physician or pharmacist approval before dispensing, which allows expert input in antibiotic selection and dosing, and prevent unnecessary initiation of antibiotics.
Facility specific treatment guidelines	Hospital specific guidelines for common infections, based on hospital microbiology data, susceptibility results and hospital formulary, which can enhance optimal antibiotic use.
B. Actions focusing on the most common indications for hospital antibiotic use (Common infection-based interventions)	
Urinary tract infections	Common indications for antimicrobial prescribing and presents a great opportunity to optimise antimicrobial selection and duration of use.
Community acquired pneumonia	
Skin and soft tissue infection	
C. Actions focusing on less common indications for hospital antibiotic use (Less common infection-based interventions)	
Sepsis	Early administration of the correct antibiotic can be lifesaving in case of sepsis.
Methicillin resistant *Staphylococcus aureus*	Follow up on microbiology results for clinical cases suspected with MRSA infection and change to a beta lactam antibiotic if the case was proven to be non-MRSA.
Clostridioides difficile	Stop unnecessary use of antibiotics in patients with ***Clostridioides difficile*** infection.
Culture proven invasive infection	Invasive infections such as blood stream infections is a great opportunity to optimise antimicrobial use.
Review of planned outpatient parenteral antibiotic therapy (OPAT)	Decision can be reviewed by ASP team and according to clinical progress of the case OPAT might be recommended or fully avoided.
D. Provider-based intervention	
Antibiotic time out	This is provider-led reassessment of the continuing need and choice of antibiotics when more diagnostic information, especially results of cultures and rapid diagnostics, is available. Usually conducted 48 – 72 hours after initiation of antibiotic treatment.
Assessing penicillin allergy	Using medical history data, physical examination, and challenge dose to avoid unnecessary occurrence of penicillin allergy.
E. Pharmacy-based interventions	
Documentation of indication	Documentation of indication for prescribing antimicrobials can facilitate other actions such as prospective audit and feedback and enhance treatment outcomes.
Automatic IV to oral switch	The use of oral antibiotics, especially those which have good oral absorption can have major contribution in enhancing patient safety. This should be done in the

CDC core element four: Action	
	appropriate clinical context.
Dose adjustment	For patients with organ failure and based on therapeutic drug monitoring data.
Dose optimisation	Such as adjusting dose based on therapeutic drug monitoring, central nervous system penetration and extended infusion for beta-lactams.
Duplicative therapy alerts	Automatic alert in case of duplication of antibiotics which are overlapping in spectrum of activity.
Time sensitive automatic stop order	Especially in surgical prophylaxis.
Detection and prevention of antibiotic related drug-drug interaction	Such as interaction between fluoroquinolones and some vitamins or antacids.
F. Microbiology-based interventions	
Selective reporting of antimicrobial susceptibility testing results	An opportunity to tailor hospital susceptibility reports to show antibiotics that are consistent with hospital treatment guidelines or recommended by ASP team members.
Comments in microbiology reports	Support provider in identifying specimen showing colonisation or contamination.
G. Nursing-based interventions	
Optimising antimicrobial cultures	Techniques for specimen collection to avoid contamination and correct indications for when to collect specimen.
Intravenous to oral transitions	Nurses are aware of opportunities at which oral administration is recommended based on their close follow up for patients.
Promote antibiotic review “time out”	Nurses can prompt re-evaluation of antimicrobial use based on their knowledge of duration of use and availability of microbiology reports.

In the USA, the CDC Division of Healthcare Quality Promotion (DHQP) has been using this framework (seven core elements) to evaluate the level of ASP implementation across acute care hospitals and to identify and define gaps to be addressed at a national level (61, 62). The framework has been also used in several USA studies as an analysis tool to identify gaps in ASP implementation in acute care hospitals (62, 63, 64, 65). In addition, it has been adopted in the development of consensus-based checklists that suits both high and low to middle income countries (54, 55).

Further details on adopting the CDC core elements as a framework to identify areas of deficiency and in evaluation of the magnitude of success of ASP implementation are presented in Chapter 3.

1.4. UAE efforts in fight against antimicrobial resistance

Before 2010, there was a dearth of data about AMR patterns in UAE except for some research efforts reporting decline in sensitivity of microorganisms to antibiotics and the emergence of Multi-Drug Resistant Microorganisms (MDR-M) which had serious implications (66, 67, 68). An early report from a tertiary referral hospital, with limited resources and lacking antimicrobial prescribing restrictions, described increased AMR rates for *Escherichia coli*, *Shigella sonnei*, *Campylobacter spp.*, and *Streptococcus pneumonia* (67). More recent reports identified the significant increase of Methicillin Resistant *staphylococcus aureus* (MRSA), extended spectrum Beta-lactamase producing microorganisms (ESBL) (66) and epidemic Carbapenem-Resistant *Enterobacterales* (69) in hospital isolates.

Different factors might have contributed to the reported continuous rise of AMR. One of the significant causes reported in early studies, prior to 2010, is the low level of control on antibiotic prescribing in UAE health care system. Before inception of formulary restrictions, the only control was the availability of antibiotics in the pharmacy (67). Even when antibiotic policies were in place, there was little evidence on effective implementation of policies. One study from a UAE tertiary referral hospital that adopted the United Kingdom (UK) MRSA guidelines, reported the lack of auditing activities to ensure actual guideline implementation (70). Other factors that might have implicated the rise in AMR is having a multi-national community, where individuals are from different geographical regions, which can lead to changes in the pattern of microbial prevalence as well as changes in the suitable empiric therapy for different infectious

diseases. Also, the increased frequency of travelling abroad for leisure or treatment by UAE community as well as receiving tourists from different destinations, may have impacted AMR rates (67, 71). These factors set the scene for the regulatory authorities to address the problem of emerging AMR in a structured manner.

The Department of Health (DoH) in the Abu Dhabi Emirate was the first to respond to the increased risk of AMR through the establishment of the Abu Dhabi Antimicrobial Resistance Surveillance (AD ARS) in 2010. This was the first electronic surveillance system at an Emirate level. Initially only governmental hospitals were connected to the AD ARS, yet multiple private hospitals were included afterwards (72). Although this system was considered a major positive step, implementing it at an Emirate level and not at a national level was a drawback since Abu Dhabi hospitals receive patients from other Emirates. Accordingly, the need for a national surveillance system emerged, which also matches objective two of GAP-AMR as described by WHO (39). By 2015, AD ARS was expanded nation-wide under the patronage of MOHAP (73). In the following years, multiple initiatives were taken forward by UAE health authorities as summarised in Table 1.9. The importance of endorsing ASP implementation in UAE hospitals was also recognised through the issuing of national ASP mandates by local health authorities (74, 75, 76).

Table 1.9: A summary of UAE response to WHO global efforts in the fight against AMR (73, 77)

Date	UAE initiative
2010	Establishment of Abu Dhabi Antimicrobial Resistance Surveillance (AD ARS).
April 2014	UAE Higher Committee for Antimicrobial Resistance was established by MOHAP.
2015	Antimicrobial Surveillance system was expanded nation-wide by MOHAP.
May 2015	A delegation from the UAE, led by UAE Minister of Health and Prevention, attended the 68th World Health Assembly (WHA68.7) in Geneva, where all member states adopted the GAP-AMR.
June 2015	MOHAP issued a resolution to: • Implement the proposed actions for member states in the GAP-AMR, adapted to national priorities and specific contexts. • Mobilise human and financial resources through domestic, bilateral, and multilateral channels to implement plans and strategies in line with the GAP-AMR. • Establish UAE NAP-AMR that is aligned with the GAP-AMR.
2016	• MOHAP appointed a UAE National Focal Point for AMR (NFP-AMR) for the human health sector. • UAE Ministry of Climate Change and Environment appointed a National Focal Point for AMR for the animal health sector.
2017	DoH issued standard mandating ASP implementation in Abu Dhabi hospitals.
2017	UAE Higher Committee for Antimicrobial Resistance was re-established as National AMR Committee which oversees: 1. Sub-Committee for AMR Surveillance. 2. Sub-Committee for ASP. 3. Sub-Committee for IPC in Healthcare Sector. 4. Sub-Committee for Improving prevention and control of AMR in the food animal and environment sector.
2018	UAE starts contributing to GLASS established by WHO.
2018	DHA issued a circular mandating ASP implementation in Dubai hospitals.
2019	MOHAP issued policy and procedure standard mandating ASP in MOHAP hospitals.
2019	The first UAE National Action Plan on Antimicrobial Resistance (NAP-AMR) 2019-2023 was issued by UAE Higher Committee for AMR in collaboration with WHO-EMRO.

Abbreviations: AMR; Antimicrobial resistance, ASP; Antimicrobial Stewardship Programme, DHA; Dubai Health Authority, DoH; Department of Health, GAP-AMR; Global Action Plan on AMR, GLASS; Global Antimicrobial Resistance and Use Surveillance System, MOHAP; Ministry of Health and Prevention, NAP-AMR; National action plan on antimicrobial resistance, UAE; United Arab Emirates, WHO; World Health Organization, WHO-EMRO; World Health Organization - Eastern Mediterranean regional office

As previously described, UAE hospitals are obliged to seek international accreditation to secure the best patient outcomes in accordance with UAE Vision 2021 (21). The Joint Commission for International Accreditation (JCIA) is one of the most sought-after bodies by UAE healthcare facilities to achieve international accreditation. Currently around 216 UAE based healthcare facilities are endorsed on the JCIA webpage (78). In 2017, JCIA announced ASP standard as a new medication management standard (MMS), which mandates the establishment of ASP to showcase quality in medication management (79). This decision further strengthened ASP implementation in UAE healthcare facilities.

1.5. ASP implementation

1.5.1. Implementation research

Implementation research is defined as "*the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices (EBP) into routine practice, and hence, to improve the quality and effectiveness of health services*" (80 p. 3). It has been increasingly adopted in healthcare systems to examine translation of research-based knowledge into practice, explore best implementation strategies and identify contextual factors impacting decisions to initiate or scale-up healthcare interventions (81).

The outcome of implementation of healthcare interventions can differ from one setting to another due to the impact of contextual factors that require embedding adaptations to the intervention to render it successful. Contextual factors include health system design and resources, implementers such as healthcare professionals, and organisational behaviour (81).

Implementation research can be designed to target multiple aspects of implementation for a healthcare service such as: (1) implementation process reporting, (2) implementation outcomes, (3) factors impacting implementation and (4) sustainability and scalability of the healthcare service (82).

1.5.2. The need for ASP implementation studies

Despite the vast number of ASP effectiveness studies, there is an acknowledged gap in implementation research ASP studies to transition from theoretically informed ASP practices to impactful ASP implementation (83, 84). Several factors are key challenges to ASP

implementation at both organisational and personal levels, affecting an array of processes, groups, and individuals (85). Implementation research has been prioritised by leading experts of the Joint Programming Initiative on Antimicrobial Resistance (JPIAR), to provide in-depth, comprehensive understanding of facilitators and barriers to ASP implementation (84). In particular, a recently released statement by the Society for Healthcare Epidemiology of America (SHEA) highlighted the value of theoretically informed implementation research in leveraging ASP implementation, addressing multiple inter-related factors leading to better understanding of ASP implementation processes (85).

1.5.3. State of knowledge at time of PhD inception

At inception of the doctoral studies, an initial literature search was conducted as a preparatory step to identify all systematic reviews related to ASP implementation in institutionalised settings. The search was conducted (from inception to 2017) in databases of Medline, Cumulative Index of Nursing and Allied Health Literature (CINAHL), International Pharmaceutical Abstracts (IPA), Science Direct and Google Scholar using the following search string:
(Antimicrobial OR antibiotic OR antibacterial)
AND
(Stewardship OR prescribing practice OR program*)
AND
(Systematic review OR review OR overview).

Ten systematic reviews focusing on ASP implementation within institutionalised settings were identified (86, 87, 88, 89, 90, 91, 92, 93, 94, 95). The aims of these reviews were diverse, including: characterising and describing ASP interventions, assessing the impact of ASP on antimicrobial use, determining effectiveness or efficiency of ASP, and exploring the use of behaviour change techniques such as self-monitoring, feedback, goal setting and action planning in improving antimicrobial prescribing. While most were not restricted by country, some focused on specific areas of the Asian Pacific (92) and the Middle East (90). Similarly, a few studied aspects of ASP implementation in the specific clinical areas of emergency department, critical care, and paediatrics (86, 88, 95).

The heterogeneous nature of the review aims, populations and outcome measures reduced the potential for pooling review findings. However, one recurring conclusion was the lack of high-quality robust study design, data generation and analysis (88, 89, 92, 95). From these ten

systematic reviews, it was evident that interventions which included clinical audit and performance feedback, clinical antimicrobial guidelines implementation and the use of decision support systems were shown to be effective (88). There was, however, uncertainty as to the optimal and most cost-effective combinations of interventions (88, 90, 93).

Findings of the ten systematic reviews provided some evidence that ASP interventions can significantly impact patient outcomes (e.g., reduced length of hospital stay and mortality) and microbiological outcomes (e.g., a reduction in AMR and *Clostridium difficile* infection). However, it was also clear that there was a lack of any systematic review which focused specifically on: comparison of ASP interventions to international guidance statements, a wide range of outcome measures, and facilitators and barriers to ASP implementation, sustainability, and scalability. ASP outcome sustainability refers to maintaining the same level of accomplished outcomes on a long-term basis, while outcome scalability refers to expanding ASP implementation to other sectors of the same facility or other institutions (96).

Identification of facilitators and barriers to ASP implementation was a secondary review objective for only two systematic reviews (87, 93). Most of the studies included in these two reviews did not specifically address facilitators and barriers as a study aim, accordingly only a small number of facilitators and barriers were reported. Notably, no qualitative studies were included, with the majority adopting a quantitative approach including a randomised controlled trial, a retrospective cohort, and an uncontrolled before-after design. Adopting a qualitative approach can allow in-depth exploration of the facilitators and barriers related to study context. Facilitators included the value of multi-disciplinary approach, respecting professional autonomy, availability of ASP team at point of care and the importance of human resources and the use of information technology in delivering ASP interventions. Barriers included variation in acceptability and adherence to clinical antimicrobial guidelines and poor attendance at ASP educational sessions.

Notably, only one of the ten systematic reviews was based on studies conducted within the Middle East including studies from the six GCC states: Kingdom of Saudi Arabia (n=6), Qatar (n=3), UAE (n=2), Oman (n=2), Kuwait (n=1) and Bahrain (n=1) (90). The primary objective of this systematic review was to assess antimicrobial utilisation and prescribing behaviour in hospital settings. Of the 20 studies included, only two studies reported the use of proactive core interventions as positively affecting prescribing behaviours through audit and feedback. The

remaining primarily described adherence of antimicrobial prescribing to local/national policies or international guidelines (90). One key finding was the need to consider cultural issues and the healthcare setting in developing and implementing strategies. This review could identify a few facilitators based on review findings which were effective multidisciplinary collaborative approach and the value of collating baseline surveillance data to guide choice of ASP interventions.

Multiple gaps were established through this preparatory literature search and informed this doctoral research:

First, most systematic reviews identified focused mainly on ASP implementation processes and outcomes as their primary aim, and only very few explored facilitators and barriers impacting implementation as their secondary aim (87, 93).

Second, studies reporting facilitators and barriers included in these systematic reviews adopted a quantitative approach to assess ASP implementation and outcomes. The use of a qualitative approach can provide further in-depth exploration of contextual factors impacting implementation. A detailed comparison of quantitative and qualitative approaches is available in Chapter 2.

Third, none of the studies reporting facilitators and barriers paid attention to the use of theory in exploring implementation. The use of theory can be useful at multiple levels: providing guidance for study design and conduct, and aiding interpretation of study findings (97). The value of using theory in implementation research is further detailed in Chapter 2.

Fourth, many systematic reviews reported the lack of ASP implementation studies with high-quality robust study design, data collection and analysis. A recently conducted systematic review assessing the methodological quality of studies evaluating ASP interventions identified the limited overall quality of ASP studies that did not improve over time, which limits its validity and translation of research findings to clinical practice guidelines (98). This observation dictates the need for ASP studies with high methodological quality.

Fifth, only one systematic review included GCC states among other Middle Eastern countries (90), while the rest were either without geographical restrictions or focusing on Asian Pacific

region (92). The majority of the systematic reviews were from western communities and their findings cannot be generalised or transferred to GCC states and specifically to UAE. This is because local inner environment of an organisation, external outer environment, personal behaviour, and culture are all intercalated variables that intervene in the success of ASP implementation even when adopting strategies known to be effective elsewhere.

Therefore, the need for a robust and rigorous programme of research exploring ASP implementation in UAE healthcare context has been identified. The use of theory as an underpinning throughout the research journey can help strengthen the relevance and rigour of findings to understand key determinants impacting ASP implementation.

1.6. COVID-19 pandemic and its impact on Antimicrobial Stewardship Programmes

On the 31st of December 2019, a cluster of pneumonia cases were reported by Wuhan Municipal Health Commission originating from Wuhan, Hubei province - China, identified as a novel coronavirus outbreak that was eventually named Coronavirus Disease 2019 (COVID-19). Soon after, in January 2020, the WHO set up the Emergency Committee (EC) which revised the situation and provided consensus recommendation to WHO Director General to announce the outbreak of a Public Health Emergency of International Concern (PHEIC), and a global pandemic in March 2020 (99). To date, according to WHO COVID-19 dashboard, close to seven million deaths have been reported worldwide due to COVID-19 infection and associated complication (100). The WHO recommended self-isolation, distancing, and personal hygiene to restrict the viral spread (101). Yet many governments worldwide imposed public movement restrictions ranging from overnight curfew to a complete lockdown in efforts to contain the infection, delay surge in demand on hospital beds and protect vulnerable populations of older people, pregnant females, and patients with comorbidities (102). All restrictions led to significant mental, economic and health consequences all around the globe (103).

The literature describes the temporary disruption in delivery of routine healthcare services to non-COVID-19 patients following the initial outbreak of the pandemic. This has been attributed to several causes such as: patients' concern regarding risk of infection leading to self-medication for acute illnesses and refraining from emergency room visits. Other causes identified include cancellation of some services such as elective surgeries, medications reviews and routine health

checks so that healthcare professionals are available for COVID-19 patients' clinical care (104, 105).

The disruption caused by COVID-19 on ASP has been acknowledged yet not explored in-depth (106, 107). Published research addressing the impact of COVID-19 on ASP implementation is largely in the form of letters (108), commentaries (107, 109) or short communications (110). A literature search retrieved one UK based survey of all antimicrobial leads in UK hospitals. Results identified short-term disruption of ASP activities including disregarding ASP team recommendations, interrupting ASP regular activities and logistical difficulties in conducting ASP team meetings and rounds (106). This led to a negative impact on ASP outcomes, of most concern was a global surge in antimicrobial consumption associated with the management of COVID-19 patients and subsequent emerging antimicrobial resistance. A meta-analysis estimates that more patients have been prescribed antibiotics that are likely to have been co-infected with a bacterial infection (107, 111).

There has also been positive impact of the pandemic on the delivery of healthcare, including an accelerated development and reform, specifically adopting digital healthcare solutions, adapting the role of healthcare providers, closer collaboration between private and governmental sectors and expanding the remit of primary care and family medicine (112, 113, 114). This rapid reform has also affected ASP activities, where efforts to resume ASP practices described through embracing technology to facilitate ASP meetings and rounds, upgrading existing electronic health systems, increasing use of procalcitonin to differentiate between viral and bacterial infections and increased adoption of outpatient parenteral antimicrobial therapy (OPAT) (106, 110). ASP team members have efficiently contributed to the pandemic relief effort through their roles in novel antiviral clinical trials, COVID-19 disease management guideline development, repurposing prospective audit and feedback, formulary restriction and pre-authorisation to support COVID-19 patients (107, 115).

The impact of COVID-19 on ASP implementation is presented separately in Chapter 5.

1.7. Aims and objectives of this doctoral research

The overall aim of the doctoral research was to explore ASP implementation in acute care hospitals in UAE. The following are the doctoral research phases described in terms of the research designs and the associated aims and objectives.

Phase one: Systematic review

The aim of this systematic review was to critically appraise, synthesise and present the available evidence on ASP implementation in acute care hospitals in the GCC states. Review objectives were to:

1. Compare ASP interventions in GCC states with reference to the CDC framework.
2. Identify facilitators and barriers to effective ASP implementation in GCC states.

Phase two: Qualitative study (semi-structured interviews)

The overall aim of the research was to explore ASP implementation in UAE hospitals. The specific research objectives were to:

1. Explore the perspectives and experiences of key stakeholders regarding ASP implementation in UAE hospitals.
2. Identify key facilitators and barriers for ASP implementation.

Qualitative study methodology and findings are presented in Chapter 4. Since data generation during the qualitative study was heavily impacted by COVID-19 pandemic, quotes representing participants views of the impact of COVID-19 on ASP implementation were analysed and presented separately in Chapter 5.

1.8. Chapter summary

This chapter provides a general introduction for the research project context in UAE as well as an introduction to the escalating challenge of AMR and the subsequent development of ASP. The following chapter will present the methodological underpinning for the doctoral research project.

2

Chapter 2

Methodology

Chapter 2 Methodology

2. Introduction to the chapter

This chapter provides the theoretical basis of the adopted methodology for the doctoral research. Comprehensive justification is provided for the selection of research paradigms, methodologies, key methodological approaches, and where appropriate the use of underpinning theories and frameworks such as the Consolidated Framework for Implementation Research (CFIR). Steps to ensure good research governance are described.

The doctoral research was carried out over two phases. A justification of choices made will be the focus of this chapter.

Doctoral research phases:

1. **Phase one: Synthesis of findings from the literature**

A systematic review mapping hospital ASP in GCC States against international standards. See chapter 3 and the associated published outputs:

- Systematic review proposal registered in the International Prospective Register of Systematic Reviews (PROSPERO) (116)
- Systematic review abstract published as conference proceedings (117)
- Published complete systematic review (118)

2. **Phase two: Data generation**

Theoretical qualitative exploration of ASP implementation in UAE hospitals using semi-structured online interviews conducted with ASP team members and non-members. See chapter 4 and the associated published outputs:

- Chapter 4 abstract published as conference proceedings (119)
- Chapter 4 published study (120)

Quotes representing participants views regarding the impact of COVID-19 on ASP implementation have been analysed and presented separately in chapter 5 and associated published outputs:

- Chapter 5 abstract published as conference proceedings (121)
- Chapter 5 published study (122)

2.1 Literature review (Phase 1)

2.1.1 Introduction

A literature review is defined as an objective thorough summary and critical analysis of the available literature on a specific topic. Characteristics of a good literature review include acknowledging potential bias, clear search, and selection strategy as well as referencing (123).

A literature review was included as phase one to enhance the doctoral student's knowledge and background of the most up-to-date literature in the field of ASP. It also allowed identification of the research gap and potential for future research in this area. According to Creswell et al 2023 (124), the following are some of the purposes for carrying out a literature review:

- To share results of other studies related to the researched topic.
- To provide a framework to establish importance of the study.
- To create a benchmark to compare findings of studies.

Fourteen different types of reviews have been identified by Grant and Booth (125) with the most used ones presented in Table 2.1.

Table 2.1: Types and key characteristics of different reviews (125)

Review Type	Definition	Synthesis of findings
Systematic review	Systematically search for, appraise, and synthesise research evidence, often adhering to guidelines on the conduct of a review.	Typically narrative with tabular representation.
Meta-analysis	Combining results of quantitative studies using statistical techniques to provide a more precise effect of the results.	Graphical and tabular with narrative commentary.
Umbrella review	A review which compiles evidence from multiple reviews into one document. Focuses on a problem for which there are competing interventions and highlights reviews that address these interventions and their results.	Graphical and tabular with narrative commentary.
Literature review	Published material that can cover a wide range of subjects that examine recent or current literature.	Typically narrative.
Scoping review	A review which aims to identify nature and extent of research using preliminary assessment of potential size and scope of available research literature.	Typically tabular with some narrative commentary.
Overview	A generic term describing an attempt to survey the literature and describe its characteristics.	Synthesis depends on whether systematic or not. Typically narrative but may include tabular features.

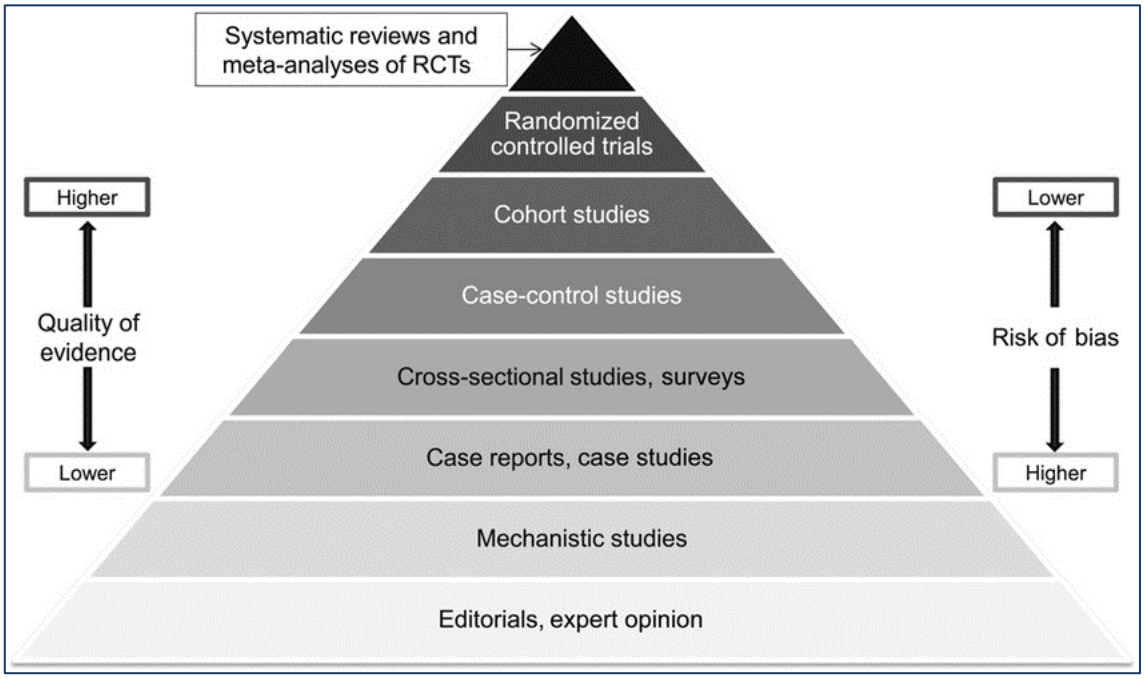
2.1.2 Review types conducted in the doctoral programme

At the outset of the doctoral research, a review of the literature was conducted to determine what was already known about ASP and to identify potential gaps in research that could be addressed in the doctoral study for potentially informing practice in UAE and beyond. This identified multiple published systematic reviews addressing various aspects related to ASP in hospitals. To develop a clear understanding of the selected topic, the doctoral student conducted a systematic review about ASP implementation in GCC states. Further details about the choice of GCC states as geographical location for systematic review is available in Chapter 1. The preference of systematic review over other types of review was for multiple reasons:

- Provides clear comprehensive overview of evidence on a specific research question.
- Refines literature search conclusion through assessment of quality of evidence.
- Highlights any methodological concerns in published studies that could be addressed in the doctoral project.
- Gains critical analysis and synthesis skills for future research.
- Identifies research gaps for the doctoral project development.

2.1.3 Systematic review organisation, protocol development and reporting

Systematic reviews are located on top of the hierarchy pyramid of evidence-based literature (see Figure 2.1). This pyramid qualitatively presents the amount and strength of evidence expected from each study design. Therefore, systematic reviews are captured as presenting the highest quality of evidence along with the lowest risk of bias in comparison to other types of literature (126).



Abbreviation: RCT; Randomised controlled trial.

Figure 2.1: Hierarchy pyramid of evidence-based literature (126)

A systematic review is considered a reproducible piece of observational research, where a protocol is constructed at the outset describing the strategy to minimise selection bias while allowing reproducibility of literature retrieval. This protocol development step differentiates a systematic review from a literature review (127). Literature reviews do not require objective and systematic selection criteria of studies, leading to research findings that may represent the author's perspective rather than remaining focused on an initial research question (128). For this doctoral degree, a systematic review was selected rather than a literature review for the reasons outlined above and to minimise bias through extraction of knowledge related to the topic and its subsequent critical analysis. Conducting a systematic review follows a set of steps which is presented in Table 2.2.

Table 2.2: Steps for conducting a systematic review (127)

Steps	Description
Development of protocol	Protocol will define research question (PICO), inclusion and exclusion criteria, search strategy and databases.
Selection of studies	Selection of studies should be based on application of search strategy on the pre-defined databases taking in consideration inclusion and exclusion criteria.
Assessment of risk of bias	Critical appraisal of included studies to assess methodological quality should be reported in detail.
Data extraction	Independently conducted by two reviewers. Reasons for exclusion should be documented.
Data synthesis	Methods for pooling of data should be described in the protocol. Any reason for deviation from protocol should be clearly reported with justification.
Conclusion based on data	Conclusion should be based on data retrieved including quality assessment of studies.

Abbreviation: PICO; Population-intervention-comparator-outcome

Multiple organisations have set criteria for protocol development and registration of systematic reviews such as the Centre for Reviews and Dissemination (CRD) at the University of York through PROSPERO (129), Cochrane Collaboration (130), Campbell Collaboration (131) and Joanna Briggs Institute (132). According to PROSPERO website (https://www.crd.york.ac.uk/prospero/), researchers are advised to search PROSPERO registrations for a similar previous or ongoing systematic review prior to embarking on a systematic review so that they can avoid duplication of work. The presence of such registries also enables evaluation of bias, where researchers can compare the protocol to the completed published systematic review.

Furthermore, to enhance the quality of reporting of systematic reviews and ensure production of a transparent, complete, and accurate record of what has been carried out, it is recommended to follow guidelines specifically designed for this purpose. The most widely used are the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA). These provide guidance, a checklist and a flow diagram that can support development and final reporting of systematic reviews (133), thus enhancing the quality and ensuring that the final product will be beneficial to users and inform practice.

The systematic review protocol prepared by the doctoral student and supervisory team was registered with PROSPERO (129), followed PRISMA-P guidance for protocol development and the

PRISMA statement and checklist for final reporting. The full details of the systematic review are provided in Chapter 3.

2.2 Research methodology

Research methodology is a description of the general strategy by which research has been conducted, including beliefs and philosophical assumptions underpinning the choice of the research method. It is also considered the lens through which the analysis has occurred (134).

2.2.1 Research philosophy

Research philosophy is defined as 'a system of beliefs and assumptions about the development of knowledge' (135). It has also been termed as 'worldview' or 'paradigm' referring to the general philosophical orientation researchers embed into a study usually influenced by previous research experience, the discipline, knowledge, and mentors (124). It also represents the perspective held by a group of researchers based on shared assumptions, practices, and values (136).

When commencing research, several assumptions are made by researchers to clarify the research philosophy (135) and to justify the overall research approach:

- Ontological assumptions (assumptions regarding nature of reality).
- Epistemological assumptions (assumptions regarding knowledge).
- Axiological assumptions (assumptions regarding influence of beliefs and values on the research).

Four different paradigms (philosophical approaches) have been identified (124). Table 2.3 provides a brief description of each.

Table 2.3: A Brief description of the four major philosophical approaches (124)

Philosophical approach (paradigm)	Brief description
Postpositivist	Traditional form of research where researchers are attempting to identify causes which affect outcomes. Research process starts with a theory, then data is collected objectively to refine or refute the theory.
Constructivist	Rely on participants' views of the topic being researched, where researchers will use broad open-ended questions to attempt to understand the world in which participants live and work providing subjective meanings of their experiences.
Transformative	Includes researchers who are interested in marginalised individuals in our society, issues related to discrimination, and oppression.
Pragmatic	It combines facts and experience of individuals where researcher combine both qualitative and quantitative techniques, reconciling both objectivism and subjectivism.

Postpositivist and constructivist are considered the two most major philosophical assumptions commonly adopted. Table 2.4 sheds the light on the most important assumptions related to them.

Table 2.4: Summary of philosophical assumptions related to postpositivist and constructivist approaches (135)

Assumptions	Postpositivist	Constructivist
Ontological assumption (nature of reality)	Fixed, stable, observable and measurable, one true reality, independent.	Flux of processes and experiences. Typically complex and rich, socially constructed through experience of individuals.
Epistemological assumption (what constitutes acceptable knowledge)	Using scientific methods to collect measurable, quantifiable and observable facts.	Focus on narratives and stories. Knowledge is gained through understanding of other's experience.
Axiological assumption (role of values)	Researcher is value-free, detached and independent. Presence of subjectivity or bias can lead to error.	Researcher's interpretation is key to understanding while learning participants' subjective ideas.
Methodological research strategy	Quantifiable methods only, experimental, quantitative, typically deductive using high sample size.	Qualitative methods only, typically inductive in nature, low sample size, employing in-depth qualitative investigations.

2.2.2 Methodological choice

The research continuum is a term coined to indicate the methodological approach to research, which can be purely quantitative or purely qualitative. Other types of research can fall at any point of the continuum to include different aspects of both qualitative and quantitative (136).

Mixed methods approach, which is a mixture of both qualitative and quantitative, is gaining acceptance to improve research findings since researchers can gain insights beyond the information provided solely by either qualitative or quantitative (124). Table 2.5 provides a summary of differences between qualitative and quantitative research approaches.

Table 2.5: Summary of differences between quantitative and qualitative approaches (136, 137)

Aspect	Quantitative research approach	Qualitative research approach
Definition	An approach for testing objective theories by examining the relationship among variables.	Exploring and understanding the meaning individuals or groups ascribe to a social or human problem.
Scientific method	Confirmatory, where researcher is testing hypothesis and theory.	Exploratory, where researcher generates and constructs knowledge from data collected during fieldwork.
Reasoning process	Deductive, from general to specific. Researcher starts with a general idea then develops a theory and hypothesis from it that can be tested by data.	Inductive, from specific to general. Researcher starts by collecting data and building up observations for testing from them.
Research focus	Narrow, specific.	Broad, complex.
Ontology (i.e., nature of reality/truth) (Researcher stance)	Objective – structural, unbiased and neutral.	Subjective – constructed, subjectivity is a reality to be acknowledged.
Epistemology	Universal scientific standards, Scientific realism, search for truth.	Varying standards, relativism, based on individual's justification.
Axiology	Researcher is independent from data (objective stance).	Researcher is part of what is researched (subjective stance).
Methodology (strategy)	Descriptive, correlational, quasi-experimental and experimental.	Narrative, ethnography, phenomenology, grounded theory, and case study.
Focus	Narrow angle lens, testing specific hypothesis.	Wide angle, in-depth lens, examining breadth and depth of a phenomena.
Nature of data	Numerical data, variables.	Non-numerical data such as text and pictures.
Data collection instrument	Structured and validated tools for quantitative data collection such as questionnaires.	Researcher is the primary data collection tool, collecting qualitative data such as open-ended questions, field notes and observations.
Questions asked	How many and how much?	How, why and what?
Data analysis	Determine statistical relationship between variables.	Descriptive data, identify themes, features and patterns.
Results	Generalised from sample to population.	Particularistic findings.
Final reporting	Statistical report with correlations and measurements of statistical significance.	Narrative with quotes of participants and detailed contextual description.

2.2.3 Summary of the selected research approach

Based on the systematic review findings (see Chapter 3), which aimed to critically analyse and appraise the available literature about ASP in the GCC region, the decision was to focus on adopting a qualitative approach for the reminder of the doctoral degree time frame, using constructivist philosophical assumptions and phenomenological qualitative methodology. Figure 2.2 presents the research approach adopted for phase two of doctoral degree.

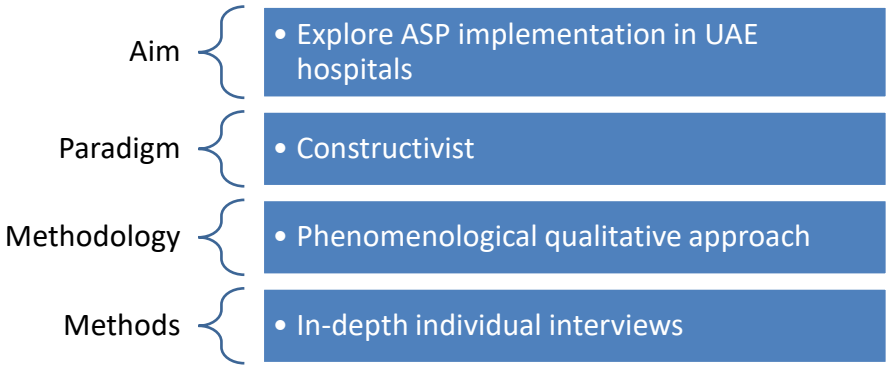


Figure 2.2: Research approach of phase two of the doctoral degree

The choice of qualitative approach has been considered advantageous for this doctoral research in comparison to any other approach based on the findings of the systematic review. According to Johnsen et al., qualitative research is employed when little is known about a topic or phenomenon and there is a need to learn more about it, so that the researcher can understand participants' experiences and voice their perspectives (136). It also allows researchers to make observations generating new ideas rather than just testing previous ones. The qualitative approach is dynamic, using a wide, deep angle approach of observation allowing holistic study of human behaviour and choices. It also tries to understand multiple layers of reality including looking at human groups and other factors that impact their behaviour. The use of probes provides depth and insights into participants' experiences which can enrich data generated (138). The systematic review showed scarce evidence of in-depth exploration of ASP implementation in UAE. Only a few quantitative studies were conducted describing ASP interventions and reporting a few outcomes. Thus, a gap was established that could only be addressed by a qualitative approach closely exploring perspective of ASP team members and non-members regarding ASP implementation, multiple environmental factors impacting the implementation process. Further details justifying the choice of research methodology is presented in the following sections.

2.3. Qualitative Approach (Phase 2)

Qualitative inquiry is a broad term describing the approach adopted by qualitative researchers to explore social circumstances and identify meanings that participants have constructed of their own world. As such, qualitative researchers are constructivists, working closely with participants attempting to make sense of what they say and do (139).

Creswell et al identified several characteristics for qualitative research (124). Table 2.6 provides a summary of characteristics and how these were applied to this doctoral study.

Table 2.6: Summary of qualitative research characteristics (124) **and their application to this doctoral research**

Qualitative research characteristics	Application to doctoral project
In qualitative research, data generation occurs in the natural setting where participants act and behave in their own context. This feature is an important distinction from the quantitative approach.	Traditionally interviews are conducted as face-to-face, but in this doctoral research face-to-face communication was transferred to audio-visual (online) communication due to COVID-19 constraints.
The researcher is a key data generation tool for qualitative research, through examining documents, interviewing individuals, and observing their behaviour.	For this research, data generation were through online interviews.
Open-ended approach to interviewing is adopted.	Interview questions were open ended to allow in-depth exploration.
In qualitative research, data analysis using an iterative approach is adopted, where the researcher will go back and forth through the data to organise codes and ensure inclusion of all emerging themes.	Iterative approach was adopted by doctoral student and main supervisor, where discussion sessions were arranged to ensure correct coding and inclusion of all emerging themes.
Qualitative research is emergent. There is no tight plan for research, where changes can be introduced along the process to ensure in-depth exploration, including changing questions, mode of data generation and participants to be interviewed.	After piloting of interviews, questions were revised to ensure clarity of language. Also, given the COVID-19 pandemic constraints, interviews were online instead of face-to-face.
Qualitative researchers are encouraged to practise reflexivity and often 'bracket' their own experience. This is conducted through acknowledging their background and how it might influence data generation and analysis.	Discussion of doctoral student background has been conducted in the foreword section. Also, continuous discussion sessions with supervisory team to ensure data analysis is reflecting participants' views without an impact from doctoral student's background.

2.3.1. Qualitative research methodologies

Research methodology is considered a plan by the researcher on how questions will be answered and a link between research philosophy and subsequent sections of data generation and analysis. Qualitative research is a general term which includes five major approaches or methodologies: narrative, ethnographic, phenomenological, grounded theory, or case study approach (135, 136). A comparison of these have been summarised in Table 2.7.

Table 2.7: Major types of qualitative research methodologies (124, 136, 140)

Aspect	Ethnography	Phenomenology	Grounded theory	Narrative inquiry	Case study
Definition	Human inquiry which focuses on studying of behaviour shared by a group in their natural setting over a long period of time. The term ethnography means 'writing about people'.	Researchers describe a phenomenon through the lived experience of participants who experienced this phenomenon, by living their experience.	Researcher aims to develop and generate theories grounded in real-world observations.	Researcher aims to inquire about people lived and told stories, which can add to understanding of the lived experience.	A design of inquiry including many fields, especially evaluation with in-depth analysis of a case, such as a program or an activity.
Discipline	Anthropology and sociology.	Psychology and philosophy.	Sociology.	Historically from multiple human storytelling disciplines.	Multidisciplinary including medicine, education, social sciences, business, and law.
Area of inquiry	Researcher uses holistic description where they describe members of the group interaction.	Culminating experiences of all individuals who lived the experience within their experiential world or 'lived-world'.	Social structural process within a social setting.	Area of inquiry from humanities.	Area of inquiry from multiple fields.
Focus	Understanding the meanings, behaviours, shared attitude, and values associated with the membership of groups.	Provide insightful accounts of individual's experience and exploring how they make sense of their world.	Building and generating theories about social phenomena.	Exploring life of individuals.	Describe one or more cases in-depth to address research question.
Data generation	Observation and interviews.	Strong philosophical underpinning, using interviews.	Multiple steps of data generation, followed by refining to identify relationship between categories of data.	Multiple conversations with a participant, around 3-5 with inquiring of associated artefacts and documents.	Multiple methods employed such as interviews, documents, and observations.

Factors which impact the choice of qualitative research methodology (140) include nature of research problem and questions, the scientific knowledge researcher is seeking, access to study setting and possible participants as well as resources and time available.

The aim of the qualitative study for this doctoral research was to explore key stakeholders' (ASP team members and non-members) perspective regarding ASP implementation in UAE hospitals with a focus on the identification of facilitators and barriers for implementation. Since little is known about ASP implementation in the UAE as a phenomenon, adopting a phenomenological approach was deemed most suitable. According to Johnson et al. phenomenology refers to describing individuals' lived experience. The purpose is to obtain their views and understand what something means to them (136). This applies to the doctoral research aim, with the need to explore the stakeholders' experience. Other forms of qualitative inquiry were all deemed unsuitable based on their description as outlined in Table 2.7. Grounded theory is used to develop a theory from data systematically collected and analysed, so the goal here is different which is to construct a grounded theory. Ethnography is based on observing a social group in their natural setting focusing mainly on their habits and behaviour, which is a different qualitative approach mainly employed in anthropologic studies. Similarly, narrative inquiry was deemed unsuitable since it is based on 'storytelling' of a few participants; around 3-5, which cannot be suitable for studying ASP implementation at a UAE national level, where maximising variation in views is required to capture the lived experience of ASP team members and non-members. Finally, case-study methodology was also deemed unsuitable, since it focuses on a specific activity or facility using multiple sources of data, which is not the case in this doctoral study where focus was on individuals as a source of information (136).

Two types of phenomenology have been identified: interpretive and descriptive (141). Descriptive phenomenology was founded by Edmund Husserl – father of philosophy of phenomenology – who adopted the theory of knowledge (epistemology) where conscious experience was described, and pre-conceived opinions were bracketed and set-aside. According to Husserl, researchers are advised to bracket their prior knowledge or experience of the phenomenon under research not to impact research findings. Interpretive phenomenology was founded by Martin Heidegger, who rejected the theory of knowledge and adopted the theory of being (ontology). He extended and broadened hermeneutics, which is the philosophy of interpretation that moves beyond description into the meaning of everyday event. According to Heidegger, it is impossible to negate researchers' experience and the fact that description of events is driven from its interpretation. Descriptive

phenomenology is used when researchers are seeking understanding of a phenomenon while bracketing their experience. On the other hand, interpretive phenomenology is used when the research question is about the meaning of a phenomenon where researchers will attempt interpreting events without bracketing their previous experience and knowledge about researched phenomenon (141, 142).

Given that the aim of this study focused on ASP members and non-members lived experience of ASP implementation in UAE healthcare system, the decision was to adopt descriptive phenomenology. Both bracketing and reflexivity were adopted to ensure that doctoral student's previous knowledge and work experience in pharmacy practice in UAE does not impart data analysis and presentation of findings. Bracketing is when the researcher keeps personal knowledge aside not to intervene with participants' views and beliefs. It helps to protect researcher from being distracted by other presuppositions (141). Reflexivity is a process of continuous self-critique to examine how researcher's background, culture and work experience can potentially impact data analysis and dissemination of themes (124). Multiple measures were in place including discussion of doctoral student's background in forward section and continuous iterative discussions among supervisory team to ensure that data analysis was reflecting participants' views and was not affected by doctoral student's background. Further details are presented in Chapter 4.

2.3.2. Qualitative data generation tools

Qualitative data generation attempts to obtain thick, in-depth description, rich, highly detailed accounts (139). Although multiple sources of data can be used throughout the qualitative inquiry, interviews (one-to-one or group interviews) are the most commonly adopted form of data generation (124). Multiple advantages of interviews have been reported over other forms of data generation (observations, documents, audio-visual or digital material) including: (1) ability to establish rapport with the participant to facilitate sharing of information and (2) chance to obtain depth and breadth in information collected through probing and further questioning on key areas of interest (139). In view of these advantages and the doctoral study aim as well as adopting a phenomenological qualitative approach, interviews were used as a tool for data generation. Further details about different types of interviews and the choice for doctoral research, will be separately presented in the following section (2.3.3 qualitative research interviews). For completeness, key characteristics of different forms of qualitative data generation tools have been summarised in Table 2.8.

Table 2.8: Key characteristics of qualitative data generation tools (124)

Key characteristics	Qualitative interviews	Qualitative observations	Documents	Audio-visual/digital material
Definition	Researcher collects data directly from participant through personal interaction in a conversational format including follow up questions.	Researchers take field notes of their observations following structured (using pre-set questions for which researcher seeks answers) or unstructured ways.	Usually collected during the research process from governmental or private sources.	Includes any photographs, video material, social media content or web sites.
Advantage	Useful when participants cannot be directly observed allowing control for researcher over the progress of the conversation.	Data are recorded quickly as it occurs Useful for sensitive topics that are uncomfortable to discuss.	Unobtrusive source of information that can be accessed at any convenient time by researcher. Does not require transcribing so saves time and expenses.	Can be unobtrusive source of information that visually captures attention.
Disadvantage	Not all participants are equally articulate Researcher's presence may bias responses.	Researchers are intrusive to participants Researchers might not have good observation skills.	Information can be hard to find, non-accurate or incomplete.	Researcher can be considered obtrusive (e.g., photographer) that can impact participants responses Sometimes difficult to interpret.

2.3.3. Qualitative research interviews

The research interview is a purposive conversation, intended to elicit information about a specific topic from participant. This is usually carried out between two or more individuals where broad questions are asked to gather data relevant to research question through attentive listening to participants. There are different types of interviews (see Table 2.9) based on: (1) the level of structure introduced to questions, (2) number of participants and (3) interview modes (135).

Table 2.9: Key characteristics of different types of interviews *(135, 136, 143)*

Interview types	Key characteristics
Classification based on level of structure introduced to questions	
Structured	A quantitative form of data generation, where interviewers ask identical questions in a similar tone to all participants and data are collected. Responses are fixed for participants to choose from. Data generated are simple, easily aggregated and analysed. Yet limited choices of responses can lead to impersonalising the response and generating irrelevant and mechanistic data. Also, it is considered very much like questionnaire/survey, yet it is researcher administered.
Semi-structured	A qualitative form of data generation, where key questions are based on a pre-determined set of themes to guide interview progress. Allows comparison of different responses to explore underpinning reality. Presence of an outline leads to comprehensive generation of somewhat systematic data that can be aggregated for analysis. Yet flexibility of interviewer in probing for further details, creates differences in responses between participants which decrease comparability of responses.
Unstructured	Also called in-depth (narrative) interviews, which are entirely exploratory and emergent. A form of qualitative data generation, where area of interest is explored through open discussion with participants that tell a 'story' of their experience with the topic of interest with very little interference of interviewer. No pre-determined set of questions, instead open-ended questions can emerge based on interviewees' verbal accounts. Themes emerge through participants' quotes. Interviews are matched to each individual and in view of different circumstances. Data generated are less systematic hence difficult to analyse.
Classification based on number of participants per interview	
One to one interview	Limited to interviewer and interviewee. Provides a confidential environment for participants for topics that does not require group stimulation. It can also provide a deeper, comprehensive understanding of each participants' experience. Considered suitable for topics that are sensitive, embarrassing, controversial or personal.
Group interview	Known as focus group where the group moderator leads discussion with a group of homogenous individuals, usually 6-12. As the name implies, the moderator keeps the discussion focused on the topic of interest. Usually employed when group interaction is required to stimulate data generation. Confidentiality can be an issue that inhibits some participants from providing insightful account. Also poorly trained moderators can cause bias due to loss of focus on the topic of discussion.
Classification based on mode of interviewing	
Face-to-face interview	Meeting in-person with participants helps in building rapport between interviewer and participant which eliminates any concerns regarding confidentiality that might hinder data generation.
Telephone interview	Interview is conducted through a phone call which is more suitable in case of distance separating interviewer and participant. Offers fast access to participants at a low cost. Limited scope of personal communication and relay on linguistic communication.
Internet mediated interview	Interview is conducted through internet-based techniques to overcome distance separating interviewer and participant. Can be conducted asynchronous (using texts) or synchronous (real time using video conferencing software). Video conferencing facilitates easy access to participants allowing visual and verbal communication.

Based on the doctoral study aim, the choice was for semi-structured, one to one interviews conducted through online platforms. Justification for that choice is as presented below:

- Semi-structured interviews can provide a level of systematic approach for data generation where pre-determined themes based on an underpinning theoretical framework (see section 2.4 for further details) allows comprehensive data retrieval about ASP in an organised fashion that facilitates data aggregation and analysis. Also, probes can be used to gain the required depth and breadth of data generation where participants were asked to provide extra details to enhance the researcher's understanding of ASP implementation.
- Participants were interviewed on one-to-one basis rather than focus group for multiple reasons. Firstly, exploring ASP implementation requires individual in-depth exploration of each participant's experience which can be better achieved through in-person interviews. Secondly, this can also help in avoiding logistical issues related to arranging group meeting for healthcare providers from different locations to meet at specific time. Finally, it helps to avoid inhibition of personal views and dominance of specific participants under the influence of mixing participants as in the case with focus groups. So, in case of in person one-to-one interviews, participants are allowed to share opinions freely after the establishment of rapport with interviewer.
- The initial plan was to conduct face-to-face interviews, yet a change to online platforms (such as Microsoft Teams, Zoom, and Blackboard Collaborate Ultra especially provided by RGU Moodle support team) was necessary due to multiple reasons brought about by the COVID-19 pandemic including:
    - Restrictions on travel across different Emirates amid the COVID-19 pandemic.
    - Compliance with UAE enforced safety measures restricting gatherings and group meetings.
    - Restricted access to hospitals where only COVID-19 patients are allowed.

2.3.4. Approaches to sampling

It is very important to identify the target population at the initial phases of research preparation to ensure correct sampling of individuals who are the actual focus and target of research inquiry (135, 136).

There are two broad categories of sampling: random (probability) and non-random (non-probability) sampling. Random sampling is usually applied in quantitative (survey-based) research. On the other

hand, non-random sampling is usually applied in qualitative research (136). Table 2.10 provides a summary of key characteristics for different sampling techniques.

Table 2.10: Summary of key characteristics for different sampling techniques (135, 136)

Sampling technique	Key characteristics
Probability (random) sampling	
Simple	The most basic form of random sampling where a procedure is used to allow a fair chance for every possible sample to be selected from the population.
Systemic	Easier to use, especially when selecting samples from a list where a sampling interval is determined from a random starting point and selection will continue until reaching the required sample size.
Stratified	Population is divided into strata (exclusive groups) then simple or systemic sampling is adopted.
Cluster	A cluster rather than a single individual is randomly selected, where a cluster is a collective unit with multiple elements.
Non-probability (non-random) sampling	
Quota	Researcher starts by identifying major groups and the number of individuals for each group, then select a convenience sample of people from each group.
Purposive	Also called judgmental sampling, where the researcher will specify characteristics of population of interest. Multiple forms are there: **Extreme case:** Unusual or special cases which enables answering the research question **Maximum variation:** Heterogeneous sample of participants with sufficiently diverse characteristics. **Homogenous:** Focus on a particular subgroup where all participants are similar. **Typical case sampling:** an illustrative profile using a particular case. **Critical case sampling:** selecting cases which have a dramatic effect and attempting to understand each critical case. **Opportunistic sampling:** depend on researcher's judgement to recognise opportunities in research involving inductive theory building. **Theoretical sampling:** a special case of purposive sampling associated with grounded theory where subsequent sample selection is based on emerging theory.
Snowball	Participants who volunteered to take part in the study are asked to refer others who are willing to participate and having similar characteristics.
Convenience	Known as haphazard sampling, where researchers select volunteers or individuals who are willing to participate.

For this doctoral research, the target population was carefully defined by inclusion and exclusion criteria to ensure that data drawn from participants will address the research question. Two forms of non-probability (non-random) sampling were combined: purposive and snowballing. Purposive sampling was adopted given the need to identify individuals who were highly informed about ASP and would contribute to data generation. On the other hand, snowballing was used to promote in-depth exploration where those who agreed to participate through purposive sampling were asked to

refer other participants with rich experience in ASP implementation. Throughout recruitment of participants, maximum variation sampling was adopted to ensure diversity of participants and gain insights into their perspectives. Diversity of participants was to ensure representation of the following categories:

- Different governing health authorities (Department of Health – Abu Dhabi, Dubai Health Authority – Dubai and Ministry of Health and Prevention – Northern Emirates)
- Governmental and private hospitals
- Different bed size, staffing and resources
- Different specialities and thus different scope and experience

2.3.5. Sample size determination in qualitative research

Sampling in qualitative research is considered flexible and continuous based on iterative analysis of data, theories generated, and richness of information retrieved (144). Ritchie et al have identified multiple criteria which can influence the required sample size in qualitative interviews and further increase the number of interviews, including: heterogeneous diverse population, number of selection criteria, and groups of special interest to be studied extensively (144).

The idea of data saturation was introduced in 1967 by Glaser and Strauss in the field of grounded theory of qualitative research, yet it has been widely accepted in different qualitative methodologies including the phenomenological approach (135). It has been commonly defined as the point at which no further data collection and/or analysis is required. Four approaches/models to data saturation have been identified and they differ in the degree of emphasis on data collection, analysis, and theorising (145). See Table 2.11 for a summary of their characteristics.

Table 2.11: Summary of characteristics of models of data saturation (145)

Model of data saturation	Characteristics	Principal focus
Theoretical saturation	Rooted in traditional grounded theory. The criterion for additional data collection is the development of categories and emerging theory in the analysis process.	Sampling
Inductive thematic saturation	Relates to the emergence of new codes or themes where saturation is based on the number of emerging codes or themes rather than the completeness of existing theoretical categories.	Analysis
A priori thematic saturation	Relates to the degree to which identified codes or themes are exemplified in the data.	Sampling
Data saturation	Saturation is about identifying redundancy or repetition in the data, not necessarily reference to the theory linked to these data.	Data collection

Sample size determination for qualitative data generation of this doctoral research were impacted by the following factors:

- Based on the doctoral study aim and chosen methodological approach, the 'Data saturation' model has been deemed most suitable to determine stopping criterion for interviewing participants. Data saturation (no further data to be collected) was determined through identifying redundancy and repetition of new data/themes in previously collected data/themes.
- This doctoral study was underpinned by the use of theory throughout data collection and analysis process (see section 2.4 of this chapter), the aim was to ensure saturation of themes and ideas of the analytical framework (see section 2.3.6 of this chapter for approach of data analysis). Therefore, data collection continued until saturation of analytical framework.
- The presence of multiple stratification criteria identified for participants to ensure maximum variation and heterogeneity of the sample is another factor which impacted sample size determination.

2.3.6. Data analysis in qualitative research

Data analysis in qualitative research starts at an early stage during data generation. The inductive nature of data analysis and generation allows for an approach where themes emerge during data generation (135).

The following are to be considered by a researcher in preparing data for analysis (135):

- The first step in data analysis is the transcription process, which is usually verbatim (word for word), to consider what is being said as well as contextual factors that affect participant. This step allows for researchers to immerse in the data.
- After transcribing, transcripts are reviewed to ensure accuracy of verbatim transcribing and anonymity.
- If appropriate, participants are offered to review transcripts for accuracy of account.
- Researcher can consider the use of Computer Aided Qualitative Data Analysis Software (CAQDAS).
- Researchers should ensure that transcripts are 'clean' before importing to CAQDAS. The term 'clean' refers to absence of spelling mistakes and complete clear accounts of participants' narration as well as anonymity of data.
- Researchers can consider research memos or reflective diaries for contextual information about the interview.

There are multiple approaches to analyse qualitative data based on the methodological choice and research question. A brief description of the six most commonly used ones is presented in Table 2.12 (144).

Table 2.12: Brief description of the most commonly used qualitative data analysis approaches (144)

Qualitative data analysis approach	Brief description
Narrative analysis	This type of analysis identifies the story being told by participants focusing on their intentions. Researchers can gain insights to the way people make sense of reality. Commonly used for narrative inquiry methodology.
Content analysis	The most common type of analysis where researchers evaluate pattern and frequency of occurrence of themes by analysing both content and context, then link to external variables such as gender or role of participants.
Discourse analysis	Discourse is the written communication or debate. In this type of analysis, language is analysed within the social context focusing on interaction, linguistic style and performance.
Grounded theory	This type of analysis is used to create a theory from the data generated. Requires continuous data generation and conceptualisation till saturation and development of theory. Commonly used in grounded theory methodology.
Interpretive phenomenological analysis	Helps to understand the phenomenon (life event) of interest of a group of people to allow interpretation of their experience to established concepts. Commonly used in phenomenological methodology.
Thematic analysis	Foundational method for qualitative data analysis and is commonly adopted. Conducted through grouping of data according to similarities to explore participants' experiences and views.

Thematic analysis is a general approach for qualitative data analysis that is not tied to a specific discipline. Thus, it can be adopted in various qualitative methodological approaches and is considered a generic method of data analysis, where researchers work systematically to identify topics that can be integrated into key themes in order to address the overall research aim (144).

For this doctoral research, thematic analysis was used to systematically identify key themes and sub-themes that answer the research question. A theoretical framework, which is the Consolidated Framework for Implementation Research (CFIR), underpinned different stages of this doctoral research (further detailed in section 2.4 of this chapter), hence the framework approach for thematic data analysis as described by Ritchie et al. was considered most suitable (144).

The framework approach for thematic analysis allowed a systematic approach for data management where commonalities and differences between sets of data were identified before searching for relationships between different parts thereby drawing descriptive explanatory conclusions. This

approach is not linked to a specific methodological approach rather it can be used for any form of qualitative data analysis that involves development of themes (146).

The following are the data management steps comprising the framework approach (144):

Step one: Familiarisation

First step in the analytical process is to get an overview and thorough familiarisation of the data by re-listening to all audio/video recordings, revising contextual reflective notes. By the end of this step the researcher must determine themes that will be used to label, sort and compare data.

Step two: Constructing an initial thematic framework

The researcher, after reviewing all transcripts can construct an arrangement of themes and subthemes. This structure is not permanent but functions at this stage to ensure clarity with no data overlap or omission. A detailed description of the framework should be available to guard against distraction and help focus analytical thinking.

Step three: Indexing and sorting

The thematic framework is applied to data to locate where each theme or sub-theme is particularly located. An alternative commonly used term to 'Indexing' is 'coding'. This is currently commonly conducted using CAQDAS such as NVivo software (147). Sorting will then follow where material with similar content or properties are grouped and physically clustered.

Step four: Reviewing data extracts

In this step, the researcher will examine data to ensure coherence and revise unindexed data to check for any missing important themes from the framework that should be added.

Step five: Data summary and display using framework

Here data will be reduced to a more manageable level where the process of evidence distillation will start by analytical inspection of each word to assess its meaning and relevance to subject. Navigating the data sets can be facilitated by creating a thematic matrix where the researcher can summarise data related to a specific theme throughout all transcripts to allow deep immersion in the subject matter and a refined understanding of content and variation.

After finalising the five data management steps, the researcher can progress to abstraction and interpretation where answers to research objectives are elucidated with possible addition of new research questions that have emerged from the data management process. Several iterations of the process can be conducted until researcher is satisfied with the level of data categorisation. Some researchers continue and attempt to find linkage between different sets of data.

The application of framework approach for thematic data analysis to this doctoral study is further explored in chapter 4 and 5.

2.3.7. Quality (trustworthiness) in qualitative research

Trustworthiness is defined as rigor and robustness of a study or "*the degree of confidence in data, interpretation, and methods used to ensure the quality of a study*" (148). Ensuring rigour and robustness in qualitative research is essential to demonstrate the 'integrity' of findings to have an impact (149). In 1985, Lincoln and Guba introduced the four criteria of trustworthiness in naturalistic (qualitative) approach: credibility, transferability, dependability, and confirmability, which can be used in preference to other quantitative terms (150). The definitions of each criterion, along with strategies to ensure trustworthiness, are summarised in Table 2.13.

Table 2.13: Summary of Lincoln and Guba criteria to ensure trustworthiness in qualitative research (151)

Criterion	Definition	Strategies to ensure trustworthiness
Credibility	Used in preference to internal validity It refers to confidence in truth of research findings and correct interpretation of participants' views.	- Member check where participants are encouraged to review transcripts where they participated to ensure accuracy of data. Also, verification of emerging theories with participants. - Adoption or research methods that are well established in previous comparable projects especially in terms of interview questions and data analysis. - Prolonged engagement to enhance familiarisation with context and setting especially at early stages of research. This can support researcher's understanding of the setting and building trust between different parties. - Persistent observation to identify characteristics most relevant to study. - Random sampling to ensure recruiting participants who are a representative sample of the larger group. - Triangulation which involves the use of different methods of data generation such as observations, individual interviews and focus groups. This can be also accomplished by using a wide range of participants to produce a rich picture of views and attitudes, as well as triangulation of sites which reduces the impact of factors related to a specific site. - Use of tactics to ensure honesty of participants such as volunteer participation in interviews, opportunity to reject participation and confirming confidentiality of interviews throughout the process. - Iterative questioning and probing of participants to elicit detailed rich data. - Frequent debriefing sessions between researchers to support development of ideas. - Peer scrutiny of research project through conference presentations or feedback from colleagues. This can support researchers to strengthen their argument. - Reflective commentary and continuous evaluation of project development. - Rich description of the phenomenon under scrutiny. - Examination of previous research findings so that researcher can relate their findings to the existing body of knowledge.
Transferability	Used in preference to external	- Rich description of contextual information about the fieldwork sites to enable reader to judge

Criterion	Definition	Strategies to ensure trustworthiness
	validity/generalisability. The degree to which qualitative study results can be transferred to other contexts	transferability of findings to their own setting. - Description should include: number of participating sites, exclusion criteria for participation, number of participants, data generation method, number and length of data generation sessions and time over which data was collected.
Dependability	Used in preference to reliability. Stability of study findings over time.	- Audit trail which allows reader to view transparency in the research path through clear description of decisions made throughout research process, team meetings, reflective thought and emergence of findings. - The processes within the study should be reported in details to allow future researchers an opportunity to repeat the study even if results will be different given the qualitative nature of data generation. - Detailed description of the following should be provided; research design and its implementation, details of data generation process and reflective appraisal of the process.
Confirmability	Used in preference to objectivity. The degree to which study findings are confirmed by other researchers as derived from the data	- Researcher needs to ensure that study results are driven from participants and data generation rather than researcher's preference. This can be confirmed by data triangulation from different sources, reflective commentary as well as audit trails allowing reader to trace the course of research step by step.

Several quality control measures were adopted to ensure trustworthiness of the doctoral research. The application of Lincoln and Guba criteria for trustworthiness to this doctoral study is further presented in chapter 4 and 5.

2.3.8. Ethics in qualitative research

Ethics is defined as "*an understanding of conflicts arising from moral obligations and how to deal with it across various levels*" (152 p. 86). In the context of research, it is the standard of behaviour in relation to the rights of participants (135). The four ethical principles addressed by researchers are autonomy, non-maleficence, beneficence and justice as defined by Beauchamp and Childress (153). It is the shared responsibility of researchers, research institutes and ethics review committees to ensure the perseverance of ethical principles while conducting research.

2.3.8.1 Research ethics in Robert Gordon University

The initial step was to approach Robert Gordon University (RGU) research ethics committee for ethical approval. In order to comply with research ethical principles, a research protocol was submitted to the ethics committee, outlining detailed description of research aim, methodology, involved parties, description of multiple ethical consideration including voluntary participation, anonymity, confidentiality and data protection. Other necessary documentation that was submitted included: data collection tool (interview questions) to demonstrate relevance of questions to research aim, participant's information leaflet and consent form.

2.3.8.2 Research ethics in UAE

According to the UAE Medical Liability Law number 6, year 2016, article 12, medical research involving human participants is only allowed after obtaining written approval from executive regulators and involved human participants (154). As such, doctoral student sought ethical approval from executive regulators for governmental and private hospitals prior to inception of research. Similar to the RGU ethics application, a research protocol, data collection tool, participant's information leaflet and consent form were supplied. Additionally, extra documents were supplied as requested by different entities including: doctoral student resume, research proposal cover letter summarising research aim, involved parties and expected outcome, declaration of conflict of interest letter, confidentiality and anonymity letter.

Further details are presented in Chapter 4.

2.3.8.3 Application of the four ethical principles (defined by Beauchamp and Childress) to doctoral research

The four ethical principles of autonomy, non-maleficence, beneficence, and justice as defined by Beauchamp and Childress (153), have been upheld throughout the research process. Further details of the application of these principles are presented here.

Respect for autonomy, also named self-governance, is where participants are free to participate after provision of comprehensive information and allowed enough time to understand the research background. In this doctoral research, participants received an information leaflet with details regarding study organising bodies, involved researchers, any conflict of interest, capacity to

withdraw at any time and ensuring anonymity and confidentiality of collected data. Participants were also provided with a consent form and allocated sufficient time before interviews to clarify any doubts.

Non-maleficence (do no harm) and beneficence (promotion of benefit) were achieved by stating the benefits of the doctoral research in the information leaflet and assuring that no harm or conflicts of interest were expected to arise from participation in research. Also, data confidentiality and anonymity were protected throughout the full research process. Participants were reassured regarding confidentiality during the interview session. Data storage and handling were clarified in research proposal and ethics approval granted from RGU and every participating hospital, as detailed in chapter 4. Confidentiality and anonymity were also maintained during the data analysis and reporting process, where participants' quotes were used without any introduction of changes or falsification.

Justice in research is related to maintaining social equality where participants were equally treated and given equal chance to participate or withdraw without any negative consequences. Participants' decision to participate was voluntarily and were allowed to withdraw at any time as described in the provided information leaflet.

2.4 The use of theory in implementation research

2.4.1. Introduction

The importance of implementation research in the healthcare field has been escalating over the past decade, largely to address challenges associated with the use of EBP in delivery of healthcare services. Early attempts of implementation research were empirically driven without focus on theoretical underpinning of implementation leading to difficulty in identifying factors supporting successful implementation (80). It has been noted that the use of theory in implementation research can increase the robustness, rigour, relevance and impact of the findings. Theories can be applied at different levels including; constructing research aim, designing methodological or theoretical stance, developing data generation tool as well as data analysis and interpretation (155).

It is important to shed the light on different taxonomies used in implementation research including theory, model and framework. Theory is a "*set of analytical principles or statements designed to*

structure our observation, understanding and explanation of the world" as defined by Nilsen (80 p. 55). While theory is very much similar to model, the major difference is that a model is descriptive with a narrow scope of explanation, whereas theory is both descriptive and explanatory (156). Frameworks broadly define variables and the relationship among them (157) and can also be used to refer to a constellation of theories (158). Further information about the differences between these three taxonomies are illustrated in Figure 2.3 adopted from Rapport et al. (157).

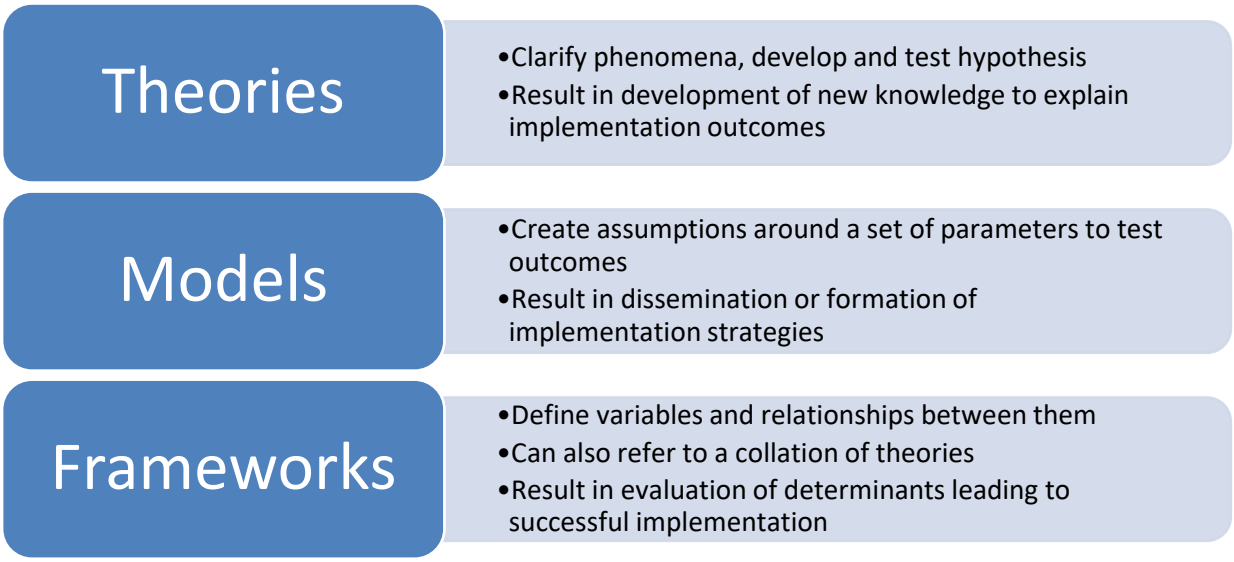


Figure 2.3: Differences between theory, model and framework taxonomies (157)

There are five main categories of theoretical approaches for implementation research, illustrated in Table 2.14, adopted from Nilsen 2015 (156).

Table 2.14: Categories of theoretical approaches for implementation research (156)

Categories of theoretical approaches	Aim of use	Description
Process models	Describe/guide the process of translating research into practice.	Guide and specify steps for translating research into practice, including the implementation and use of research.
Determinant frameworks	Understand/explain what influence implementation outcomes.	Specify determinants acting as barriers and enablers, influencing implementation outcomes.
Classic theories		Explain aspects of implementation through the use of theories external to implementation science, e.g., psychology, sociology and organisational theory.
Implementation theories		Theories developed by implementation researchers to explain aspects of implementation.
Evaluation frameworks	Evaluating implementation.	Specify aspects of implementation that can evaluate implementation success.

Determinant frameworks were selected for data generation phase of this doctoral project given that the overall aim was to explore ASP implementation in UAE hospitals with focus on determinants shaping implementation as facilitators or barriers and impacting outcomes. Determinant frameworks describe domains of determinants which can be classified as facilitators or barriers to implementation (independent variables) and are found to influence implementation outcomes (dependant variables). Many of them also describe determinants at multiple levels starting from end-user (healthcare provider) to variable organisational levels (156). Several determinant frameworks are available as presented in Table 2.15.

Table 2.15: Common determinant frameworks/models characteristics (Adapted from Nilsen, 2015) (156)

Framework/model	Characteristics of the object (implementation research, guidelines, interventions, innovations and evidence)	Characteristics of the users/adopters (e.g. health care practitioners)	Characteristics of the end users (e.g. patients)	Characteristics of the context	Characteristics of the strategy or other means of facilitating implementation	Outcomes
Promoting Action on Research Implementation in Health Services (PARIHS) Framework	Characteristics of the evidence.	Characteristics of the clinical experience, as an aspect of the evidence element.	Characteristics of the patient experience, as an aspect of the evidence element.	Characteristics of the context (culture, leadership and evaluation).	Characteristics of the facilitation, which is the process of enabling the implementation.	Successful implementation of research.
Conceptual model	Innovation attributes.	Aspects of adopters, nature of the adoption and assimilation by organisations.	Not addressed.	Features of the inner context and outer context.	Influences from diffusion to dissemination.	Successful diffusion, dissemination and implementation of innovations.
Ecological framework	Characteristics of the Innovation.	Provider characteristics.	Not addressed.	Community-level factors.	Features of the prevention support system.	Successful Implementation of innovations.
Consolidated Framework for Implementation Research (CFIR)	Intervention characteristics.	Characteristics of individuals.	Patient needs and resources, as an aspect of the outer setting.	Characteristics of the inner setting and outer setting.	Effectiveness of process by which implementation is accomplished.	Successful Implementation of interventions.

The Consolidated Framework for Implementation Research (CFIR) was deemed the most appropriate determinant framework given its comprehensiveness and inclusion of other relevant peer-reviewed implementation theories and frameworks (158). The choice of CFIR to guide data generation phase is explored in the next section.

2.4.2. Overview of the Consolidated Framework for Implementation Research

Multiple implementation theories have been published, yet some were missing key constructs or overlapped with others (158). CFIR is a determinant framework that was structured based on the need for clear identification and understanding of constructs that can be applied in specific contexts to guide exploration of facilitators and barriers to implementation process. Damschroder et al. revised the literature searching for theories that are used in healthcare sector to facilitate translation of research findings into practice. The term theories is used to collectively refer to theories, models and frameworks. Theories published in peer-reviewed journals related to dissemination, innovation, organisational change, implementation, knowledge translation, and research uptake have been included. Snowball sampling approach was also used to identify further published studies including such theories through approaching colleagues involved in implementation research. Review of the literature was limited to theories developed based on synthesis of literature or part of a large study (158). A list of these theories is provided in Table 2.16.

Table 2.16: List of theories/models analysed for the formation of CFIR (158)

Models analysed for formation of CFIR
1. Conceptual Model for Considering the Determinants of Diffusion, Dissemination, and Implementation of Innovations in Health Service Delivery and Organisation.
2. Conceptual Model for Implementation Effectiveness.
3. Dimensions of Strategic Change.
4. Theory-based Taxonomy for Implementation.
5. PARiHS Framework: Promoting Action on Research Implementation in Health Services.
6. Ottawa Model of Research Use.
7. Conceptual Framework for Transferring Research to Practice.
8. Diagnostic/Needs Assessment.
9. Stetler Model of Research Utilisation.
10. Technology Implementation Process Model.
11. Replicating Effective Programs Framework.
12. Organisational Transformation Model.
13. Implementation of Change: A Model.
14. Framework of Dissemination in Health Services Intervention Research.
15. Conceptual Framework for Implementation of Defined Practices and Programs.
16. Will it Work Here? A Decision-maker's Guide Adopting Innovations.
17. Availability, Responsiveness and Continuity: An Organisational and Community Intervention Model.
18. A Practical, Robust Implementation and Sustainability Model (PRISM).
19. Multi-level Conceptual Framework of Organisational Innovation Adoption.

CFIR is a 'meta-theoretical overarching typology', with a list of 39 constructs arranged across five domains along with their definitions that positively or negatively influence implementation without specifying the interaction between these constructs. The five domains are I) Intervention characteristics (eight constructs), II) Outer setting (four constructs), III) Inner setting (14 constructs), IV) characteristics of individuals (five constructs) and, V) Process (eight constructs) (158).

CFIR developers constructed a website (https://cfirguide.org/) to support researchers in systematically using the framework to guide analysis of contexts impacting intervention implementation. The website includes detailed definitions of each domain and construct to enable operationalising the framework to suit the type of intervention and context of implementation. Other tools are provided including; interview guide tool, coding template, framework matrix based on CFIR domains and constructs to support qualitative data generation (159). Detailed definitions of the domains and constructs are provided in Table 2.17 adapted from CFIR website (https://cfirguide.org/).

Table 2.17: Definitions of CFIR domains and constructs (Adapted from CFIR resources on CFIR website) (159)

Construct	Short Description
I. INTERVENTION CHARACTERISTICS	
A Intervention Source	Perception of key stakeholders about whether the intervention is externally or internally developed.
B Evidence Strength & Quality	Stakeholders' perceptions of the quality and validity of evidence supporting the belief that the intervention will have desired outcomes.
C Relative Advantage	Stakeholders' perception of the advantage of implementing the intervention versus an alternative solution.
D Adaptability	The degree to which an intervention can be adapted, tailored, refined, or reinvented to meet local needs.
E Trialability	The ability to test the intervention on a small scale in the organisation, and to be able to reverse course (undo implementation) if warranted.
F Complexity	Perceived difficulty of implementation, reflected by duration, scope, radicalness, disruptiveness, centrality, and intricacy and number of steps required to implement.
G Design Quality & Packaging	Perceived excellence in how the intervention is bundled, presented, and assembled.
H Cost	Costs of the intervention and costs associated with implementing the intervention including investment, supply, and opportunity costs.
II. OUTER SETTING	
A Patient Needs & Resources	The extent to which patient needs, as well as barriers and facilitators to meet those needs, are accurately known and prioritised by the organisation.
B Cosmopolitanism	The degree to which an organization is networked with other external organizations.
C Peer Pressure	Mimetic or competitive pressure to implement an intervention; typically because most or other key peer or competing organisations have already implemented or are in a bid for a competitive edge.
D External Policy & Incentives	A broad construct that includes external strategies to spread interventions, including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting.
III. INNER SETTING	
A Structural Characteristics	The social architecture, age, maturity, and size of an organisation.
B Networks & Communications	The nature and quality of webs of social networks and the nature and quality of formal and informal communications within an organisation.
C Culture	Norms, values, and basic assumptions of a given organisation.

	Construct	Short Description
D	Implementation Climate	The absorptive capacity for change, shared receptivity of involved individuals to an intervention, and the extent to which use of that intervention will be rewarded, supported, and expected within their organisation.
1	Tension for Change	The degree to which stakeholders perceive the current situation as intolerable or needing change.
2	Compatibility	The degree of tangible fit between meaning and values attached to the intervention by involved individuals, how those align with individuals' own norms, values, and perceived risks and needs, and how the intervention fits with existing workflows and systems.
3	Relative Priority	Individuals' shared perception of the importance of the implementation within the organisation.
4	Organisational Incentives & Rewards	Extrinsic incentives such as goal-sharing awards, performance reviews, promotions, and raises in salary, and less tangible incentives such as increased stature or respect.
5	Goals and Feedback	The degree to which goals are clearly communicated, acted upon, and fed back to staff, and alignment of that feedback with goals.
6	Learning Climate	A climate in which: a) leaders express their own fallibility and need for team members' assistance and input; b) team members feel that they are essential, valued, and knowledgeable partners in the change process; c) individuals feel psychologically safe to try new methods; and d) there is sufficient time and space for reflective thinking and evaluation.
E	Readiness for Implementation	Tangible and immediate indicators of organisational commitment to its decision to implement an intervention.
1	Leadership Engagement	Commitment, involvement, and accountability of leaders and managers with the implementation.
2	Available Resources	The level of resources dedicated for implementation and on-going operations, including money, training, education, physical space, and time.
3	Access to Knowledge & Information	Ease of access to digestible information and knowledge about the intervention and how to incorporate it into work tasks.
IV. CHARACTERISTICS OF INDIVIDUALS		
A	Knowledge & Beliefs about the Intervention	Individuals' attitudes toward and value placed on the intervention as well as familiarity with facts, truths, and principles related to the intervention.
B	Self-efficacy	Individual belief in their own capabilities to execute courses of action to achieve implementation goals.
C	Individual Stage of Change	Characterisation of the phase an individual is in, as he or she progresses toward skilled, enthusiastic, and sustained use of the intervention.
D	Individual Identification with Organisation	A broad construct related to how individuals perceive the organisation, and their relationship and degree of

Construct	Short Description
	commitment with that organisation.
E Other Personal Attributes	A broad construct to include other personal traits such as tolerance of ambiguity, intellectual ability, motivation, values, competence, capacity, and learning style.
V. PROCESS	
A Planning	The degree to which a scheme or method of behaviour and tasks for implementing an intervention are developed in advance, and the quality of those schemes or methods.
B Engaging	Attracting and involving appropriate individuals in the implementation and use of the intervention through a combined strategy of social marketing, education, role modelling, training, and other similar activities.
1 Opinion Leaders	Individuals in an organisation who have formal or informal influence on the attitudes and beliefs of their colleagues with respect to implementing the intervention.
2 Formally Appointed Internal Implementation Leaders	Individuals from within the organisation who have been formally appointed with responsibility for implementing an intervention as coordinator, project manager, team leader, or another similar role.
3 Champions	Individuals who dedicate themselves to supporting, marketing, and 'driving through' an implementation, overcoming indifference or resistance that the intervention may provoke in an organisation.
4 External Change Agents	Individuals who are affiliated with an outside entity who formally influence or facilitate intervention decisions in a desirable direction.
C Executing	Carrying out or accomplishing the implementation according to plan.
D Reflecting & Evaluating	Quantitative and qualitative feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience.

A systematic review by Kirk et al. examining the current use of CFIR highlighted the increased use of CFIR in healthcare related implementation research over the past decade. According to this systematic review, different studies have integrated CFIR throughout the research process at different phases of implementation (pre-, during and post-implementation) reflecting applicability of CFIR to a wide range of study designs, interventions and settings. Yet, the majority of studies used CFIR to guide data analysis only and a few of them examined implementation outcomes (160). Accordingly, there is a need to have studies explicitly justifying the choice of CFIR domains and constructs, using the framework at different stages of the research process and appropriately using CFIR according to the implementation phase where

post-implementation research should use CFIR to link determinants of implementation to outcomes.

For this doctoral research, CFIR was adopted as a theoretical underpinning for the qualitative phase, throughout data generation tool development, data analysis, interpretation and reporting of findings. CFIR constructs functioned as a checklist to avoid missing any constructs that may influence implementation. Further details on the employment of CFIR for this doctoral research is presented in chapter 4 and 5.

2.5 Chapter summary

This chapter summarised the methodological approaches adopted for this doctoral project. Further details are provided in chapters 3, 4 and 5. The research project was conducted over two phases. First phase (chapter 3) was a systematic review mapping hospital ASP in GCC states against international standards. This phase informed the second phase and supported refining of the research aim and objectives for data generation. The second phase adopted a qualitative approach for data generation and is presented over two chapters (chapter 4 and 5). Data generated were highly impacted by COVID-19 pandemic and the research team opted to present this impact separately in chapter 5. ASP implementation in UAE hospitals is presented in chapter 4.

3

Chapter 3

Systematic review

Chapter 3 Mapping hospital Antimicrobial Stewardship Programmes in the Gulf Cooperation Council States against international standards: A systematic review

3. Introduction to the chapter

This chapter describes the aim, objectives, method, results and discussion of a systematic review, conducted in accordance with a protocol based on the PRISMA-P standards (161) and reported in accordance with the PRISMA standards (133).

As discussed in Chapter 1, although there is evidence of implementation of antimicrobial stewardship programmes in the GCC states, there has been limited benchmarking and mapping to international standards and frameworks. Given that these GCC countries have common political and economic backgrounds, and that the co-operation was founded to foster joint working, it was considered that there may be some commonality in the healthcare intervention processes. Focus for this systematic review was on acute care hospitals given that ASP focus and interventions vary across different healthcare settings such as: community, primary care, acute care, long term care and rehabilitation.

3.1 Systematic review aim

The aim of this systematic review was to critically appraise, synthesise and present the available evidence on ASP implementation in acute care hospitals in the GCC states.

Review objectives:

1. To compare ASP interventions in GCC states with reference to the CDC framework (49).
2. To identify facilitators and barriers to effective ASP implementation in GCC states.

3.2 Methods

As described in Chapter 2, the systematic review protocol was developed based on the PRISMA-P (Preferred Reporting Items for Systematic Reviews and Meta-analysis for Protocols) standards (See Appendix 3.1 for PRISMA-P checklist). PRISMA-P is a 17-item checklist that facilitates the preparation and reporting of a robust protocol describing the rationale, aim and planned methods. PRISMA-P was developed by an international group of experts with the intention of

improving the transparency, accuracy, completeness, and frequency of systematic reviews (161). The systematic review protocol was registered with PROSPERO (International Prospective Register of Systematic Reviews) under registration code (PROSPERO 2017 CRD42017079597) (116). PROSPERO is an 'international database of prospectively registered systematic reviews in health, social care, welfare, public health, education, crime, justice, and international development, where there is a health-related outcome'. It is based at the Centre for Reviews and Dissemination, University of York and funded by the UK National Institute for Health Research (NIHR) (129).

3.2.1 Inclusion criteria

Studies were included if they reported ASP implementation within acute care (short term stay or urgent care) hospital settings in the GCC states. Studies could either report ASP or any of the specific elements of ASP, as defined in the core elements of the CDC (49). Studies were descriptive with no comparator (other than pre- post- implementation). Review outcomes were the description of implementation and facilitators and barriers. All primary research studies of any design (quantitative, qualitative or mixed), published in English from 2010 to January 2020 were included. A preliminary search of the peer reviewed literature identified no studies reporting ASP implementation in the GCC prior to 2010 hence this was search index date. Conference abstracts, proceedings and grey literature were excluded due to the lack of details to permit quality assessment and data extraction in such resources. Studies were excluded if addressing primary care, nursing homes, outpatient or dental settings.

3.2.2 Search strategy

The search was conducted in Medline, Cumulative Index of Nursing and Allied Health Literature (CINAHL), International Pharmaceutical Abstracts (IPA), Web of Science and Cochrane databases. The description of the databases included in this search is provided in Table 3.1.

Table 3.1: Description of databases included in the search

Online databases	Description
Cumulative Index of Nursing and Allied Health Literature (CINAHL)	CINHAL is a powerful research tool with advanced search features that provides indexing to the ultimate nursing and allied health literature. It includes journals, publications, health care books, dissertations, selected conference proceedings, standards of practice, audio-visuals and book chapters. The coverage expands to include nursing, biomedicine, health sciences librarianship, alternative/complementary medicine, consumer health and 17 allied health disciplines (162).
Medline (via PubMed)	MEDLINE is the (Medical Literature Analysis and Retrieval Online System) which is part of the National Library of Medicine (NLM). This database can be accessed freely through the PubMed interface to browse more than 26 million records from 5,639 selected publications covering biomedicine and health from 1950 to the present (163).
International Pharmaceutical Abstracts (IPA)	International Pharmaceutical Abstracts (IPA) is an online database that has been introduced by the American Society of Health system Pharmacists (ASHP). It indexes more than 750 pharmaceutical, medical and health-related journals and provides access to topics on drug therapy, toxicity, and pharmacy practice, as well as legislation, regulation, technology, utilisation, biopharmaceutics, information processing, education, economics, and ethics as related to pharmaceutical science and practice (164).
Cochrane Database of Systematic Reviews (CDSR)	Cochrane reviews provide peer reviewed, most up to date evidence-based health care resources through collaborations with around the world contributors. The reviews are systematic reviews of primary research in human health care and health policy (130).
Web of Science	Contains a breadth of international literature, connecting to citation indexes to track development of topics providing a comprehensive resource of abstracts (165)

Search terms applied to all databases are in Table 3.2. The reference lists of all identified papers were hand-searched to establish any further studies and database alerts created to notify of newly published studies during the timeline of the review. A random sample of 10% of titles, abstracts and full papers were independently reviewed (NH and AT or DS) to confirm reliability of the screening process.

Table 3.2: Search string applied to databases

First concept	Boolean operator	Second concept	Boolean operator	Third concept
anti-bacterial (MeSH) OR anti-infective (MeSH) OR antimicrob* (AB, TI) OR anti-microbial (AB, TI) OR antibio* (AB, TI) OR anti-biotic (AB, TI) OR antiinfect* (MeSH) OR infection* (AB, TI) OR antibacterial* (AB, TI)	**AND**	stewardship* (AB, TI) OR prescrib* (AB, TI) OR polic* (AB, TI) OR practic* (AB, TI) OR use (AB, TI) OR program* (AB, TI) OR manage* (AB, TI) OR intervent* (AB, TI) OR surgical prophylaxis (AB, TI) OR consum* (AB, TI) OR pattern* (AB, TI) OR trend*(AB, TI) OR optimi* (AB, TI) OR therap*(AB, TI) OR implement* (AB, TI) OR educat* (AB, TI) OR inform* (AB, TI) OR audit* (AB, TI) OR feedback* (AB, TI) OR disseminat* (AB, TI) OR guid* (AB, TI) OR quality assurance (AB, TI) OR utilization review (AB, TI) OR quality indicator* (AB, TI) OR formular* (AB, TI) OR pathway* (AB, TI) OR streamlin* (AB, TI) OR decision* (AB, TI) OR rational* (AB, TI) OR improper* (AB, TI) OR unnecessary* (AB, TI) OR resist* (AB, TI) OR over-use* (AB, TI) OR overus* (AB, TI) OR improv* (AB, TI) OR inform* campaign (AB, TI) OR educat* campaign (AB, TI) OR manag* (AB, TI) OR intraven* to oral switch (AB, TI)	**AND**	gulf cooperation council (AB, TI) OR gulf* (AB, TI) OR GCC OR Middle East* (MeSH) OR Bahrain (AB, TI) OR Kuwait (AB, TI) OR Oman (AB, TI) OR Qatar (AB, TI) OR Saudi (AB, TI) OR KSA (AB, TI) OR United Arab Emirates (AB, TI) OR Emirate* (AB, TI) OR UAE (AB, TI)

Abbreviations: AB, Abstract; MeSH, Medical Subject Headings; TI, Title.

3.2.3 Assessment of methodological quality

Specific study quality assessment tools were adopted, based on the study design, from the National Heart, Lung and Blood Institute (NHLBI) (166) and the Consolidated Criteria for

Reporting Qualitative Research (COREQ) (167). Quality assessment tools were applied by two independent reviewers (NH plus one of AT, DS or DP), with a third consulted in the case of any disagreements. Quality assessment assessed the potential for bias, with studies rated as good, fair or poor (168). The COREQ checklist was used to evaluate qualitative studies in three domains of research team and reflexivity, study design and data analysis and reporting (167).

3.2.4 Data extraction

Data extraction was independently undertaken by two reviewers (NH plus one of AT, DS or DP). Data extracted were: aim, setting, study design, dates of data collection, sample description and study outcomes.

3.2.5 Data synthesis

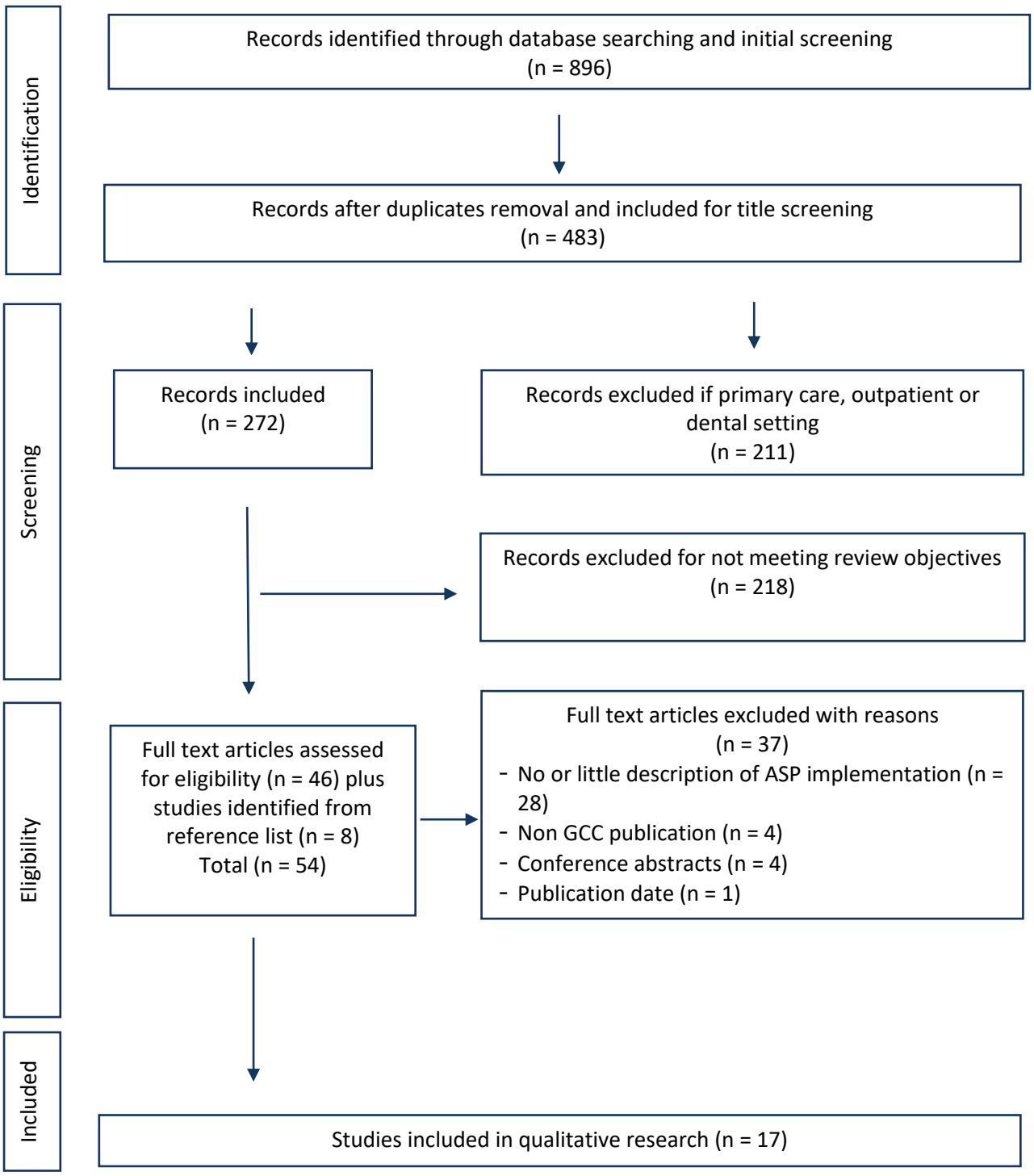
Given the lack of homogeneity of the study designs, methods and outcome measures, results were synthesised using a narrative approach, since retrieved data cannot undergo statistical meta-analysis (137). ASP interventions described were mapped to the seven core elements of the CDC framework (49), which has proven successful as an auditing tool in several US hospitals (62, 63, 64, 65). The core elements were categorised as: infrastructure elements (leadership, accountability, pharmacist expertise); and implementation practices (actions, tracking, reporting and education), as described by Pollack et al (62). The approach to narrative synthesis was aligned to the specific review objectives.

3.3 Results

3.3.1 Study screening

Eight hundred and ninety-six papers were identified and reduced to 483 following removal of duplicates. Screening of titles excluded a further 211 that were not in the included healthcare setting. Screening of remaining 272 abstracts excluded a further 218 records that did not meet review objectives. Full paper screening excluded an additional 37 as summarised in Table 3.3 (28 had no description of ASP implementation, four not conducted in GCC, four abstracts, one was published prior to the search index data, several were excluded for multiple reasons). The 17 papers comprised nine cohort studies, six before-after studies, one cross-sectional survey and

one qualitative study. The PRISMA flowchart provided in Figure 3.1 summarises the screening and selection process.



Abbreviations: ASP, antimicrobial stewardship programme; GCC, Gulf Cooperation Council.

Figure 3.1: PRISMA flow chart for search and inclusion process. Adopted from Moher et al *(169)*

Table 3.3: Studies excluded at the full text review stage, with justification (n = 37)

Author, year	Study Title	Justification for exclusion
Adjepon et al., 2000 (170)	Aminoglycoside usage and monitoring in a Saudi Arabian teaching hospital: a ten-year laboratory audit.	Not part of ASP. Not included in initial keywords.
Al-Abri et al., 2012 (171)	An audit of inpatient management of community-acquired pneumonia in Oman: a comparison with regional clinical guidelines.	Limited ASP perspective.
Blanquart et al., 2017 (172)	An evolutionary model to predict the frequency of antibiotic resistance under seasonal antibiotic use, and an application to Streptococcus pneumonia.	Non GCC publication.
Tolba et al., 2018 (173)	An observational study of perioperative antibiotic-prophylaxis use at a major quaternary care and referral hospital in Saudi Arabia.	No ASP implementation.
Zowawi et al., 2016 (174)	Antimicrobial resistance in Saudi Arabia. An urgent call for an immediate action.	No ASP implementation.
Keown et al., 2014 (175)	Antimicrobial resistance: addressing the global threat through greater awareness and transformative action.	No ASP implementation. Not GCC specific.
Mazi et al., 2014 (176)	Central line-associated bloodstream infection in a trauma intensive care unit: impact of implementation of Society for Healthcare Epidemiology of America/Infectious Diseases Society of America practice guidelines.	Limited ASP perspective.
Moslemi et al., 2010 (177)	Comparative evaluation of prophylactic single-dose intravenous antibiotic with postoperative antibiotics in elective urologic surgery.	Non GCC publication.
Memish et al., 2007 (178)	Executive summary of the Gulf Cooperation Council practice guidelines for the management of community-acquired pneumonia.	No ASP implementation.
Memish et al., 2002 (179)	Guidelines for the management of community-acquired pneumonia in Saudi Arabia: a model for the Middle East region.	No ASP implementation.
Mah et al., 2001 (180)	Impact of antibiotic prophylaxis on wound infection after cesarean section in a situation of expected higher risk.	No ASP implementation.
Khdour et al., 2018 (181)	Impact of antimicrobial stewardship programme on hospitalised patients at the intensive care unit: a prospective audit and feedback study.	Non GCC publication.
Kilan et al., 2017 (182)	Improving antibiotic prophylaxis in gastrointestinal surgery patients: A quality improvement project.	Not part of ASP.
Ghazal et al., 2011 (183)	Intervention to reduce the incidence of healthcare-associated methicillin-resistant Staphylococcus aureus infection in a Tertiary Care Hospital in Saudi Arabia.	Low quality publication (letter to the editor).
Alothman et al., 2016 (184)	Knowledge and Attitude of Physicians Toward Prescribing Antibiotics and the Risk of Resistance in Two Reference Hospitals.	No ASP implementation.
Al-Mousa et al., 2012 (185)	Kuwait national campaign for proper use of antibiotics.	Not peer reviewed primary research (letter to the editor).
Memish et al., 2007 (186)	Management and prevention strategies for community-acquired pneumonia in the Gulf Corporation Council.	Limited ASP perspective.

Author, year	Study Title	Justification for exclusion
		No ASP implementation.
Resio et al., 2004 (187)	Mass mailing and telephone contact were effective in recruiting veterans into an antibiotic treatment randomised clinical trial.	Not part of ASP. Not GCC specific.
Moussa et al., 1998 (188)	Outcome of implementing antimicrobial programme in a Saudi Arabian military hospital.	Exclusion by date.
Al-Yamani et al., 2016 (189)	Patterns of Antimicrobial Prescribing in a Tertiary Care Hospital in Oman.	No ASP implementation.
John et al., 2014 (190)	Patterns of antimicrobial therapy in acute tonsillitis: A cross-sectional hospital-based study from UAE.	No ASP implementation. Out-patient setting.
Al-Harthi et al., 2015 (191)	Perceptions and knowledge regarding antimicrobial stewardship among clinicians in Jeddah, Saudi Arabia.	No ASP implementation.
Baadani et al., 2015 (192)	Physicians' knowledge, perceptions, and attitudes toward antimicrobial prescribing in Riyadh, Saudi Arabia.	No ASP implementation.
Alanazi et al., 2015 (193)	Prevalence and predictors of antibiotic prescription errors in an emergency department, Central Saudi Arabia.	Not ASP interventions.
Memish et al., 2010 (194)	Rationale for producing evidence-based guidelines for community-acquired pneumonia in the Gulf Corporation Council.	Limited ASP perspective. No ASP implementation.
Mahboub et al., 2015 (195)	Real life management of community-acquired Pneumonia in adults in the Gulf region and comparison with practice guidelines: a prospective study.	Limited ASP perspective. No ASP implementation.
Youssif et al., 2018 (196)	Retrospective evaluation of piperacillin-tazobactam, imipenem-cilastatin and meropenem used on surgical floors at a tertiary care hospital in Saudi Arabia.	No ASP implementation.
Assiri et al., 2017 (197)	The strategic plan for combating antimicrobial resistance in Gulf Cooperation Council States, KSA perspective.	No ASP implementation.
Balkhy et al., 2016 (42)	The strategic plan for combating antimicrobial resistance in Gulf Cooperation Council States.	No ASP implementation.
Alomi, 2017 (198)	National Antimicrobial Stewardship Programme in Saudi Arabia; Initiative and the Future.	No ASP implementation.
AlAwdah et al., 2015 (199)	Antimicrobial stewardship program in a pediatric intensive care unit of a tertiary care children's hospital in Saudi Arabia-a pilot study.	No ASP implementation.
Abdul Haseeb et al., 2015 (200)	Evaluation of Antimicrobial Stewardship Programmes in Makkah Region Hospitals, Kingdom of Saudi Arabia.	Not peer reviewed primary research (poster presentation).
Garcell, 2017 (201)	Incidence of surgical site infection and compliance with antibiotic prophylaxis in cesarean section in a community hospital in Qatar.	No actual implementation of ASP activity.
Pawluk et al., 2015 (202)	Strategies for improving antibiotic use in Qatar: a survey of pharmacists' perceptions and experiences.	No ASP implementation.
Rehmani et al., 2014 (203)	Implementing a collaborative sepsis protocol on the time to antibiotics in an emergency department of a Saudi hospital: quasi randomised study.	Not part of ASP. Not included in initial keywords.

Author, year	Study Title	Justification for exclusion
Al Matar et al., 2019 (204)	Point prevalence survey of antibiotic use in 26 Saudi hospitals in 2016.	No ASP implementation.
Nasr et al., 2019 (205)	Practice implications of an antimicrobial stewardship intervention in a tertiary care teaching hospital, Qatar.	Not addressing ASP implementation.

Abbreviations: KSA, Kingdom of Saudi Arabia; UAE, United Arab Emirates.

3.3.2 Quality assessment

Study quality assessment is summarised in Tables 3.4 and 3.5. Five studies (29.4%) were rated 'good', 12 (70.6%) 'fair' and none 'poor' quality. The qualitative study was assessed using the COREQ tool (167) as given in Table 3.6. Key study limitations were the lack of detail on methodological underpinning, and measures to maximise researcher reflexivity and credibility (206).

Table 3.4: Quality assessment of the cohort (n=9) and cross-sectional (n=1) studies

Criteria	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	El-Lababidi et al., 2019 (215)	Baraka, M.A. et al., 2019. (216)
Was the research question or objective in this paper clearly stated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the study population clearly specified and defined?	Yes	Yes	Yes	Yes	No	CD	Yes	Yes	No	Yes
Was the participation rate of eligible persons at least 50%?	NA	Yes	CD	Yes	NA	NA	CD	NA	CD	Yes
Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study pre-specified and applied uniformly to all participants?	CD	Yes	Yes	Yes	CD	CD	Yes	Yes	Yes	No
Was a sample size justification, power description, or variance and effect estimates provided?	CD	No	CD	No	NA	No	No	NA	No	Yes
For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	NA	Yes	NA	Yes	No	NA	Yes	No	NA	NA
Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	Yes	Yes	NA	No	NA	Yes	Yes	Yes	Yes	NA
For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	NA	Yes	NA	NA	NA	NA	NA	NA	Yes	NA

Criteria	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	El-Lababidi et al., 2019 (215)	Baraka, M.A. et al., 2019. (216)
Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Yes	NA	Yes	Yes	CD	Yes	No	No	Yes
Was the exposure(s) assessed more than once over time?	NA	NA	NA	NA	Yes	Yes	Yes	Yes	NA	NA
Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the outcome assessors blinded to the exposure status of participants?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Was loss to follow-up after baseline 20% or less?	NA	NA	NA	NA	NA	NA	CD	NA	NA	CD
Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	CD	No	No	No	No	NA	No	No	No	NA
Overall Quality rating	**Fair**	**Fair**	**Fair**	**Good**	**Fair**	**Fair**	**Fair**	**Fair**	**Good**	**Good**

Abbreviations: CD, cannot determine; NA, not applicable.

Table 3.5: Quality assessment of the before-after (pre-Post) studies (n=6)

Criteria	Dib et al. (217)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	Abdallah et al., 2017 (221)	Momattin et al., 2018 (222)
Was the study question or objective clearly stated?	Yes	Yes	Yes	Yes	Yes	No
Were eligibility/selection criteria for the study population pre-specified and clearly described?	Yes	Yes	Yes	Yes	Yes	Yes
Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?	Yes	Yes	Yes	Yes	CD	CD
Were all eligible participants that met the prespecified entry criteria enrolled?	Yes	Yes	Yes	No	No	CD
Was the sample size sufficiently large to provide confidence in the findings?	No	CD	CD	CD	No	CD
Was the test/service/intervention clearly described and delivered consistently across the study population?	Yes	Yes	Yes	Yes	Yes	CD
Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?	Yes	Yes	Yes	Yes	No	Yes
Were the people assessing the outcomes blinded to the participants' exposures/interventions?	NA	No	NA	NA	No	No
Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis?	NA	Yes	NA	NA	CD	NA
Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?	Yes	Yes	Yes	Yes	Yes	Yes

Criteria	Dib et al. (217)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	Abdallah et al., 2017 (221)	Momattin et al., 2018 (222)
Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e., did they use an interrupted time-series design)?	No	No	No	No	NA	Yes
If the intervention was conducted at a group level (e.g., a whole hospital, a community, etc.) did the statistical analysis take into account the use of individual-level data to determine effects at the group level?	No	NA	No	No	No	NA
Overall quality rating	**Fair**	**Fair**	**Fair**	**Good**	**Fair**	**Fair**

Abbreviations: CD, cannot determine; NA, not applicable.

Table 3.6: Quality assessment for a qualitative study (Alghamdi 2019) *(206)* **using COnsolidated criteria for REporting Qualitative research (COREQ) – 32 items Checklist**

Item	Guide questions/description	Response to guide question
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Inter viewer/facilitator	Which author/s conducted the interview or focus group?	Saleh Alghamdi.
2. Credentials	What were the researcher's credentials? E.g. PhD, MD	PhD student.
3. Occupation	What was their occupation at the time of the study?	PhD researcher.
4. Gender	Was the researcher male or female?	Male.
5. Experience and training	What experience or training did the researcher have?	Not clear.
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	Not clear.
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	Informed consent and relevant approvals from facilities has been taken, other information not clear.
8. Interviewer characteristics	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	Not reported. PhD funded by a Saudi university.
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	Not reported.
Participant selection		
10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	Not reported. Author mentioned random sample.
11. Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	Not reported.
12. Sample size	How many participants were in the study?	22 in total.
13. Non-participation	How many people refused to participate or dropped out? Reasons?	Not mentioned.
Setting		
14. Setting of data collection	Where was the data collected? e.g. home, clinic, workplace	Not mentioned.
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	Not mentioned.

Item	Guide questions/description	Response to guide question
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	Dates were mentioned but No clear description of individual's background, years of experience, years of work at current facility, age.
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Interview schedule was not provided. It was prompted by the author.
18. Repeat interviews	Were repeat inter views carried out? If yes, how many?	22 interviews in total.
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	Yes, audio recording only.
20. Field notes	Were field notes made during and/or after the interview or focus group?	Not mentioned.
21. Duration	What was the duration of the interviews or focus group?	45 minutes meeting.
22. Data saturation	Was data saturation discussed?	Not discussed.
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	Not mentioned.
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	Not mentioned.
25. Description of the coding tree	Did authors provide a description of the coding tree?	No.
26. Derivation of themes	Were themes identified in advance or derived from the data?	Derived from data.
27. Software	What software, if applicable, was used to manage the data?	Not mentioned.
28. Participant checking	Did participants provide feedback on the findings?	Not mentioned.
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Yes.
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes.
31. Clarity of major themes	Were major themes clearly presented in the findings?	Yes.
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	No minor themes were discussed.

3.3.3 Data extraction

The cohort and before-after studies were conducted in KSA (n=9), Qatar (n=3), UAE (n=2) and Kuwait (n=1), with none from Bahrain or Oman. Hospitals were described as tertiary (n=11), community (n=3) and quaternary (n=1), with data collected from the entire hospital(s) (n=9), or exclusively from surgical units (n=3), intensive care units (ICU) (n=2) or specific hospital departments (surgical, obstetrics and gynaecology, medical, critical care, medical intensive care, surgical intensive care unit) (n=1). Data collection periods in the studies ranged from 6 months to 3 years. One study from KSA, Mecca, included Hajj time (annual Islamic pilgrimage) in one of the phases of data collection, since this mass gathering is significantly increasing the risk for development of AMR (219).

The cross-sectional study included a total of 184 health professionals practising in six large hospitals from KSA (216). The qualitative study was also conducted in KSA comprising 22 interviews with hospital practitioners, managers and Saudi health authority representatives (206). Hospitals in the cross-sectional survey and qualitative study were described as tertiary. Data extraction of the 17 studies is given in Table 3.7.

Table 3.7: Characteristics of studies included in the systematic review (n=17)

Authors, year	Country	Aim(s) as stated by the study authors	Study design	Setting	Sample (type of hospital, wards and patient)	Data collection period
Dib et al., 2009 (217)	Kingdom of Saudi Arabia	Evaluate appropriateness of vancomycin use.	Retrospective before-after study.	One tertiary governmental hospital.	All patients admitted who were prescribed vancomycin (n=74 before, 34 after).	Specific dates for data collection not reported; intervention implemented 2008, point prevalence at least 6 months post-intervention.
Aly et al., 2012 (207)	Kuwait	Measure physicians' adherence to local hospital antibiotic policy guidelines.	Retrospective cohort.	Nine government, four tertiary and five specialised hospitals.	Patients discharged in 2007 (n=2300).	July – December 2008.
Al-Tawfiq, 2013 (208)	Kingdom of Saudi Arabia,	Evaluate the role of the ID consultations in reducing inappropriate antibiotic usage.	Prospective cohort.	One government tertiary hospital.	Adult patients requiring an ID consultation (n=1444).	January 2006 – December 2009.
Amer et al., 2013 (218)	Kingdom of Saudi Arabia	Compare prescribing appropriateness of empirical antibiotic therapy before and after ASP implementation.	Prospective before-after study.	One government tertiary hospital.	Patients ≥18 years admitted to medical ICU (n=139; 49 control, 24 active, 66 excluded).	July – December 2009 (control); March 2011 (inception of intervention, end date not stated).

Authors, year	Country	Aim(s) as stated by the study authors	Study design	Setting	Sample (type of hospital, wards and patient)	Data collection period
Al-Somai et al., 2014 (219)	Kingdom of Saudi Arabia	Measure impact of CP and ID consultant interventions on use of caspofungin, imipenem, meropenem.	Prospective before-after study.	One government tertiary hospital.	receiving caspofungin, meropenem or imipenem regardless of condition, age, sex or ward (559 orders, 357 patients).	March 2011 – August 2012.
Al-Tawfiq et al., 2015 (220)	Kingdom of Saudi Arabia	Examine effect of selective reporting of selected broad-spectrum agents against pathogens with high resistance rates.	Prospective before-after study.	One government tertiary hospital.	Cultures susceptible to GNB: *Enterobacter aerogenes* (n=104 in 2009, 75 in 2010); *Proteus mirabilis* (n=168 in 2009, 116 in 2010); *Pseudomonas aeruginosa* (n=481 in 2009, 414 in 2010).	December 2009 – May 2010 (pre-intervention); June – December 2010 (post-intervention).
Tobaiqy et al., 2015 (210)	Kingdom of Saudi Arabia	Investigate tigecycline prescription and patient outcomes in Saudi Arabia.	Retrospective cohort.	Three government tertiary hospitals.	All 37 patients prescribed tigecycline.	January 2013 – May 2014.
El Hassan et al., 2015 (209)	UAE	Assess surgeons' adherence to SAP guidelines and evaluate antibiotic selection, first-dose timing, dosage interval and treatment duration.	Retrospective cohort.	One governmental tertiary hospital.	Clean or clean-contaminated surgeries (n=250).	2012.

Authors, year	Country	Aim(s) as stated by the study authors	Study design	Setting	Sample (type of hospital, wards and patient)	Data collection period
Alawi and Darwesh, 2016 (211)	Kingdom of Saudi Arabia	Analyse and evaluate safety and cost- effectiveness of a gradually implemented ASP.	Prospective cohort.	One government tertiary hospital.	Admissions to six hospital departments (surgical, obstetrics and gynaecology, medical, critical care, medical intensive care, surgical intensive care unit), number of patients not stated.	April 2012 – December 2013.
Garcell et al., 2016 (212)	Qatar	Evaluate antibiotic consumption trend.	Prospective cohort.	One community hospital.	281 admissions in 2012; 1278 in 2013; 3052 in 2014; 3741 in 2015.	2012- 2015.
Garcell, 2017 (214)	Qatar	Determine effect of focused ASP in compliance with antibiotic prophylaxis, and consumption in appendectomies.	Prospective cohort.	One community hospital.	All appendectomy patients (n=603).	January 2013 – December 2015.
Garcell, Arias, et al., 2017 (213)	Qatar	Describe compliance with antibiotic prophylaxis in selected surgical procedures.	Retrospective cohort.	One community hospital.	Gynaecology, obstetrics, plastic surgery, trauma, and general surgical procedures, medium complexity ones, open and laparoscopic procedures excluding transplant surgery (n=2386 procedures).	January 2013 – June 2016.
Abdallah et al., 2017 (221)	Kingdom of Saudi Arabia	Compare antimicrobial susceptibility pattern of *P. aeruginosa* before and after carbapenem restriction.	Retrospective before-after study.	One tertiary governmental hospital.	Adult patients in ICU prescribed carbapenem (August 2016, 819 cultures; December 2016, 947 cultures).	May – June 2016 pre-implementation); August – December 2016 (post implementation).

Authors, year	Country	Aim(s) as stated by the study authors	Study design	Setting	Sample (type of hospital, wards and patient)	Data collection period
Momattin et al., 2018 (222)	Kingdom of Saudi Arabia	Compare DDD, DOT, DDD per 100 bed-days, and adjusted DDD according to CMI.	Retrospective before-after study.	One tertiary governmental hospital.	Adult patients (>15 years, n not stated).	2011 (baseline), 2013 – 2015.
El-Lababidi et al., 2019 (215)	UAE	Report on the outcomes of an advanced ASP.	Single-centre quasi-experimental cohort.	A recently activated quaternary care hospital.	Total discharges 1790 in 2015, 5365 in 2016 and 7181 in 2017.	July 2015 – December 2017.
Baraka et al., 2019 (216)	Kingdom of Saudi Arabia	Investigate practitioners' perceptions regarding ASP implementation and identify challenges and facilitators to execution.	Cross-sectional study.	Six large hospitals (four governmental and two private).	Physicians, pharmacists or nurses practicing in the hospitals (n=184).	Specific dates for data collection not reported.
Alghamdi et al., 2019 (206)	Kingdom of Saudi Arabia	Explore ASPs team members' perspectives regarding the factors influencing the adoption and implementation of these programmes in Saudi hospitals.	Qualitative study.	Three MOH governmental hospitals.	Total of 22 interviews (Physicians, nurses, pharmacists, infection control practitioners, infectious disease consultant, microbiologist, and hospital managers and representatives from the Saudi MOH departments of Infection Control and Pharmaceutical Care).	January – February 2017.

Abbreviations: ASP, Antimicrobial stewardship programme; CP, clinical pharmacist; DDD, Defined daily dose; DOT, Days of therapy; ID, infectious disease; IV, Intravenous; *P. aeruginosa*, *Pseudomonas aeruginosa*; SAP, Surgical antimicrobial prophylaxis.

3.3.4 Data synthesis

Data were synthesised according to the review aims with ASP interventions mapped to CDC core elements, and facilitators and barriers to implementation.

3.3.4.1 Mapping of ASP interventions to CDC core elements

The mapping of the ASP interventions to the CDC core elements is summarised in Table 3.8.

A. Infrastructure elements

Only one study reported hospital commitment and leadership support (core element one), described in terms of financial resources, integrated information technology (IT), clinical decision support systems, an identified ASP point of contact and dedicated ASP time for staff (215). While ID physician involvement in ASP activities was described in six studies (208, 210, 215, 217, 218, 219), only two referred to physician leadership with respect to accountability for programme management and outcomes (core element two) (208, 210). Pharmacist expertise (core element three) was described in nine studies, five of which reported dedicated full-time ASP pharmacists (215, 217, 219, 220, 221) and one had a pharmacist with special infectious diseases training (215). The other studies only reported pharmacist involvement in monitoring antimicrobial consumption (211, 214, 218, 222).

B. Implementation practices

All studies described practises related to core element four (Actions), although the specific descriptions of the scope of practices varied. The majority of the studies reported locally developed guidelines based on antimicrobial culture and sensitivity testing, as recommended in the CDC framework (206, 207, 208, 209, 212, 213, 214, 215, 216, 217, 220). Prospective audit and feedback were the most commonly reported practices (208, 210, 211, 212, 214, 215, 217, 218, 219, 221) followed by pre-authorisation (206, 210, 211, 215, 216, 218, 221).

Pharmacy-based interventions largely comprised documentation of indication for antibiotic use in patients' medical records as described in ten studies (209, 210, 211, 212, 213, 214, 215, 217, 218, 219). Only six studies reported optimising antimicrobial dose (208, 210, 215, 217, 218, 222), three of which additionally emphasised dose adjustment (210, 217, 218). The remaining pharmacy-based interventions namely time sensitive automatic stop order, IV to oral switch and

duplicative therapy alerts, were minimally reported while detection and prevention of antibiotic related drug-drug interactions were not reported at all.

Provider-based interventions were seldom reported, with antibiotic 'timeouts' described in three studies (212, 215, 222). None of the papers refer to assessing patients for penicillin allergy, as recommended by CDC for provider-based interventions.

Microbiology-based interventions and infection-based interventions were scarcely reported, with only one study describing the effect of selective reporting of antimicrobial susceptibilities (220) and another referred to comments in microbiology reports (221). Notably, none of the studies reported any nursing-based interventions.

The fifth core element (Tracking) is classified as antibiotic use measures, and outcome measures and process measures for quality improvement. The majority of studies reported at least one of the CDC tracking measures. Eight studies monitored antibiotic use, by reporting defined daily doses (DDD) (212, 214, 218, 219, 220, 221, 222) or days of therapy (DoT) (215, 222). Alawi et al monitored number of units of restricted antibiotics pre and post implementation (211). All these studies have shown a statistically significant decline in antimicrobial consumption with optimising antibiotic use.

The specific outcome measures described in CDC core element five (financial impact, antimicrobial resistance or *Clostridioides difficile* infection) were all minimally reported. Studies addressing financial impact have shown variable reduction in antimicrobial expenditure from pre-intervention or initial phase of intervention (211, 215, 218). Four studies reported statistically significant decline in infection rate by multidrug resistant organisms (211, 215, 220, 221) and three described statistically significant reduction in *Clostridioides difficile* associated disease rate (215, 218, 220).

Among the different process measures for quality improvement (high priority and additional measures), monitoring adherence to local facility-specific guidelines was the most commonly reported measure, being described in seven studies. Increased adherence and compliance to local hospital guidelines was observed over study duration in five studies (212, 213, 214, 215, 217), while the remaining two reported low compliance rate (207, 209). Other additional process measures as specified in the CDC framework, on monitoring antibiotic timeout and IV to oral switch (215) as well as performing medication use evaluation (219) were minimally reported.

Reported outcomes (not part of CDC framework) were: faster rate of transfer from ICU to regular ward with 4 -5 days of follow up (218) and infectious disease consultation with beneficial impact on antimicrobial utilisation (208, 215).

The sixth core element, personal communication with staff to improve antibiotic use and resistance, was reported in nine studies (211, 212, 213, 214, 215, 217, 218, 219, 220), four of which described circulating facility-specific reports on antibiotic use to prescribers (212, 213, 214, 218). Only in two studies, an antibiogram was distributed to prescribers (215, 220).

Eight studies described the seventh core element, education of prescribers and health care workers, comprising small group meetings, verbal and personal communications and e-mail reminders (212, 213, 214, 215, 217, 218, 220, 222).

Table 3.8: Mapping of studies (n=17) against CDC core elements (49)

CDC core element	Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
Infrastructure elements (Leadership, Accountability and Pharmacy expertise)																		
Core element one: Hospital leadership commitment																	√	1
Core element two: Accountability for programme management and outcome			√					√										2
Core element three: Pharmacy expertise	√			√	√	√			√		√		√	√			√	9
Implementation practices (Actions, Tracking, Reporting and Education)																		
Core element four: Actions that implement interventions that report antibiotic use																		
A. High priority interventions																		
Prospective audit and feedback	√		√	√	√			√	√	√	√		√				√	10
Pre-authorisation				√				√	√		√				√	√	√	7

CDC core element	Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
Facility specific treatment guidelines	√	√	√			√	√			√		√	√		√	√	√	**11**
B. Actions focusing on the most common indications for hospital antibiotic use (Common infection-based interventions)																		
Urinary tract infections																		**0**
Community acquired pneumonia										√				√				**2**
Skin and soft tissue infection																		**0**
C. Actions focusing on less common indications for hospital antibiotic use (Less common infection-based interventions)																		
Sepsis																		**0**
Mecithillin resistant *Staphylococcus aureus*	√																√	**2**
Clostridioides difficile				√		√											√	**3**
Culture proven invasive infection																		**0**

CDC core element	Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
Review of planned outpatient parenteral antibiotic therapy (OPAT)																		**0**
D. Provider-based intervention																		
Antibiotic time out										√				√			√	**3**
Assessing penicillin allergy																		**0**
E. Pharmacy-based interventions																		
Documentation of indication	√			√	√		√	√	√	√		√	√				√	**10**
Automatic IV to oral switch										√				√			√	**3**
Dose adjustment	√			√				√										**3**
Dose optimisation	√		√	√				√						√			√	**6**
Duplicative therapy alerts																	√	**1**
Time sensitive automatic stop										√	√		√				√	**4**

CDC core element	Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
order																		
Detection and prevention of antibiotic related drug-drug interaction																		0
F. Microbiology-based interventions																		
Selective reporting of antimicrobial susceptibility testing results						√												1
Comments in microbiology reports											√							1
G. Nursing-based interventions																		
Optimising antimicrobial cultures																		0
IV to oral transitions																		0

CDC core element	Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
promote antibiotic review "time out"																		0
Core element five: Tracking																		
A. Antibiotic use measures																		
Consumption data reported as days of therapy (DoT) or defined daily doses (DDD)				√	√	√				√	√		√	√			√	8
B. Outcome measures																		
Clostridioides difficile infection				√		√											√	3
Antibiotic resistance patterns						√			√		√						√	4
Financial impact in terms of cost reduction				√					√								√	3
C. Process measures for quality improvement focusing on specific interventions implemented in the hospital																		
Priority process measures																		
Tracking prospective audit																		0

CDC core element	Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
and feedback																		
Monitoring pre-authorisation																		0
Monitoring adherence to facility specific treatment guidelines	√	√					√			√		√	√				√	7
Additional process measures																		
Monitor antibiotic "timeouts"																	√	1
Performing medication use evaluation					√													1
Monitor IV to oral switch,																	√	1
Monitor unnecessary duplicates in therapy																		0
Monitor discharge on correct																		0

CDC core element	Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
antibiotic																		
Core element six: Reporting on antibiotic use and resistance	**√**			**√**	**√**	**√**			**√**	**√**		**√**	**√**				**√**	**9**
Core element seven: Education	**√**			**√**		**√**				**√**		**√**	**√**	**√**			**√**	**8**

Abbreviations: IV, Intravenous.

3.3.4.2 Facilitators and barriers to implementation

While facilitators and barriers to implementation were reported in majority of the studies (n=14), the scope and detail of description varied widely. These were described in terms of regional and national levels, hospital organisation, culture and environment. Education and training were the most commonly reported facilitator followed by pharmacist, microbiology and infection control personnel involvement. There appeared to be less focus on investigating barriers; when reported, a lack of higher managerial support was most frequent [see Tables 3.9 and 3.10].

While one study from KSA reported that regional and national legislation facilitated implementation, the lack of enforcement of the legislation and lack of surveillance were reported as barriers (206).

In terms of hospital organisational facilitators, five studies reported higher managerial support (206, 213, 215, 216, 218). That was exemplified through addressing several issues such as: policy enforcement by higher management (206), recruitment of personnel to overcome lack of ASP dedicated staff including the lack of infectious diseases physicians and clinical pharmacists, availing time for ASP audits (218) and mandating infection prevention and medication safety educational activities (213).

For human resources, the importance of personnel focusing on ASP activities was highlighted in ten studies (207, 208, 209, 213, 215, 216, 217, 218, 219, 220). Lack of personnel dedicated to ASP activities was reported as a major barrier to effective ASP implementation (206, 211, 216, 218), notably increased workload associated with audits (211, 216, 218).

For information resources, education and training of healthcare professionals was the most commonly reported facilitator through various forms of education, hospital policies and guidelines (206, 207, 209, 211, 213, 216, 217, 218, 220). Lack of education and training on local hospital guidelines was considered a major barrier (206, 207, 213, 216, 217), especially in newly established settings with staff diverse backgrounds and a range of experiences (213). Information technology support has been reported as a solution supporting implementation of hospital policies and guidelines (206, 207, 215, 216, 218).

For hospital functionality, several studies addressed the diagnostic and prescribing challenges faced by physicians leading to potential unnecessary antibiotic prescribing (206, 207, 211, 220).

Diagnostic challenges took the form of inaccurate diagnosis, imprecise recognition of conditions warranting antibiotics, inconsistent availability of antibiotics (211), lack of microbiological testing and suboptimal triage systems (220). Novel diagnostic systems such as procalcitonin biomarker (207) and enhancing availability of antimicrobial susceptibility testing were potential solutions to diagnostic and prescribing barriers (215, 216, 218, 220, 221).

The effect of hospital culture and environment was addressed in several studies. Factors such as resistance to changing prescribing habits (207, 211), fear of liability risk (207), lack of confidence (216) and poor communication among teams (206) were identified. Lack of adherence to guidelines was suggested to be due to lack of awareness of the existence of such policies (206, 216).

Facilitators to ASP implementation reported in included studies are summarised in Table 3.9 and barriers summarised in Table 3.10.

Table 3.9: Facilitators to ASP implementation reported in included studies (n=17)

		Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
Facilitators																			
A. Regional and national level																			
Regional and national legislation																	√		**1**
B. Hospital organisational level																			
Higher managerial support					√								√			√	√	√	**5**
Human resources	Pharmacist feedback	√			√	√	√	√								√		√	**7**
	Microbiology and infection control personnel involvement	√	√	√	√		√						√					√	**7**
Information resources	Formulary management									√						√	√		**3**
	Institutional policy and guidelines		√					√				√	√					√	**5**
	Supplemental online ASP resources															√			**1**

		Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
	Education and training for healthcare professionals	√	√		√		√	√		√			√			√	√		9
	Education and training for undergraduate medical students and at an early stage of medical training						√			√									2
	Integrating clinical decision support system in hospital IT system		√		√											√	√	√	5
Financial resources	Adequate budget				√														1
ital funct ional	Introduction of novel diagnostics		√																1

		Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
	Availability of Antimicrobial susceptibility testing				√		√					√				√		√	5
C. Hospital culture and environment																			
Key antibiotic prescribers' support									√									√	2
Peer to peer communication					√		√												2

Abbreviations: ASP, Antimicrobial stewardship programme; IT, Information technology.

Table 3.10: Barriers to ASP implementation reported in included studies (n=17)

		Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
Barriers																			
A. Regional and national level																			
Lack of enforcement of national legislations																	√		**1**
Lack of AMR and antibiotic consumption national surveillance systems																	√		**1**
B. Hospital organisational level																			
Lack of higher managerial support			√		√					√			√			√	√		**6**
Human resources	Lack of dedicated ASP personnel				√					√						√	√		**4**
	Shortage of ID physicians																√		**1**
	Shortage of microbiologist																√		**1**
	Lack of clinical pharmacist																√		**1**
	Physicians' high turnover									√									**1**

		Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
	Physicians' high workload and limited time				√					√						√			3
Information resources	Lack of internal policy and guidelines									√						√			2
	Lack of education and training on local hospital guidelines	√	√										√			√	√		5
	Lack of ASP information resources															√			1
	Lack of health information technology																√		1
Financial resources	Limited funding				√											√			2

		Dib et al., 2009 (217)	Aly et al., 2012 (207)	Al-Tawfiq, 2013 (208)	Amer et al., 2013 (218)	Al-Somai et al., 2014 (219)	Al-Tawfiq et al., 2015 (220)	El Hassan et al., 2015 (209)	Tobaiqy et al., 2015 (210)	Alawi and Darwesh, 2016 (211)	Garcell et al., 2016 (212)	Abdallah et al., 2017 (221)	Garcell, Arias, et al., 2017 (213)	Garcell, 2017 (214)	Momattin et al., 2018 (222)	Baraka et al., 2019 (216)	Alghamdi et al., 2019 (206)	El-Lababidi et al., 2019 (215)	Total
Hospital functionality	Microbiology-related barriers						√										√		**2**
	Diagnostic challenges		√				√			√									**3**
C. Hospital culture and environment																			
Lack of confidence																√			**1**
Poor communication among teams																	√		**1**
Fear of liability risk			√																**1**
Lack of support from senior to junior staff			√																**1**
Physicians' resistance to changing their prescribing habits			√							√									**2**
Lack of adherence to guidelines			√					√								√	√		**4**

Abbreviations: AMR, Antimicrobial resistance; ASP, Antimicrobial stewardship programme; ID, Infectious diseases; IT, Information technology.

3.4 Discussion

3.4.1 Statement of key findings

When studies reporting ASP implementation were aligned to the CDC framework, it was found to be variable and generally incomplete. The most commonly reported core elements were: pharmacy expertise, aspects of implementation actions, reporting on antibiotic use and resistance, and education. Seldom reported core elements were: hospital leadership commitment, accountability for programme management and outcome, and tracking. Key implementation facilitators were physician and organisation support, information systems and education with barriers being lack of dedicated staff, increased workload and less funding.

3.4.2 Strengths and limitations

There are several strengths to this review. The protocol was developed according to the standards of PRISMA-P (161), registered in the PROSPERO database (129) and the systematic review reported according to PRISMA criteria (133). One key strength is the approach to synthesis of information on ASP implementation using the CDC framework which will facilitate international comparison. There are some weaknesses hence the review findings should be interpreted with caution. Restricting the search to English language excluding those written in Arabic may have limited retrieval of potentially relevant studies. However, English is the preferred language of most professional organisations in the GCC states. While there was rationale in restricting the review to studies conducted in the GCC states, this may reduce the potential generalisability and transferability to other countries in the Middle East and beyond. Of note, the majority of the studies included were from KSA.

3.4.3 Interpretation of key findings

Mapping studies to standardised quality criteria identified that most were of fair quality, often with small sample sizes hence emphasising the need for higher quality, larger, more robust studies with greater consideration of validity and reliability. Notably none of the studies employed an implementation theory or framework to explore ASP implementation allowing identification of facilitators and barriers related to the context of implementation.

Implementation research in the healthcare sector focuses on a full and complete description of the implementation processes, allowing for consideration of contextual factors that affect delivery of the intervention and provide a link between what can be theoretically achieved and real-life practice (82). For successful implementation, researchers are encouraged to focus on factors such as process of implementation, context, influencing factors and evaluation (223) which facilitates improvement, accountability and long-term sustainability (224). Furthermore, complete description of the intervention, together with details about real-world setting conditions, will enable understanding of what was actually implemented thus aiding replication (224, 225).

Implementation frameworks ideally provide focus on the nature of the interventions and the implementation processes thus facilitating interpretation of implementation outcomes (82). Given that these frameworks target specific components, they must be carefully selected (223).

This systematic review used the CDC framework to provide a complete description of ASP interventions and implementation, with elements relevant to infrastructure, practices and monitoring (59). Furthermore, the CDC framework has been adopted by Joint Commission International (JCI), the most widely sought accreditation body across GCC hospitals (226, 227), as an ASP standard for hospital accreditation (59, 79) which is an added strength and further adds to the relevance of the results in the GCC context. While most studies in this review had key limitations when mapped to this framework, it should be borne in mind that these may reflect deficiencies in study reporting and not necessarily weaknesses in ASP intervention and implementation. Compliance with the framework was found to be variable outwith GCC studies (228, 229) reaching almost 100% in US studies (62, 63, 64, 65) where CDC framework is adopted at a US national level. Of note, the compliance of GCC studies with CDC core elements has increased in the recent years especially with the release of the AMR strategic plan for GCC-IC (42) and inclusion of ASP in JCI accreditation standards (79), which reflects the increased importance of ASP in confronting the increasing risk of AMR.

A collaborative approach engaging all key stakeholder groups in intervention development and implementation is more likely to result in successful outcomes generally (82), and those specifically related to ASP implementation (47, 59, 62, 230). One limitation of the studies in this systematic review was the lack of input from regulatory authorities, which was cited as a barrier to ASP implementation. Indeed, there were reports of only two GCC states having a national

action plan to combat AMR (231, 232). This limitation was also reported as a finding of two other systematic reviews conducted in the Middle East (90, 233). Further evidence of a less well-established ASP infrastructure as defined by CDC (59) is noted, with hospital leadership support (core element one) described in only one study (215) and accountability for programme management (core element two) in another two studies (208, 210). It is evident that positive collaboration amongst key stakeholders at different levels can identify barriers to implementation and promote an iterative approach to improvement (82).

According to the WHO ASP toolkit (47) , the ASP team should be multidisciplinary comprising physicians, pharmacists, nurses, microbiologists (56, 57, 59), including infectious disease (ID) physicians, ID trained pharmacists and infection prevention and control specialist where available (47). This systematic review identified potential barriers to ASP implementation with reported shortages of ID physicians, and limited contributions from pharmacists, infection control preventionists, microbiologists and nurses (206, 211, 216, 218). Given the global shortage of healthcare professionals (234) and the difficulties of establishing an ASP team (235, 236), consideration should be given to optimising the contribution of existing professionals through role extension (237) and professional development (215, 238).

Smart clinical decision support systems can leverage ASP implementation, especially when linked to antimicrobial resistance surveillance tools and antibiotic prescribing guidelines (239). This was identified as a facilitator in included studies (206, 207, 215, 216, 218) and similar observations were reported in other non-GCC studies (239, 240). Embedding such smart clinical decision support systems linked to validated antimicrobial prescribing guidelines, to ensure appropriateness to local context, could enhance ASP implementation effectiveness and efficiency with consequences for resources and outcomes (241). Furthermore, facilitating education (core element seven) as well as training is crucial in terms of changing practice habits especially in a diversity of backgrounds as present in GCC hospitals. It is recommended that GCC hospitals include ASP education in hospital seminars, ward rounds and annual meetings (242).

Central to the continuum of implementation research is ongoing evaluation; allowing pre-implementation insights into intervention suitability, monitoring change in practice during implementation and observing post-implementation impact and consequences (82, 223, 243). CDC categorised tracking (core element five) into: antimicrobial consumption; outcome measures and processes measures (59). However, according to this systematic review, the

current focus in GCC is on implementation phase evaluation with majority of included studies reporting antimicrobial consumption (212, 214, 215, 218, 219, 220, 221, 222) and adherence to facility specific treatment guidelines (207, 209, 212, 213, 214, 215, 217) as the indicators of successful ASP implementation, and with only a few reporting other tracking measures. There is a need to focus on exploring and maintaining positive outcomes in the long term after overcoming implementation challenges (244). As ASP implementation continues to evolve and mature in GCC states, more focus should be placed on analysis of post implementation long-term effects and determinants of sustainability.

3.4.4 Recommendations for practice

Findings of this systematic review provides evidence-based recommendations that can be embedded in practice to leverage ASP implementation. Recommendations can be introduced at multiple levels including national and hospital-based implementation. Given the results of the systematic review, there is a clear need for every GCC state to issue their own national action plan for ASP implementation and for health authorities to endorse the execution of this plan and continuously monitor antimicrobial consumption and AMR prevalence rates. At a hospital level, ASP teams should pay attention to international bundles for ASP implementation such as CDC framework (59), ensuring the presence of a well-established infrastructure of hospital leadership support and ASP (physician-pharmacist) co-leadership and expertise. Also, the foundation of a multi-speciality ASP team is crucial since it ensures the inclusion of all the healthcare professionals, facilitating the infusion of ASP practices in different hospital sectors.

3.4.5 Gaps in the literature

There is a need for enhanced reporting of ASP implementation aligned to the CDC framework in GCC states. Further consideration should also be given to the application of implementation theory to provide focus on facilitators and barriers to implementation. To facilitate identification and understanding of constructs that govern translation of research findings into real practice within the healthcare sector in GCC states, there is a need for rigorous qualitative in-depth research that utilise implementation frameworks.

3.4.6 Recent literature

Since conducting the literature search for the systematic review, ten studies have been identified which meet the inclusion and exclusion criteria, mainly from KSA (n=6), UAE (n=3) and Qatar (n=1). The increased number of studies reported reflects the escalating importance and relevance of ASP implementation in different GCC states. A summary of findings extracted from identified studies is presented in Table 3.11.

Table 3.11: Summary of findings extracted from identified studies

Author, year	Location and study type	Study aim	Alignment to SR objective one		Alignment to SR objective two	
			Infrastructure core elements*	Implementation practices core elements**	ASP facilitators	ASP barriers
Alghamdi et al., 2021 (245)	Kingdom of Saudi Arabia. Qualitative semi-structured interviews. Exploratory case study.	Aimed to explore how an ASP was implemented in a hospital, the challenges faced and how they were overcome, and the programme outcomes.	Relevant leadership support was described. ASP team formation was described including ID physician and pharmacist expertise. Accountability was not clearly stated.	Multiple ASP actions were described including antimicrobial restriction, preauthorisation, prospective audit and feedback. Availability of outcome measures such as antimicrobial consumption and reporting outcome measures to hospital staff. Education of hospital staff was in place.	Leadership support. Training and education. Dedicated ASP staff.	Shortage of staff. Lack of IT support.
Al-Omari et al., 2020 (246)	Kingdom of Saudi Arabia. Before-after quasi experimental.	Aimed to measure ASP impact by measuring consumption and cost of antimicrobial agents before and after the ASP implementation. Also measure rate of healthcare associated infections occurrence in adult in-patients in four hospitals.	No data regarding any of the infrastructure core elements.	ASP actions available included preauthorisation and prospective audit and feedback. Outcome reporting and tracking included antimicrobial consumption, clinical and microbiological outcomes. Continuous education for hospital staff was described.	Not addressed.	Not addressed.

Author, year	Location and study type	Study aim	Alignment to SR objective one		Alignment to SR objective two	
			Infrastructure core elements*	Implementation practices core elements**	ASP facilitators	ASP barriers
Abdul Haseeb et al., 2020 (247)	Kingdom of Saudi Arabia. Before-after quasi experimental.	Aimed to evaluate the impact of multidisciplinary ASP interventions on antimicrobial use with cost and clinical outcomes as the primary and secondary outcome, respectively.	Hospital adopted CDC core elements for ASP implementation. Leadership support was evident. ASP team members were described including physician and pharmacist expertise. No clear statement for accountability.	ASP actions included antimicrobial restriction, prospective audit and feedback. Tracking ASP outcomes were reported such as cost, clinical and economic outcomes. Education for hospital staff was described.	Not addressed.	Not addressed.
Alghamdi et al., 2021 (248)	Kingdom of Saudi Arabia. Cross-sectional survey.	Aimed to explore the status of the adoption of ASPs in Saudi MOH hospitals, at a national level, and explore the factors that may affect their implementation.	ASP core elements were not described. Study aim and focus was to explore factors affecting ASP implementation.		Legislative regulation demanding ASP implementation. Higher managerial support.	Lack of knowledge. Lack of ASP dedicated staff.
Abdul Haseeb et al., 2020 (249)	Kingdom of Saudi Arabia. Cross-sectional survey.	Aimed to assess the current level of ASPs in Makkah region hospitals and their perceived level of success rate.	Evidence of multidisciplinary ASP team formation including pharmacist expertise. No data regarding physician accountability or leadership support.	ASP actions described include de-escalation, automatic stop order and reliance on clinical guidelines. Evidence of reporting and tracking antimicrobial sensitivity reports and education were available.	Not addressed.	Not addressed.

Author, year	Location and study type	Study aim	Alignment to SR objective one		Alignment to SR objective two	
			Infrastructure core elements*	Implementation practices core elements**	ASP facilitators	ASP barriers
Ahmed et al., 2022 (250)	Kingdom of Saudi Arabia. Before-after quasi experimental.	Aimed to investigate the impact of interventions in a SAP programme on process outcome parameters (administration of prophylactic antibiotics) and patient outcome (reduction in SSI rate and cost of consumed antibiotics) at a hospital.	No evidence of leadership support. Evidence of ASP team availability were present, yet no clear description of physician accountability. Pharmacist expertise was included.	ASP actions include development and dissemination of guidelines. Tracking and reporting of outcomes included evaluation of the appropriateness of antimicrobial prescribing in alignment to guidelines. Evidence of education on ASP guidelines was present.	Not addressed.	Not addressed.
Sadeq et al., 2021 (251)	UAE. Before-after quasi experimental.	Aimed to evaluate the impact of an ASP multidisciplinary team intervention on clinical, microbiological, and other relevant measured outcomes among hospitalised patients, highlighting the clinical pharmacist's role as a part of an ASP.	Leadership and accountability core element were absent. Description of ASP team with physician and pharmacist expertise were provided.	ASP intervention included review of antimicrobial therapy in line with ASP guidelines. ASP outcomes tracked and reported readmission rate, length of hospitalisation, microbiological data, antimicrobial consumption and cost. Education core element was not described.	Not addressed.	Not addressed.

Author, year	Location and study type	Study aim	Alignment to SR objective one		Alignment to SR objective two	
			Infrastructure core elements*	Implementation practices core elements**	ASP facilitators	ASP barriers
Hamdan et al., 2020 (252)	UAE. Qualitative – semi-structured interviews.	Aimed to investigate ASP activities and barriers and limitations to effective implementation of ASP within hospitals in Abu Dhabi.	Presence of pharmacist expertise and value of leadership support were described. No evidence of physician accountability.	ASP actions included prospective audit and feedback. Outcome tracking and reporting was not described. Education core element was described.	Education. Value of clinical pharmacist.	Shortage of licensed clinical pharmacists. Lack of management Support. Weak funding and poor IT Support.
Alshehhi et al., 2021 (253)	UAE. Before-after quasi experimental.	Aimed to assess the implementation of newly designed and introduced local hospital SAP guidelines and to evaluate the adherence of physicians to the guidelines.	ASP team formation was described including physician accountability and pharmacist expertise. Leadership support was not described.	ASP actions included development and implementation of SAP guidelines. Outcome tracking and reporting included change in antimicrobial prescribing practice after guidelines implementation. Education core element was described.	Not addressed.	Not addressed.

Author, year	Location and study type	Study aim	Alignment to SR objective one		Alignment to SR objective two	
			Infrastructure core elements*	Implementation practices core elements**	ASP facilitators	ASP barriers
Sid Ahmed et al., 2020 (254)	Qatar. Before-after quasi experimental.	Aimed to describe how implementation of an institutional multimodal ASP affected the susceptibility of *P. aeruginosa*, the prevalence of MDR *P. aeruginosa* and antibiotic use in the hospital setting.	ASP team formation including physician and pharmacist expertise. Missed CDC core elements of leadership support and accountability.	ASP actions mainly prospective audit and feedback. Tracking and reporting specific outcomes including antimicrobial consumption and microbiological outcomes. Missed education core element.	Not addressed.	Not addressed.

*Infrastructure core elements are leadership support, accountability and pharmacist expertise.

**Implementation practices are: ASP actions, outcome tracking and reporting, and education

Abbreviations: ASP, Antimicrobial stewardship programme; CDC, Center for Disease Control and Prevention; MDR P. aeruginosa, Multi-drug resistant *Pseudomonas aeruginosa*; MOH, Ministry of Health; ID, Infectious diseases; IT, Information technology; SAP, Surgical antimicrobial prophylaxis; SR, Systematic review; SSI, Surgical site infection.

The majority of studies were before-after quasi-experimental (n=6) with fewer cross-sectional cohort (n=2) or qualitative studies (n=2). Most of the studies reported pharmacist expertise and aspects related to ASP actions, outcome reporting and tracking, and education in alignment with CDC core elements. Addressing infrastructure core elements was still suboptimal, where only a few studies reported leadership support and programme accountability. Notably, only three addressed facilitators and barriers related to context of implementation. No new facilitators and barriers were identified. None of the studies were underpinned by an implementation framework or theory to support comprehensive identification of facilitators and barriers. Therefore, these studies did not lead to significant change of the systematic review findings.

3.5 Conclusion

There appears to be a need to enhance the reporting of ASP implementation in GCC hospitals. Notably, ASP infrastructure is found to be insufficient and heterogeneous. A rigor infrastructure framework (leadership support, accountability and pharmacist expertise) is required to enhance efficacy, governance and ensure sustainability of implementation interventions (actions, tracking, reporting and education). Attention should be paid to the CDC framework during ASP intervention development, implementation and reporting. Action is required to identify facilitators and overcome barriers, where possible.

The next phase will utilise implementation research to design a robust qualitative study exploring actual experience of implementing ASP, outcomes measures, barriers and facilitators to implementation.

4

Chapter 4

A qualitative exploration of the implementation of Antimicrobial Stewardship Programmes in UAE hospitals

Chapter 4 A qualitative exploration of the implementation of Antimicrobial Stewardship Programmes in UAE hospitals

4. Introduction to the chapter

The systematic review conducted as part of this doctoral degree (see Chapter 3) identified a lack of primary research focusing on ASP implementation in UAE. To understand contextual factors identified as facilitators or barriers for ASP implementation there is a need to conduct research underpinned by implementation theories (118).

This chapter is a detailed description of the primary research conducted to explore key stakeholders' perspective of ASP implementation in UAE hospitals. The research objectives are provided, followed by the methods, key findings, discussion, and conclusion.

4.1 Research aim and objectives

The overall aim of the research was to explore ASP implementation in UAE hospitals. The specific research objectives were to:

1. Explore the perspectives and experiences of key stakeholders regarding ASP implementation in UAE hospitals.
2. Identify key facilitators and barriers for ASP implementation.

4.2 Methods

4.2.1 Research design

A phenomenological, qualitative approach was adopted using semi-structured one-to-one interviews conducted online with key stakeholders in UAE hospitals. This allowed in-depth exploration of ASP implementation. In this study, CFIR was holistically integrated in a meaningful way and underpinned all stages of research including data generation, coding, analysis and reporting of results. Further details justifying this approach are provided in Chapter 2. The study was conducted and reported in accordance with the Consolidated Criteria for Reporting

Qualitative Research (COREQ); a 32-item checklist that is used to ensure comprehensive coverage of important aspects related to research team, study methods, context of the study, findings, analysis and interpretations (167). Refer to Appendix 4.1 for COREQ checklist completed for this research study.

4.2.2 Ethical considerations

Prior to conducting the research, ethical approval was obtained from Robert Gordon University research ethics committee (approval reference S186 available in Appendix 4.2) and each participating hospital in UAE (See Table 4.1 below and Appendices 4.3 - 4.6). Documents included as part of the ethics application are at Appendices 4.7 - 4.11.

Table 4.1: Ethics approval from each participating hospital

Hospital	Ethics approval	Appendix
Kalbaa hospital	Ministry of Health and Prevention (MOHAP) Research Ethics Committee (approval reference MOHAP/DXB-REC/JAANo.32/2019)	4.3
Saqr hospital		
Dhaid hospital		
Qassimi hospital		
Sheikh Khalifa medical city (SKMC) hospital	Abu Dhabi health services company (SEHA) – Research Ethics Committee (approval reference SEHA – 003)	4.4
Corniche hospital		
Al Ain hospital		
Zayed Military hospital	Zayed Military Hospital Ethics and Research Committee (approval reference 2020.10)	4.5
Saudi German hospital	Ethical approval letter from medical director.	4.6
Prime hospital	No ethics approval was required. Only participant consent form prior to commencing interview.	-
Al Zahraa hospital	No ethics approval was required. Only participant consent form prior to commencing interview.	-

4.2.3 Settings

Data generation was conducted in UAE, in five of the seven Emirates (Abu Dhabi, Dubai, Sharjah, Fujairah and Ras Al Khaimah) including governmental and private hospitals governed by Department of Health – Abu Dhabi (DoH), Dubai Health Authority (DHA) and Ministry of Health and Prevention (MOHAP). Data generation in the remaining two Emirates (Umm Al Quwain and Ajman) was not feasible since hospitals did not respond to the invitation email. No reason for

this was provided. The following is a description of included settings (255, 256, 257, 258, 259) , with detailed characteristics of participating hospitals in Table 4.2:

- **Emirates health services (EHS) hospitals.**

  EHS is the Federal Governmental provider of healthcare services within the Northern Emirates. Four EHS hospitals from different Emirates were included.

- **Abu Dhabi health services company (SEHA) hospitals**

  SEHA is the governmental corporate which operates public hospitals and clinics in the Emirate of Abu Dhabi. SEHA is an Arabic term which means 'Health'. Three SEHA hospitals were included from the cities of Abu Dhabi and Al Ain within Abu Dhabi Emirate.

- **Zayed Military hospital (ZMH)**

  ZMH is the main military hospital operated by the Directorate General of Medical Supplies – Armed forces – UAE, located in Abu Dhabi Emirate.

- **Prime hospital**

  Prime hospital is a private multispecialty hospital located in Dubai.

- **Al Zahraa hospital**

  Al Zahraa hospital is a private multispecialty hospital located in Dubai.

- **Saudi German hospital**

  Saudi German hospital is a private multispecialty hospital located in Dubai, owned by a healthcare group originating in Jeddah, Kingdom of Saudi Arabia with multiple branches across the Middle East/North Africa (MENA) region.

These hospitals represent variability in funding source (governmental and private), bed capacity, governing health authority and location to ensure maximum variation sampling (260). Characteristics of participating hospitals are detailed in Table 4.2.

Table 4.2: Characteristics of participating hospitals

Governing health authority	Hospital	Emirate	Funding source	Bed capacity
MOHAP	Kalbaa hospital	Fujairah	Governmental – EHS hospital	85 beds
	Saqr hospital	Ras Al Khaima	Governmental – EHS hospital	278 beds
	Dhaid hospital	Sharjah	Governmental – EHS hospital	138 beds
	Qassimi hospital	Sharjah	Governmental – EHS hospital	362 beds
DoH	Sheikh Khalifa medical city (SKMC) hospital	Abu Dhabi	Governmental – SEHA hospital	711 beds
	Corniche hospital	Abu Dhabi	Governmental – SEHA hospital	299 beds
	Al Ain hospital	Abu Dhabi	Governmental – SEHA hospital	402 beds
	Zayed Military hospital	Abu Dhabi	Governmental – Military hospital	365 beds
DHA	Prime hospital	Dubai	Private hospital	100 beds
	Al Zahraa hospital	Dubai	Private hospital	137 beds
	Saudi German hospital	Dubai	Private hospital	300 beds

Abbreviations: DoH, Department of Health; DHA, Dubai Health Authority; EHS, Emirates Health Services; MOHAP, Ministry of Health and Prevention; SEHA, Abu Dhabi Health Services company.

4.2.4 Participant inclusion criteria

Two groups of participants were included.

1. **ASP team members**

These were experts in ASP implementation concerned with governing and steering ASP activities within the hospital healthcare system. They were also potentially involved in managing antimicrobial therapy at individual patient level. The group comprised:

- Infection diseases management experts (physicians).
- Antimicrobial experts (usually clinical pharmacists).
- Patient care experts (nurses).
- Microbiology experts (clinical microbiologists).

2. **Non-ASP team members**

These were members of the multidisciplinary team who managed antimicrobial therapy at the individual patient level and unlikely to be involved in any strategic decision making. The group comprised:

- Medical practitioners (physicians dealing with antimicrobial therapy in various specialities).
- Pharmacists.
- Nurses.
- Clinical microbiologists.
- Infection control practitioners.
- Quality control professionals.

Both groups were included to provide a broad perspective on ASP implementation.

4.2.5 Sampling strategy and recruitment of potential participants

Both purposive and snowball sampling were employed as described in Chapter 2, starting in June 2020 and for seven months. Purposive sampling of ASP team members was adopted to ensure participants from a range of specialities and with varied years of experience were included who were working in hospitals regulated by different health authorities. Snowball sampling was also used, with those interviewed asked to suggest other ASP members and non-members meeting the inclusion criteria.

ASP team members were identified via the professional networks of the doctoral student and an external collaborator from MOHAP, who co-chairs the UAE National Committee for Antimicrobial Resistance. The external collaborator facilitated recruitment of participants through communication with different EHS hospitals and private hospital leaders. To further facilitate networking, the doctoral student was assigned as a member of the national ASP sub-committee to facilitate identification of potential participants.

In addition, the doctoral student sought military hospital and SEHA ethics approval and communicated with close connections from both, based on her previous work experience, to identify ASP team members.

For every hospital approached, interviews started with one of the ASP team members who, through snowballing, identified other ASP team members and non-members from the same hospital who could contribute to data generation.

4.2.6 Sample size determination

Sampling continued until the point of overall data saturation which is defined as no new emerging themes extracted from interviews within the adopted initial analytical framework (144) which was based on CFIR domains and constructs (159) . Further discussion to approach to sample size determination is available in Chapter 2.

4.2.7 Interview schedule development

Development of the interview schedule followed an iterative approach through continuous discussions between the doctoral student and supervisory team. The interview schedule was informed by:

- The CFIR framework (159) (further details are available in Chapter 2).
- A systematic review mapping hospital ASP in GCC states to international standards (118) conducted as part of this research project (See Chapter 3).

The initial draft of the interview schedule was based on the interview guide tool provided by the CFIR Research Team - Centre for Clinical Management Research (https://cfirguide.org/tools/), revised for ASP implementation.

Probes were used in a non-leading manner to allow depth and breadth of coverage of key issues. Interview questions were mapped to CFIR constructs and domains as shown in Table 4.3 and 4.4. A shortened version of the interview questions was used for non-ASP members based on their likely level of involvement in ASP implementation (Table 4.4).

The interview schedule was reviewed by two experts in the field from UAE (internal medicine physician and clinical pharmacist) as well as two academics from RGU with experience in the use of theory in qualitative research, to ensure credibility.

Following piloting of interviews with two ASP members and two non-ASP members, only minor changes were made to the interview schedules. Therefore, these pilot interviews were included in final dataset.

Table 4.3: Interview questions mapped to CFIR constructs and domains aimed at ASP team members

CFIR construct	Interview questions and probes
Domain One; Intervention characteristics	
Intervention source	**How did your hospital start ASP implementation?** • Was it developed based on ASP guidelines from other countries or other hospitals? • Who was involved in developing your ASP? • What went well and did not go so well; what helped and did not help? ○ Can you tell me more about that?
Adaptability	**Did you have to adapt or refine to suit your hospital?** • Can you describe these changes required? • Who was involved? **Or any special plan for adapting or refining ASP to integrate it within the current** practice? • Who will be involved?
Complexity	**What are your thoughts on how complex the ASP was for your hospital?** • Was there a need for stepwise implementation? • Was there any specific training program for staff around implementation? • Do you feel there will be a need for step wise implementation? How?
Cost	**To what extent was (is) cost a consideration for implementing ASP?** • Think about costs incurred and potential to save costs
Domain Two; Outer setting	
Peer pressures	**How did ASP practices from other hospitals influenced your implementation?** • Positive and negative influences?
External policies and incentives	**What kind of national policies or directions influenced the decision to implement ASP?** • Any support has been received from authorities to encourage implementation? • Special training, seminars, educational material, bonuses, or incentives?
Domain Three; Inner setting	
Structural characteristics	**To what extent does (did) your hospital need to update its infrastructure for ASP implementation? (like policies, information technology, practices and guidelines)** • Such as hospital size, staff turnover, use of technology and central decision-making.
Networks and communication	**Can you comment on the effect of formal and informal communication among teams inside your hospital on ASP implementation?** • How do you communicate with staff to get them engaged in the intervention? Formal emails, e-bulletins,

CFIR construct		Interview questions and probes

		or periodicals?
		• Do you meet regularly to discuss ASP?
		  ○ Who calls for these meetings? Who attends?
		  ○ Any specific agenda?
		  ○ How helpful are these meetings?

	Culture	**How do you think your hospital culture affected (will affect) ASP interventions?** • How do you describe the culture in your hospital? • Is it team culture or hierarchy culture? • By culture we mean (general belief, values, assumptions that people embrace) • To what extent is new ideas accepted and embraced in your hospital? (Team perspective)
Implementation climate	**Absorptive capacity**	**To what extent is ASP generally accepted in your hospital?**
	Relative priority	**To what extent is ASP implementation considered a high priority in your hospital? Why?**
	Organisational incentives and rewards	**What kind of incentives are there to ensure successful ASP implementation?** • Can you describe any special **reward or recognition** planned in relation to ASP implementation? • Is it targeting teams or individuals?
	Goals and feedback	**What are your hospital's goals (key performance indicators KPI) for ASP implementation?** • How are they communicated? • To what extent these goals are monitored for progress? • How often do you provide feedback to healthcare practitioners about ASP KPI (goals)?
Readiness for implementation	**Leadership engagement**	**What level of support for ASP implementation have you seen from leaders?** • Who are they? (Maybe medical director and heads of departments)? • To what extent are they involved? • Can you mention specific examples of support to ASP implementation? • What types of barriers they might create?
	Available resources	**Do you have sufficient resources to implement and administer ASP?** • If yes, what resources are you counting on? • If No, what resources are not available? • To what extent these individuals are available?

CFIR construct	Interview questions and probes
Access to knowledge and information	**What kind of information and material about ASP has been already made available for hospital staff?** • What kind of training is planned for hospital staff? • If staff have questions about ASP, who do they approach?
	Domain Five; Process
Planning	**How did you plan for ASP implementation?** • Who was engaged in the planning process? • What was your role? • What is your next step or future plan? • Do you have the appropriate individuals engaged in planning? How engaged are they? **Do you share your plan with health authorities? How regularly?** • Any refinement or revision process based on progress or health authority feedback?

Engaging	**What steps have you taken (OR plan to take) to encourage individuals to commit to ASP implementation?**
	• Which individuals did (do you plan to) you target?
	• How often do you communicate with them?
	• Who are the key influential staff that you need to get on board of implementation?
	  ○ Why?
	  ○ How can they influence other individuals in the hospital?
	• Can you tell us about champions for implementation?
	• Is it a voluntary work or formally assigned role?
	• Why are they considered champions?
	• Are they rewarded for this role?
	• How can they help implementation?

Executing	**Can you comment if ASP implementation is proceeding according to your plan?** • If yes, can you describe this? • If No, why not?

Reflecting and evaluating	**How do you feel about the effectiveness of ASP implementation in your hospital?**
	• How do you feel the program is going?
	• Stressed, confident, enthusiastic?
	How does ASP implementation compare to early or pre-implementation phase?
	• Can you think of any specific outcomes?
	  ○ Any advantages?
	  ○ Any disadvantages?
	What kind of information do you plan to collect as you implement ASP?

CFIR construct	Interview questions and probes
	• Are there any tracking or monitoring measures in place to evaluate ASP implementation? • Can you give more details?
Conclusion statement	**If you are advising others on ASP implementation, what would you advise them to do or to avoid?**

Table 4.4: Interview questions mapped to CFIR constructs and domains aimed at participants who were not members of an ASP team

CFIR construct		Interview questions and probes
Domain One; Intervention characteristics		
Complexity		**How was ASP implemented in your hospital?** • Was there any specific training program around implementation? • Was there a need for stepwise implementation? Was it complex to implement?
Domain Three; Inner setting		
Networks and communication		**Can you comment on the effect of communication within teams inside your hospital on ASP implementation?** • How do you get to know about any new information in the hospital (joining staff, new initiatives, new guidelines)?
Culture		**How do you think your hospital culture (general belief, values, assumptions that people embrace) affected ASP implementation?** • How do you describe the culture in your hospital? • Is it team culture or hierarchy culture? • To what extent is new ideas accepted and embraced in your hospital? (team perspective)
Implementation climate	**Absorptive capacity**	**To what extent is ASP generally accepted in your hospital?**
	Relative priority	**To what extent is ASP implementation considered a high priority in your hospital? Why?**
	Organisational incentives and rewards	**What kind of incentives are there to ensure successful ASP implementation?** • To what extent do you feel **rewarded or recognised** for implementing ASP?
	Goals and feedback	**What are your hospital's goals (key performance indicators KPI) for ASP?** • How are they communicated? • To what extent these goals are monitored for progress? • How often do you get feedback about ASP KPI (goals)? ○ Who provides it? • How helpful are these reports? How to improve it?
Readiness for implementation	**Leadership engagement**	**What level of support for ASP implementation have you seen from leaders?** • Who are they? • To what extent are they involved? • Can you mention specific examples of support to ASP implementation? • What types of barriers they might create?

CFIR construct		Interview questions and probes
	Available resources	**Do you have sufficient resources to implement and administer ASP?** • If yes, what resources are you counting on? • If No, what resources are not available?
	Access to knowledge and information	**What kind of information and material about ASP has been already made available for you?** • What kind of training is planned for you? • If you have questions about ASP, who do you approach? • To what extent these individuals are available?
Domain Four; Characteristics of individuals		
Self-efficacy		**To what extent do you feel confident and well equipped to carry out ASP activities?**
Domain Five; Process		
Engaging		**Who are the key influential (opinion leaders) individuals approached by management to come on board of implementation?** • To what extent they can influence others? • Who are the ASP implementation (formally appointed) leaders in your hospital? • What are their qualities (authority/ influence / experience) to efficiently lead?
Reflecting and evaluating		**How do you feel about the effectiveness of ASP implementation in your hospital?** • How is the program going? • Are you stressed, confident, enthusiastic? Why? **How does ASP implementation compare to early or pre-implementation phase?** • Can you think of any specific outcomes? ○ Any advantages? ○ Any disadvantages?
Conclusion statement		**If you are advising others on ASP implementation, what would you advise them to do or to avoid?**

4.2.8 Data generation

All potential participants were emailed, by the doctoral student, the following: (1) an information leaflet as an introduction to the research topic (Appendix 4.7), (2) an informed consent form (Appendix 4.8), and (3) the ethics approval letter granted by their respective hospital (Appendices 4.3 – 4.6).

Should participants be willing to participate, they were requested to identify a suitable date and time for interview and to select the most convenient online platform for interview (Zoom®, Microsoft Teams® or Blackboard Collaborate®). Face-to-face interviews were initially planned for data generation. This had been reviewed to online interviews, given the COVID-19 pandemic restrictions as clarified in Chapter 2.

Prior to commencing interviews, participants were provided an opportunity to ask questions and then provided a signed informed consent (Appendix 4.8). Then they were requested to complete a short survey with their demographic information, using the JISC online survey tool (https://www.onlinesurveys.ac.uk/, (formerly Bristol online survey – BOS ®). Questions included age, current position, speciality, years of experience at current hospital and country of last qualification related to position.

Meetings were conducted in English by the doctoral student since it is the most common language among healthcare providers. Video-recorded interviews (approximately 45 – 60 minutes) were transcribed verbatim by the doctoral student using oTranscribe® online tool (https://otranscribe.com/). This tool was used to facilitate manual transcribing by the doctoral student without the need to toggle between two different programs (interview recording and Microsoft Word® document), since both are displayed on the oTranscribe® interface (see Appendix 4.12).

Accuracy and quality of transcripts were verified by the doctoral student and any identifiable data removed. Participants were offered the opportunity to review their transcript to enhance credibility and dependability. A summary of different measures adopted to ensure trustworthiness of this qualitative research is presented in Table 4.5. Detailed discussion of trustworthiness in qualitative research, based on Lincoln and Guba criteria (151), is available in Chapter 2.

Table 4.5: Summary of measures adopted to ensure trustworthiness of this qualitative research

Guba's construct	Means of establishment of trustworthiness
Credibility	- Development of interview guide underpinned by the CFIR domains and constructs, which has been well established in previous studies as a comprehensive framework to identify key facilitators and barriers in relation to study context. - Familiarity of doctoral student with practice in UAE hospitals, based on previous experience as a pharmacist in one of the governmental hospitals in UAE. - Environmental triangulation, i.e. use of different locations and settings through recruitment of participants from multiple sites to negate the effect of local factors related to a specific site. - Allowing participants to freely decide to share their experience without concern for any negative outcome due to their participation. - Doctoral student was not affiliated with any of the hospitals at the time of interviews, thus unlikely to introduce bias in data generation. - Frequent debriefing sessions (talk-aloud) with supervisory team for iterative approach of data analysis.
Transferability	- Detailed description of participants and hospitals demographics to allow readers to determine transferability of research to other settings.
Dependability	- Detailed description of project execution provided to allow in depth coverage of the research practices that have been followed throughout the full study. - Detailed description of data gathering process.
Confirmability	- Use of diagrams and tables to show (audit trail) the development of recommendations based on data generated.

4.2.9 Data analysis

As discussed in Chapter 2, data were analysed thematically using the framework approach (144) of transcribing, data familiarisation, developing a working analytical framework, coding, charting data in framework matrix, and interpreting data.

Nvivo® software was used to facilitate data analysis and visualisation. All transcripts were transferred to NVivo® once transcribing and reviewing was complete (see Appendix 4.13).

The initial coding framework adopted was deductively based on CFIR domains and constructs (See Appendix 4.14). Further details of the theoretical underpinning of this study are available in Chapter 2. The first interview was independently coded by the doctoral student and each member of the supervisory team (AT, DS and DP) against CFIR domains and constructs. Comments from the

supervisory team were collated by the doctoral student (see Appendix 4.15) and any discrepancies discussed and resolved. The remaining transcripts were coded by the doctoral student and one member of the supervisory team.

Following completion of the initial coding against the CFIR domains and constructs, further analysis was conducted by inductively identifying themes emerging within each CFIR construct (see Appendix 4.16). Grouped quotes were then exported to Microsoft word (see Appendix 4.17), where the doctoral student continued data interpretation following an iterative approach through continuous discussions with principal supervisor (AT) (see Appendix 4.18) to identify most dominant CFIR constructs and most illustrative quotes.

To facilitate data visualisation, given the complexity and the large amount of data generated from interviews, Mindmanager® (261) was used to design mind maps for organising emerging themes (see Appendix 4.19).

The application of thematic analysis stages as defined by the Framework Approach to data analysis in this doctoral research is summarised in Table 4.6.

Table 4.6: Thematic analysis stages using the Framework Approach *(144)*

Framework Approach stage	Procedure for analysis
1. Familiarisation with the interview	Researcher familiarisation with the interview through: • Verbatim (word by word) transcription conducted by doctoral student. • Reviewing of transcripts to ensure anonymity and fill in missed gaps by re-listening to video recording several times.
2. Construction of an initial thematic framework	Using CFIR domains and constructs as an initial analysis framework.
3. Indexing and sorting (Coding)	Transcripts were transferred to NVivo® software and deductively coded against CFIR domains and constructs. This was followed by inductive coding to identify different subthemes emerging within each CFIR construct.
4. Reviewing data extracts	This was conducted manually (using Microsoft Word®) after exporting accumulated quotes for each CFIR construct from NVivo® software.
5. Data summary and display using framework	Iterative approach of reviewing quotes and coded themes with principal supervisor (AT) to agree on most dominant CFIR constructs and most illustrative quotes.

4.2.10 Doctoral student's expertise and training

The doctoral student, with a hospital pharmacy practice background and academic expertise, received specialised training on qualitative methodology, using NVivo software (147) and Mindmanager software (261) as tools to facilitate qualitative data analysis and visualisation. Training was offered by the Researcher Development Programme and facilitated by the Graduate School in RGU.

The pilot interviews were peer - observed by one of the supervisors (DP) to provide feedback on improving the interviewing technique.

Since governmental research ethics committees (SEHA and MOHAP) require evidence of completion of Good Clinical Practice (GCP) certificate, the doctoral student obtained the required certificate through completion of 12 online research modules from National Drug Abuse Treatment – Clinical Trials Network (NDAT-CTN) (262).

4.3 Findings

4.3.1 Stakeholders recruitment

Seventeen hospitals were approached from across UAE (11 governmental and six private); 11 granted ethical approval and six were non-responsive with no reason provided (see hospitals' characteristics in Table 4.7).

Table 4.7: Participating hospitals' characteristics (n = 11)

Hospitals' characteristics	Number of hospitals (n)
Location (Emirate)	
Abu Dhabi	4
Dubai	3
Sharjah	2
Fujairah	1
Ras Al khaimah	1
Governing local health authority	
Department of Health – Abu Dhabi	4
Dubai health authority – Dubai	3
Ministry of Health and Prevention – Northern Emirates	4
Hospital funding	
Governmental	8
Private	3
Bed capacity	
< 100	2
100 – 300	6
> 300	3

Purposive sampling identified 11 ASP team members who agreed to participate and nominated 29 potential participants (ASP members and non-members) through snowball sampling, of which 21 agreed to participate giving a total sample size of 32. Thirty-one interviews were used for analysis (one recording failure), where data saturation of analytical framework was achieved at 28 interviews and further three were conducted to confirm saturation (145). Less number of non-ASP team members was required towards achieving data saturation given their level of involvement in ASP related activities. A summary of the sampling strategy is available in Figure 4.1. Participants' demographics along with participants' anonymous identity codes are given in Table 4.8.

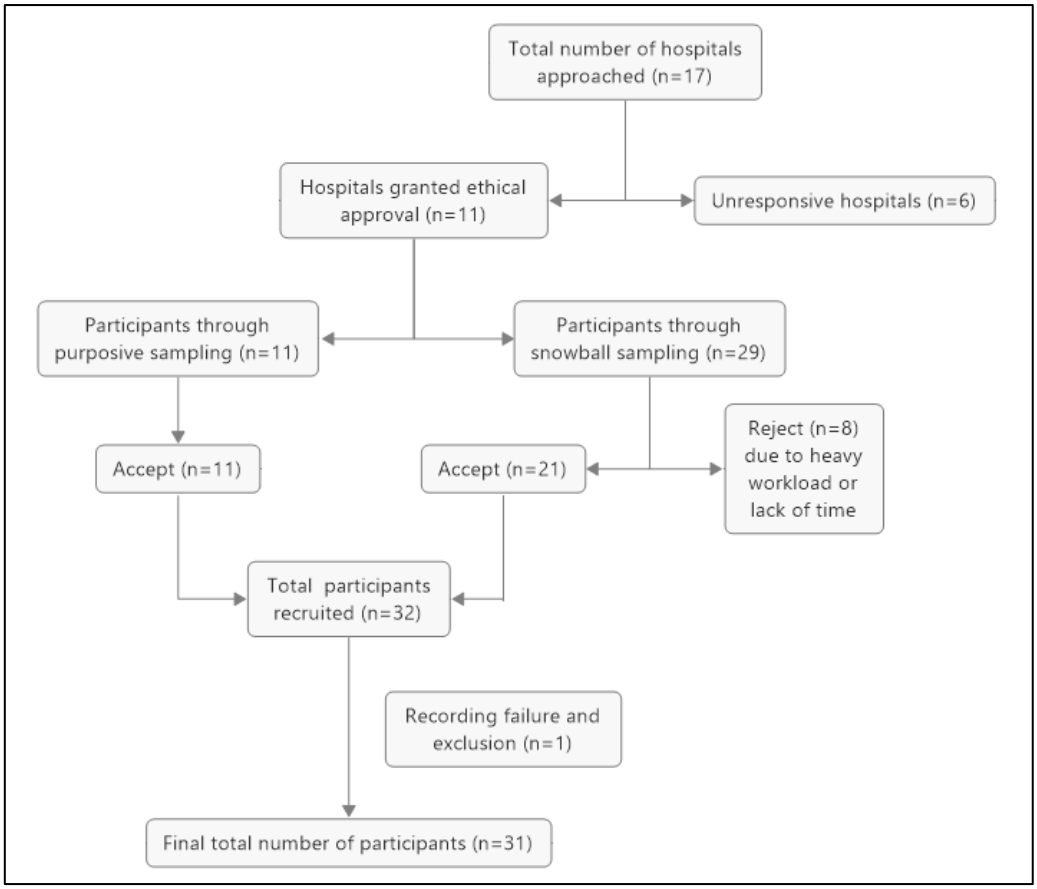


Figure 4.1: Sampling strategy for data generation

Table 4.8: Demographic characteristics of participants (n=31)

	Participants' job	Age range	Gender	Country of last qualification	Participant identity code	Hospital status
ASP team members						
1	Clinical pharmacist	31-40	Male	UAE	P1	GOV
2	Clinical pharmacist	31-40	Female	UK	P2	GOV
3	Clinical pharmacist	31-40	Male	India	P3	GOV
4	Clinical pharmacist	41-50	Female	USA	P4	GOV
5	Clinical pharmacist	31-40	Female	Egypt	P5	GOV
6	Clinical pharmacist	31-40	Female	UAE	P6	GOV
7	Clinical microbiologist	51-60	Male	UK	P7	GOV
8	Clinical microbiologist	51-60	Female	Egypt	P8	GOV
9	Intensive care consultant	41-50	Male	Jordan	P9	PVT
10	Intensive care consultant	41-50	Female	KSA	P10	PVT
11	Infectious diseases physician	41-50	Female	UK	P11	GOV
12	Infectious diseases physician	51-60	Male	USA	P12	GOV
13	Infectious diseases physician	51-60	Female	Iran	P13	PVT
14	Nephrologist	41-50	Female	Egypt	P14	GOV
15	Nurse	41-50	Female	Egypt	P15	GOV
16	Nurse	51-60	Female	UK	P16	GOV
17	Nurse	41-50	Female	India	P17	GOV
18	Quality officer	41-50	Male	Lebanon	P18	GOV
19	Surgeon	51-60	Male	UK	P19	GOV
20	Surgeon	Above 60	Male	UK	P20	GOV
21	Surgeon	41-50	Male	India	P21	GOV
22	Surgeon	51-60	Male	Iraq	P22	PVT
Non-ASP team members						
23	General practitioner	21-30	Male	UK	P23	GOV
24	Intensive care	41-50	Male	Egypt	P24	GOV

	consultant					
25	Internist	51-60	Male	USA	P25	GOV
26	Nephrologist	51-60	Female	India	P26	PVT
27	Pharmacist	31-40	Male	Egypt	P27	GOV
28	Pharmacist	51-60	Female	UK	P28	GOV
29	Pharmacist	21-30	Female	Egypt	P29	GOV
30	Pharmacist	21-30	Female	USA	P30	GOV
31	Quality officer	31-40	Male	Egypt	P31	GOV

Abbreviations: ASP, Antimicrobial stewardship; GOV, Governmental hospital; KSA, Kingdom of Saudi Arabia; PVT, Private hospital; UAE, United Arab Emirates; UK, United Kingdom; USA, United States of America.

4.3.2 Themes

The following section presents identified themes mapped to the most dominant CFIR domains and constructs based on the extent of and emphasis during the discussion.

4.3.2.1 CFIR domain I (Intervention characteristics), Complexity construct

Many participants perceived ASP complexity as a barrier to its implementation, where complexity escalated with expansion of the programme due to involvement of multiple personnel and several areas.

> "*You say start simple but gradually [ASP] becomes complex because the more and more areas you involve to bring under your stewardship programme, the more difficult it becomes and the more challenging it becomes, because of the data gathering and number of people involved*." [P7, Clinical microbiologist, ASP member]

> *"We found it difficult to start [implement ASP in] inpatient, outpatient and emergency [setting]. So, we start only in the inpatient."* [P26, Nephrologist, non-ASP member]

4.3.2.2 CFIR domain II (Outer setting), External policy and incentives construct

Participants emphasised that the publication of mandates by UAE health authorities external to the individual institutions making ASP a requirement, were facilitators for ASP implementation.

"*We started in the summer of 2017. That was after the Department of Health in Abu Dhabi issued … a circular requiring that all the hospitals operating in the Emirate of Abu Dhabi have such a programme*." [P4, Clinical pharmacist, ASP member]

"When we started receiving the circulars and the directions [from health authorities], we used it as a supporting tool in our hands when we are talking with our doctors that it is now happening at the national level, and we need more compliance." [P24, Intensive care consultant, non-ASP member]

No external incentive, such as financial rewards, was associated with UAE health authorities' mandates. However, participants confirmed that inspection visits conducted by UAE health authorities and aimed at monitoring ASP implementation and were considered a motivational factor for ASP team members, non-members and hospital leadership.

"*The other thing is the health authority of Abu Dhabi, Department of Health (DoH), they have influenced [our decision to implement ASP]. Before [we decided to implement ASP] they did [conducted] some audit on and off ... [They asked] Where is the structure for the programme? Where is the process? Where are the policies? Whatever you do is random practice*." [P3, Clinical pharmacist, ASP member]

"*We started having mandated policies from the MOHAP to have a stewardship [programme] … So that's how we … started gaining support from the administration [leadership]*." [P5, Clinical pharmacist, ASP member]

International accreditation bodies, also external to the institutions and mandating ASP as a requirement for hospital reaccreditation [e.g., Joint Commission for International Accreditation (JCIA)] were viewed as a facilitator by the majority of participants.

"*We are JCIA accredited hospital, so it [ASP implementation] is one of the requirements.*" [P27, Pharmacist, non-ASP member]

4.3.2.3 CFIR domain II (Outer setting), Cosmopolitanism construct

Some ASP team members developed networks and collaborated with other local hospitals in UAE reflecting cosmopolitanism. This allowed for provision of peer support through sharing of experiences thus facilitating ASP implementation.

"*We were influenced by hospital X. They started earlier, and when we started our programme, we communicated with them and they shared their experience in antibiotic stewardship, especially how to develop a guideline with respect to antibiogram.*" [P6, Clinical pharmacist, ASP member]

Another important outcome of cosmopolitanism was provision of training and education.

"*At the start of implementation of the antibiotic stewardship, the two clinical pharmacists we have in the hospital went for training in X hospital and joined them for about 8 weeks to be aware about how they implemented the antibiotic stewardship.*" [P14, Nephrologist, ASP member]

4.3.2.4 CFIR domain III (Inner setting), Implementation climate (Tension for change) construct

Standardising antimicrobial prescribing practices was a major motivation (tension for change) to strongly encourage ASP implementation, driven by prescribers' variability in background and reflected on their antimicrobial prescribing practices.

"*People are not using a standard protocol; each one is using his own protocol. Because we have the physicians who are trained in different countries. So, when we see the antibiotic usage, there are many things which were not consistent and standardised, so we wanted to standardise for our hospital also.*" [P19, Surgeon, ASP member]

4.3.2.5 CFIR domain III (Inner setting), Implementation climate (Organisational incentives and rewards) construct

The provision of organisational incentives and rewards was appreciated by several ASP team members who described how their efforts to implement ASP were acknowledged by leadership in different forms such as; appreciation certificates, performance appraisal reports and opportunities for funding towards conference participation.

"*Administration [leadership] obviously time and again reward their people by certification … giving us an opportunity to present our data in a number of international conferences*." [P7, Clinical microbiologist, ASP member]

ASP team members valued another form of intangible rewarding, involving recognition of good practice by JCI auditors during accreditation visits.

"A*lso, we have JCI accreditation recognising the infection control programme and recognising the ASP at our hospital as one of the best they have seen in international accreditation system, so it was very good*." [P15, Nurse, ASP member]

4.3.2.6 CFIR domain III (Inner setting), Culture construct

ASP implementation was initially hindered by some physicians' resistance to change their antimicrobial prescribing patterns which participants perceived to be influenced by cultural beliefs and assumptions, including blame culture.

"*Most of the physicians, especially the surgeons, are afraid to be blamed of postoperative infection, complications of surgery … [due to] … inadequate coverage of antibiotic or inadequate duration of antibiotic*." [P14, Nephrologist, ASP member]

Also, prescribers' antimicrobial prescribing habits were shaped by years of practice. Perceived restriction by ASP on prescribing rights was seen by some as contributing to reluctance to change antimicrobial prescribing practices.

"*These doctors [have] been prescribing antibiotics for the last 20-25 years. So, how we change the mentality? That was the challenge*." [P22, Surgeon, ASP member]

"So, we didn't face a refusal from them to follow the new guidelines, but it took time from them to get used to it." [P30, Pharmacist, Non-ASP member]

"*Some physicians feel somebody is restricting their right to prescribe*." [P27, Pharmacist, Non-ASP member]

Participants perceived acceptance of ASP as growing gradually and was influenced by various factors such as a collaborative approach between ASP team members and non-members.

"*I think the culture is very collaborative. I think that we don't leave the ASP strategy to be one person's job. I think everybody understands that it takes a village, and everyone's role is appreciated.*" [P2, Clinical pharmacist, ASP member]

"*Really, they're [prescribing physicians] accepting the changes. This [collaborative] culture helped to ease implementation of the programme, otherwise we cannot implement any programme if there is so much resistance and nobody is taking initiatives*." [P17, Nurse, ASP member]

4.3.2.7 CFIR domain III (Inner setting), Available resources construct

Lack of specialities such as ID physicians, clinical pharmacists and microbiologists was identified by several participants.

"*The thing which we are lacking is the clinical pharmacist who is dedicated to ASP activities and doing prospective audit along with an infectious disease consultant*." [P9, Intensive care consultant, ASP member]

This, together with a lack of protected time for ASP activities, contributed to an increased workload with these activities being carried out over and above the normal job, and this was considered a barrier to implementation.

"*ASP is an additional task that we are doing. We also have our own [other] work so we need at least to have some time that is dedicated for the ASP, which does not happen within the working hours. Sometimes we have to come a little bit early, stay a little bit late so that part is not well thought out*." [P5, Clinical pharmacist, ASP member]

To overcome this, a few participants noted that referral was made to external hospitals where the required speciality was available.

"*Our hospital didn't recruit an ID [Infectious diseases] consultant, but it consulted with the ID [consultant] at hospital X as needed*." [P4, Clinical pharmacist, ASP member]

Another solution for lack of some specialities was selecting ASP activities that matched the hospital available resources, for instance retrospective audit and feedback to prescribing physicians was adopted instead of prospective antimicrobial auditing activities, the latter being more feasible to conduct.

"*Prospective audit was not possible to do, rather we adopted retrospective audits and looking into our previous practice and learning from it and advising doctors accordingly based on the patterns of the prescribing*." [P9, Intensive care consultant, ASP member]

Many ASP team members emphasised the important role of information technology (IT) staff who could modify the currently available electronic medical record (EMR) systems to facilitate introduction of new functions supporting ASP duties.

> "*So, regarding the information technology, we used to communicate with our IT department to help us to improve and to keep our current electronic medical record with a design that helps in implementing ASP. For example, if there is a culture and sensitivity result, the result will be in red colour*." [P6, Clinical pharmacist, ASP member]

4.3.2.8 CFIR domain III (Inner setting), Leadership engagement construct

Many participants believed hospital leadership engagement was a facilitator for successful ASP implementation.

> "*She [hospital chief medical officer, CMO] was the main champion because what we found is when we were doing ASP in our capacity without a champion in the higher level of the C suite [executive leadership], it didn't really carry the weight. So, I think this is the most support I've seen in my 11 years being here*." [P2, Clinical pharmacist, ASP member]

> *"In my hospital, ASP has a high priority. It was started by the leader of the hospital."* [P27, Pharmacist, non-ASP member]

These participants believed leadership to become more engaged once presented with evidence of benefits of ASP such as cost savings.

> "*Cost was the motivation [for leadership engagement] because this data [cost savings data] was shared with … the senior management in order for them to … support the programme and justify ID [Infectious diseases consultant] time … they will see the value of adding this programme*." [P15, Nurse, ASP member]

Evidence of leadership engagement provided by participants included email circulation of ASP guidelines, encouraging participation in key events such as WHO World Antimicrobial Awareness Week (WAAW), providing necessary resources such as human resources, following up progress being achieved in implementation and having dedicated time for staff to conduct ASP activities.

> "*We didn't have a dedicated clinical pharmacist, He was not fully appointed to the programme [full time ASP services], so CMO had to start encouraging and dedicating time for*

him [clinical pharmacist] to start participating in the programme." [P15, Nurse, ASP member]

4.3.2.9 CFIR domain III (Inner setting), Networks and communication construct

Most participants indicated that both formal and informal communication had been extensively employed in hospitals to enable ASP implementation, gradually changing prescribing practices. Examples of formal communication given included documentation of ASP related recommendations within the electronic medical record (EMR) and informal, open discussions with physicians, and multidisciplinary clinical rounds.

"*We have formal communication in that the observations, the notes, and the recommendations that you make are documented within the health information system*." [P1, Clinical pharmacist, ASP member]

"*We had a multidisciplinary team rounds at least once weekly and that creates a good communication for the team to discuss and review*." [P15, Nurse, ASP member]

"We have CME [continuous medical education sessions], so they start giving us orientation on the policy like small meetings, small presentations and then we will take certain CME for infection control and for antibiotics." [P29, Pharmacist, non-ASP member]

Participants considered informal communication imperative to successful ASP implementation with greater emphasis placed on the value of in-person communication.

"*.., the success [of communication] was when you do communicate with the offenders, that are persistently violating what policies and procedures [you] are telling. Then you take them one to one, communicate in person.*" [P7, Clinical microbiologist, ASP member]

Notably, the value of effective communication skills between ASP members and antimicrobial prescribing physicians was highlighted as a facilitator for ASP implementation.

"*You don't come up as a policeman to police on them [physicians]. If you convey this message that … we are not challenging … your clinical decisions… and you do in a timely way the … face to face communication, that is much better than sending an email.*" [P3, Clinical pharmacist, ASP member]

"The keyword in the stewardship for anyone who's planning to start it [ASP implementation], is the proper communication." [P24, Intensive care consultant, non-ASP member]

4.3.2.10 CFIR domain V (Process of implementation), Planning construct

Several participants recommended scrutiny of available resources and a baseline analysis of antimicrobial prescribing patterns before embarking on ASP implementation. This would inform future planning efforts to overcome ASP complexity.

"*We collected baseline data for one year to help us to decide where to start. Based on our baseline data, we decided that critical care area is the highest priority … to improve the prescribing practice of antibiotics … to decrease the incidence of the development of multi-drug resistant organism*." [P6, Clinical pharmacist, ASP member]

Stepwise implementation of ASP was recommended by many participants to ensure successful accomplishment of one objective before further expansion.

"*Yes, it needs one department at the time. That is why we started only in adults. We planned first to start in adult and paediatric department. But we found it's very difficult to be applied. We started by adult department, and we found it also difficult to start inpatient and outpatient and emergency. So, we started only in the inpatient.*" [P14, Nephrologist, ASP member]

Participants also supported tailoring interventions depending on the hospital organisational structure.

"*The most important thing you need to know is the fabric of your organisation, the culture, and you identify your areas. You identify the Champions.*" [P3, Clinical pharmacist, ASP member]

4.3.2.11 CFIR domain V (Process of implementation), Stakeholders engagement construct

Multiple engaging techniques for healthcare providers were used by ASP team members to facilitate implementation such as face-to-face discussions aimed at promoting decision-making in management of infectious diseases.

"*The clinical round with the team, I believe is the one that makes difference. The most important part is the clinical discussion and case review with all people, everybody on the same table and make them more accountable.*" [P15, Nurse, ASP member]

Continuous training on ASP related policies and guidelines was conducted by ASP members to actively engage other healthcare professionals.

"*So, we will do training, an ongoing process to create more [ASP] members in an indirect way, they are not ASP members but by training them, when they know how to do that, they will do it in a stewardship mind-set.*" [P1, Clinical pharmacist, ASP member]

It has also been recommended by some ASP team members that continuous feedback to non-ASP members on the benefits of ASP implementation would enhance their engagement in ASP practices.

"*They [hospital staff] want to know what is in it for them, what value does it bring. So, you have to engage the stakeholders [non-ASP team members] and explaining these KPIs [Key performance indicators – implementation outcomes] in the context of length of stay, cost minimisation, resistant patterns, patient safety and all of that and just keep engaging people that you feel like you still need to convince.*" [P2, Clinical pharmacist, ASP member]

Notably, many of the ASP team members reported formally acknowledging hospital staff who excel in their performance with respect to ASP activities as a way to motivate others was perceived as a good opportunity to target hospital staff and highlight ASP practice.

"*We took an opportunity of the international celebration of the antibiotics awareness week and we kind of appreciated them [nurses] and gave them some medals and certificates, just to ensure that they also are engaged as part of the team*." [P4, Clinical pharmacist, ASP member]

Participants strongly supported involvement of consultant physicians at the development stage of hospital infection guidelines, to support ownership of guidelines by key individuals.

"*So, we standardised the antibiotic prophylaxis guidelines. We used to have multiple meetings with the surgeons, with ID, with Microbiology to create a consensus or an agreement where you know the surgeons are happy.*" [P3, Clinical pharmacist, ASP member]

Many strongly favoured engaging representatives from different specialities and professions such as pharmacists, critical care physicians, surgeons and nurses into the ASP team. Their presence in turn was perceived as influencing and engaging their peers.

> "*We started to have ASP links in different teams. So, like in the surgical, we have an ASP link. In the critical care, we have an ASP link and so on. So, the team grew*." [P5, Clinical pharmacist, ASP member]

Other ASP team members opted for conducting lectures about ASP elements to promote engagement of healthcare providers.

> "*We've presented the core elements at the hospital level more than one time to just have the idea settle*." [P4, Clinical pharmacist, ASP member]

An overall summary of constructs identified by the participants as facilitators or barriers for ASP implementation is presented in Table 4.9.

Table 4.9: Overall summary of CFIR constructs identified as perceived facilitators or barriers for ASP implementation.

CFIR domain	CFIR construct	Identified themes	Perceived facilitator/barrier
Domain I Intervention characteristics	**Complexity**	Perceived complexity of ASP implementation.	Perceived barrier.
	External policy and incentives	ASP mandates by UAE health authorities and international accreditation bodies.	Perceived facilitator.
Domain II Outer setting	**Cosmopolitanism**	Networking with other UAE hospitals for peer support to ASP implementation.	Perceived facilitator.
Domain III Inner setting	**Implementation climate (Tension for change)**	The desire to standardise antimicrobial prescribing practices facilitating and motivating for ASP implementation.	Perceived facilitator.
	Implementation climate (Organisational incentives and rewards)	Leadership appreciation of ASP team-members implementation efforts through various forms of recognition.	Perceived facilitator.
	Culture	Influence of blame culture on initial resistance to change antimicrobial prescribing behaviour.	Perceived barrier.
		Collaborative culture to enhance acceptance of changing antimicrobial prescribing habits.	Perceived facilitator.
	Available resources	Lack of sufficient human resources.	Perceived barrier.
	Leadership engagement	Importance of engaging leadership using cost savings data.	Perceived facilitator.
	Network and communication	Establishment of effective formal and informal communication routes among ASP team members and healthcare providers.	Perceived facilitator.
Domain V Process of implementation	**Planning**	Effective future planning for ASP implementation through selection of suitable interventions tailored to the specific organisation.	Perceived facilitator.
	Engaging key individuals	Engagement of healthcare providers through multiple engagement techniques.	Perceived facilitator.

4.4 Discussion

4.4.1 Statement of key findings

The aim of this phase was to explore key stakeholders' perspectives of ASP implementation in UAE hospitals with a focus on facilitators and barriers. CFIR based interviews were conducted with healthcare providers identified as ASP team members or non-ASP team members, and data saturation was achieved by the completion of 31 interviews.

Multiple CFIR constructs emerged throughout the interviews, categorised as facilitators or barriers to implementation. Key perceived facilitators were ASP mandates by local health authorities and international accreditation bodies, networking with other hospitals for peer support, inconsistent prescribing practices driving a need for change, effective future planning, engaging leadership to support provision of required resources, collaborative culture and effective networking and communication between ASP team members and non-members together with effective engagement techniques of healthcare providers. Fewer barriers than facilitators were identified, specifically the perceived complexity of ASP implementation, fear of blame culture, strongly embedded antimicrobial prescribing habits and insufficient human resources. Participants adopted various solutions to overcome barriers including effective planning and stepwise ASP implementation to overcome ASP complexity, referral to other hospitals in case of the lack of some specialities and selection of ASP interventions based on availability of resources.

4.4.2 Strengths and limitations

There are several strengths to this study. The adoption of a qualitative exploratory approach allowed generation of rich in-depth data from the experience of experts in the phenomena of interest (263) . Also, the research was reported using the COREQ guidance (167) (completed checklist available in Appendix 4.1).

Participants were from multiple hospitals representing variability in funding source (governmental versus private), bed capacity, governing health authority and location to ensure maximum variation sampling. This can support identifying common and variable features of the phenomena across varied contexts and provides holistic understanding of different experiences (264).

Sampling continued until the point of data saturation of the analytical framework, where no new data emerged. CFIR was used in an informative way as an underpinning for the full qualitative approach; designing data generation tool, coding, data analysis and reporting. CFIR provided a comprehensive evaluation framework to identify constructs functioning as facilitators and barriers (158, 160). The interview schedule was developed based on findings of a published systematic review (118) conducted at an earlier stage (see Chapter 3), and also based on the interview guide tool provided by the CFIR Research Team website (159).

Trustworthiness of research data and findings have been addressed at multiple steps based on Guba's constructs for establishment of trustworthiness (151). Further details are available in Chapter 2 and Table 4.5.

The main limitation in this research is that data were generated only in UAE, which can affect transferability of findings. However, the diversity of migrant workforce in UAE (5) was represented leading to inclusion of perceptions of participants from different backgrounds including both training and previous work experience. A detailed thick description of participants and hospital demographics was provided to allow readers to examine the setting and decide on transferability to their own setting.

Participants' or researchers' bias could have affected data generation, analysis and interpretation. Social desirability bias, where participants are expressing views that are potentially expected by researcher (135), could have affected study findings. However, the interviewer was not employed by and had no connection with any of the participants' institutions of employment. This was also addressed by multiple probes for open-ended questions and framing the question in a way that was neutral and did not project preference to any specific response. In addition, the participant's confidentiality and anonymity were assured at the start of interview. Confirmation bias, where the researcher tends to favour information that confirms previous beliefs (135), was addressed by iterative discussion with supervisory team to ensure that the doctoral student's views were kept neutral and did not impact data analysis.

4.4.3 Interpretation of key findings

The use of CFIR in this doctoral study enabled identification of additional facilitators to those already reported in the literature. The provision of incentives by ASP team members to implementation champions was one such facilitator emerging in this study where participants adopted a local rewarding initiative within their hospitals to support engagement of healthcare providers. Recently, the Commissioning for Quality and Innovation (CQUIN) launched by National Health Services (NHS) in England allowed financial rewarding for hospitals that share antimicrobial consumption data and demonstrate reduction in prescribing of specific antimicrobials. This financial rewarding can be used towards further improvement in the quality of services and creation of new improved patterns of care (265). This initiative demonstrates the importance of rewarding in engagement of stakeholders (266). It is recommended to adopt such rewarding system within UAE healthcare system to support engagement of healthcare providers in improvement of quality of care.

A further CFIR related facilitator that emerged in this research was the tension for change driven by inconsistent prescribing practice. Multiple barriers leading to inappropriate antimicrobial prescribing were identified in other GCC studies including: limited previous physician training and experience, lack of physicians' knowledge about appropriate narrow spectrum antimicrobial choice, limited antimicrobial choices and clinical antimicrobial prescribing guidelines that were not user friendly and difficult to interpret in clinical practice (267, 268, 269). Interestingly none have identified the variability of the background of healthcare providers as a barrier for appropriate antimicrobial prescribing, making this a finding unique to this research. The working healthcare environment in GCC states relies heavily on migrant expatriate workforce (5) leading participants to note the variability in education and training of healthcare providers and subsequent inconsistent antimicrobial prescribing practice. This inconsistency was a driver for the desire for change and a motive for ASP personnel to seek the establishment of hospital antimicrobial prescribing guidelines developed through consensus agreement and engagement of healthcare providers.

Other facilitators reported by previous studies included collaborative culture and effective communication, where face-to-face communication was recommended to enhance conversation and insights to physicians' perspective as well as to promote nurses' role in ASP activities (270, 271, 272). Yet, none have thoroughly collated the multiple forms of communication as described by our study participants.

Fewer studies described other facilitators such as: techniques for engaging healthcare providers (270), the importance of leadership engagement (270) and mandates by local health authorities (273). In contrast to our study which comprehensively identified multiple engagement techniques, Barlam et al only described the value of pharmacists' evidence-based recommendations to enhance ASP receptivity of physicians (270).

Similar to other studies reported in the literature including studies from Kingdom of Saudi Arabia (206, 252), fear of blame culture, resistance to change antimicrobial prescribing habits and a lack of sufficient ASP team members were identified by the participants as barriers (274, 275). None of the latter studies have identified ways to overcome these barriers. In contrast, participants in this study could identify the value of referral to healthcare providers from other facilities to overcome insufficient ASP expertise, as well as selecting the most suitable interventions based on the resources available. Notably international guidelines, such as WHO practical toolkit for ASP implementation in healthcare facilities (47) and the Australian National Centre for ASP (276), have also recommended arranging off-site expert access to overcome lack of specialised ASP team members. Additionally, careful consideration of local resources and availability of competencies while selecting the most suitable ASP interventions to be implemented were also recommended by these guidelines.

Based on the Medical Research Council (MRC) guidelines on developing and evaluating complex interventions, ASP is considered a complex intervention (277). Yet, a scoping review investigating the use of complexity theory in ASP published research, identified a shortage of studies examining complexity of ASP design, implementation and evaluation (278). Our study addressed this gap where the complexity of ASP implementation was identified as an additional barrier largely due to the number of individuals and hospital areas involved in implementation. Participants highlighted the value of effective planning (CFIR construct) with a need for a baseline analysis of hospital culture and resources, along with stepwise implementation as solutions to counteract complexity. Adopting effective planning is also recommended by the WHO practical toolkit for ASP implementation in healthcare facilities. This recommends conducting baseline analysis of antimicrobial prescribing habits, identifying challenges, assessing human and financial resources followed by a stepwise action plan which identifies short- and long-term priorities (47). Only a few ASP studies (279) described the adoption of planning along with gap baseline analysis and none were identified from GCC region which reflects the importance of this aspect of our study findings.

4.4.4. Future implications

Future research should consider reaching consensus among ASP experts on recommendations to support ASP implementation strategy tailored to the UAE hospitals context, based on the literature review and findings of this study. This can serve as guidance for the main three categories of ASP stakeholders in UAE hospitals i.e., local healthcare authorities, hospital leadership and ASP personnel who are starting ASP implementation in their respective hospitals. Adopting a consensus-based approach, such as the Delphi technique and including ASP experts from these three categories can be particularly useful in developing governance, promoting best practice, and informing decision makers to aid impactful ASP implementation.

4.5 Conclusion

This study contributed to filling the knowledge gap related to the employment of implementation theories as an underpinning for ASP research. In fact, the research supported identification of numerous facilitators and barriers to ASP implementation when compared to other implementation studies which did not have a theoretical basis. It highlighted the need for ASP team members to seek early leadership engagement to support provision of required resources, a need for effective planning and establishment of multiple engagement techniques and valuable communication with healthcare providers. This can create a collaborative culture promoting ASP implementation and sustainability of the service.

This chapter explored ASP implementation in UAE hospitals. The sustainability of ASP implementation and its capability to adapt in the face of challenging situations has been clearly exhibited during the COVID-19 pandemic. This impact will be separately explored in the next chapter (Chapter 5).

5

Chapter 5

The impact of COVID-19 on Antimicrobial Stewardship Programme implementation in UAE hospitals

Chapter 5 The impact of COVID-19 on Antimicrobial Stewardship Programme implementation in UAE hospitals

5. Introduction to the chapter

Data generation for this doctoral research – as presented in Chapter 4 - was conducted at the peak of the first wave of the COVID-19 pandemic. Accordingly, responses of stakeholders to interview questions were understandably impacted by the pandemic generating a volume of data. Participants' quotes related to COVID-19 and its perceived impact on ASP implementation in UAE hospitals are presented separately here in Chapter 5.

5.1 Methods

Data collection for this chapter occurred at the same time, within the same interviews that were carried out as described in Chapter 4. Thus, for a detailed account of the methods, reference can be made to Chapter 4. Aspects relating specifically to COVID-19 are described here.

A reflexive approach was adopted, and the research team discussed the possible implications of the COVID-19 pandemic on data generation. As such, the team agreed on the following: (1) to conduct interviews using online platforms in place of face-to-face meetings (detailed justification is presented in Chapter 2) and (2) to include one extra question (How did the COVID-19 experience affect ASP practice?) which was placed at the end of interview schedules for both groups, ASP members and non-members. This question intended to enable comprehensive understanding of ASP implementation within the challenging context of the pandemic. Notably, in most cases, participants referred to COVID-19 incidentally throughout the interview, without the interviewer specifically referring to this in the question.

5.2 Findings

5.2.1 Stakeholders recruitment

Recruitment of hospitals and participants is described in Chapter 4. A summary of hospitals and participants' demographic characteristics is presented in Table 4.7 and 4.8.

5.2.2 Key themes

The following three overarching themes were identified reflecting participants' experience with ASP implementation during the COVID-19 pandemic; (1) increased complexity of ASP implementation and changes in prescribing behaviour influenced by COVID-19, (2) adaptations, networking and cosmopolitanism (external networking) to enhance integration of COVID-19 management in ASP services and (3) adaptations and networking to support continuity of the ASP implementation process. Within these overarching themes, participants described aspects that mapped to multiple CFIR constructs and domains as illustrated in Table 5.1. Details of the three overarching themes are presented in narrative below (CFIR constructs are emphasised in *italics* within the text for this Chapter).

Table 5.1: Overarching themes mapped to the CFIR domains and constructs

Overarching theme	CFIR Domain	CFIR constructs
(1) Increased complexity of ASP implementation and changes in prescribing culture influenced by COVID-19	Domain I; Intervention characteristics	Complexity (Disruptiveness)
	Domain II; Outer setting	Patient needs and resources Cosmopolitanism
	Domain III; Inner setting	Culture (Prescribing culture) Implementation climate (Relative priority)
	Domain IV; Characteristics of individuals	Knowledge and belief about intervention
	Domain V: Process	Reflection and evaluation
(2) Adaptations, networking and cosmopolitanism to enhance integration of COVID-19 management in ASP services	Domain I; Intervention characteristics	Adaptability
	Domain II; Outer setting	Cosmopolitanism
	Domain III; Inner setting	Structural characteristics Implementation climate (Capacity for change) Network and communication
(3) Adaptations and networking to support continuity of ASP implementation process	Domain I; Intervention characteristics	Adaptability Complexity (Intricacy)
	Domain II; Outer setting	Cosmopolitanism
	Domain III; Inner setting	Network and communication Readiness for implementation (Access to knowledge and information)
	Domain IV; Characteristics of individuals	Knowledge and belief about the intervention
	Domain V; Process	Planning Reflection and evaluation

5.2.2.1 Theme one: Increased complexity of ASP implementation with changes in prescribing behaviour as a consequence of COVID-19

Multiple CFIR constructs were identified within this theme, most prominent were *complexity, relative priority, implementation climate, evaluation, and reflection.* Several ASP team members considered COVID-19 a major *disrupting factor* for ASP implementation due to increased *complexity* in maintaining ASP practices during the peak of the pandemic.

> "*It halted everything because we had to be pulled to cover the COVID-19 wards. Personally, I have not been doing it [ASP activities] for quite a few months, because I was pulled to cover the COVID-19 wards.*" [P11, Infectious diseases physician, ASP member]

> *"It ruined everything … a lot of empirical antibiotics were used. Any patient can get anything without any reasonable reason just because the doctor is doubting, or the patient is not improving."* [P29, Pharmacist, non-ASP member]

The management of COVID-19 patients was perceived as highest *priority* for hospital leadership when compared to established pre-pandemic ASP activities.

> "*We haven't been doing the ASP rounds like we used to again in terms of prioritisation, in terms of how much of your percentage [of workload] is down to ASP*." [P2, Clinical pharmacist, ASP member]

Consequently, this resulted in a change in *implementation climate* and the efforts of ASP team members were diverted to management of COVID-19 patients based on clinical *patient needs*.

> "*A lot of the things [ASP recommended practices] that we have implemented have gone out of the window when COVID-19 has hit*." [P5, Clinical pharmacist, ASP member]

Also, the sheer number of COVID-19 patients overwhelmed the healthcare system and diverted attention of healthcare providers away from pre-pandemic ASP activities.

> "*Unfortunately, we can't monitor ID [infectious diseases physician] approval or that the antibiotic was restricted or [needed to be] reviewed by ID [infectious diseases physician]. It was huge workflow, unbelievable workflow*." [P28, Pharmacist, non-ASP member]

"*I think we were not really looking at the ASP too much at this time, when we were in the peak, we were just like overwhelmed. Everybody is overwhelmed.*" [P25, Internist, non-ASP member]

An ASP team member also noted a reduction in antibiotic sensitivity and an increased antimicrobial resistance while *evaluating and reflecting* on ASP implementation during the pandemic.

"*We make a very big change, especially in the multidrug resistant organism. We have [had] very big improvement but due to this pandemic we start accepting medical cases [not surgical only cases as before the pandemic] … And we start noticing the increase of certain resistance to beta lactams*." [P18, Quality officer, ASP member]

Notably, *plans* for implementing new outcome measurements such as measuring antimicrobial consumption using Days of Therapy (DOT) were delayed due to the pandemic.

"*The data [antimicrobial consumption] will be available on the system and anybody want[ing] to see can see it, but DOT [Days of therapy] we started actually before COVID-19 then you know during the COVID-19, there were some delay in that one. But we will come back to it soon.*" [P1, Clinical pharmacy, ASP member]

The impact of COVID-19 on antimicrobial *prescribing behaviour* and on prescribers' decisions was evident where participants strongly endorsed the overwhelming increase of empirical antimicrobial prescribing for COVID-19 patients, especially when they presented with symptoms remarkably similar to septic shock.

"*We saw a lot of misuse of antibiotics. We saw a lot of doctors who were just if a patient comes with COVID-19 would start a lot of empirical antibiotics*." [P5, Clinical pharmacist, ASP member]

It was also noted by ASP team members that prescribers disregarded advice to de-escalate empirically prescribed antimicrobials.

"*When COVID-19 started everything [turned] upside down. People [prescribers] did not even care about the comments of ASP. So, they started all the broad-spectrum antibiotics you can imagine, although in many cases it was clear, clear viral infection*." [P24, Intensive care consultant, non-ASP member]

Several reasons were identified by participants for this sudden change in prescribers' behaviour regarding antimicrobial prescribing. Most prominent was their perception that physicians' *lack of knowledge* about COVID-19 at the time, lead to indiscriminate prescribing due to concerns that secondary bacterial infection will develop.

> "*The picture was not so much clear, what is COVID-19 and what is other bacteria which can coexist with this virus? Then we face a huge challenge to control the overprescribing of antibiotics at that time.*" [P6, Clinical pharmacist, ASP member]

> *"The antibiotics part was up to the practicing physician, because sometimes you have the patient deteriorating in front of you, and you don't know if this is COVID-19 or not."* [P24, Intensive care consultant, non-ASP member]

> *"We were not restricting the physician like before for prescribing antibiotics., because we did not know if this is just pneumonia [or COVID-19], so more empiric use of antibiotics."* [P27, Pharmacist, non-ASP member]

It was observed that physicians' lack of understanding of this novel viral infection led to several conflicting recommendations at the start of the pandemic. According to ASP members, initial guidelines recommended antimicrobial use, and this was viewed as a catalyst for increased empiric antimicrobial prescribing, again leading to changes in *prescribing behaviour*.

> "*It [COVID-19 pandemic] ruined the ASP practice. Because from the first [national] guideline [for management of COVID-19 patients] it was mentioned, you can use tazocin [piperacillin with tazobactam] or meropenem for severe cases. So, there was a lot of administrations of antibiotics and then at the beginning of the COVID-19 there were stories about giving azithromycin with the chloroquine. So, there was a lot of unnecessary azithromycin use*." [P13, Infectious disease physician, ASP member]

Overall, *patient needs* including severity of illness, and the burden of COVID-19 infection on the patients were reported by many participants as a cause for prescribing antimicrobials without evidence of bacterial infection.

> "*Sometimes we are using an antibiotic without evidence of bacterial infection. Just for the seriousness of the case [COVID-19 patient]. It's in the critical area on mechanical ventilation although the culture is negative. Although we don't have by the book indication of antibiotic,*

sometimes we put under [i.e., prescribe] antibiotic. So, we break the rules regarding ASP, especially in the critically ill patients." [P14, Nephrologist, ASP member]

Other causes identified by participants included difficulties in obtaining a microbial culture from COVID-19 patients leading to unnecessary empiric antimicrobial prescribing as well as fear of blame in case of patient deterioration, reflecting changes in *prescribing behaviour*.

"*Maybe you know taking the culture also from COVID-19 patient, it was not easy, so we found sometimes patient on antibiotic without culture*." [P1, Clinical pharmacist, ASP member]

"*It was really overuse [of antibiotics in COVID-19 cases] because people [prescribers] were also afraid if they did not give antibiotic and patient deteriorated, they will be blamed*." [P1, Clinical pharmacist, ASP member]

Despite the above reports of perceived high levels of empiric antimicrobial prescribing, there were other observed effects on antimicrobial consumption reported such as decline of antimicrobial consumption for surgical antimicrobial prophylaxis as suggested by some participants, due to cancelling of elective surgeries at the peak of the pandemic.

"*Our hospital is mainly surgical hospital … The elective operations are reduced; in that case you know the antibiotic prescription issues also will go down. So, for that part, we can say that the antibiotic usage became less [in surgical antimicrobial prophylaxis] because of the COVID-19 situation*." [P21, Surgeon, ASP member]

Antimicrobial prescribing for neonates was perceived to be not influenced by the COVID-19 pandemic, due to strict isolation procedure of neonates from COVID-19 positive mothers.

"*Our population [neonates] was definitely not [affected]. I think we were the least affected by the COVID-19 infection, because the babies born from COVID-19 mums will be going into strict isolation and once the swab come back negative … We were not really affected by it [COVID-19], from antibiotic point of view.*" [P16, nurse, ASP member]

5.2.2.2 Theme two: Adaptations, networking and cosmopolitanism (external networking) to enhance integration of COVID-19 management in ASP services

CFIR constructs identified within this theme included*: adaptability, networking and communication* and *cosmopolitanism*. Participants reported that COVID-19 was a major detractor from pre-pandemic ASP implementation. They also noted that the existing ASP structures showed capacity for *adaptability* and were repurposed to support COVID-19 relief efforts in various ways. Participants referred to the valuable contribution of ASP members in developing UAE national guidelines for management of COVID-19 patients supported by continuous meetings and consultation processes with external parties (ASP and infectious diseases experts), demonstrating *cosmopolitanism*.

> "*Experience with ASP and having structure and having consultations and having meetings with different stakeholders really allowed us [to help in building national guidelines for COVID-19], a lot of the infectious disease people are clinical pharmacist and are actually quite solid*." [P2, Clinical pharmacist, ASP member]

Furthermore, participants highlighted the important role of ASP members in *networking* and dissemination of national and hospital guidelines for management of COVID-19 patients to other hospital healthcare providers. This was based on their previous established work practice in developing and disseminating antimicrobial management guidelines as part of pre-pandemic ASP activities.

> "*People have had to listen to us with ASP in the past. It was easy for them to listen to us again when we were disseminating the national guidelines [for management of COVID-19] and our hospital guidelines [for management of COVID-19] as well as the corporate guidelines [for management of COVID-19] when it was COVID-19.*" [P2, Clinical pharmacist, ASP members]

According to majority of participants, the role of ASP team members changed compared to pre-pandemic times to accommodate COVID-19 management. This role in the continuous management and monitoring of COVID-19 patients was evident throughout the interviews. Participants confirmed ASP team members' uptake of ensuring adherence to national guidelines for management of COVID-19 patients, monitoring dose optimisation and screening for drug-drug interactions, as part of their ASP duties.

> "*… [the] Antibiotic Stewardship Committee follow the adherence of the physicians to this guideline and also the clinical pharmacist provides daily rounds for the critical care cases and the ICU [Intensive care unit] … to check the adherence to the guideline, optimising the doses of the medication and if there is any drug-drug interaction and so on.*" [P6, Clinical pharmacist, ASP member]

5.2.2.3 Theme three: Adaptations and networking to support continuity of ASP implementation process

CFIR constructs included *adaptability, networking* and *communication*, *access to knowledge and information, and cosmopolitanism*. Efforts to sustain and maintain ASP routine pre-pandemic activities during the pandemic were highlighted by many ASP team members. *Adaptability* was evident with regular face-to-face meetings being moved to online to facilitate *networking and communication* allowing continuity of ASP implementation. ASP team members described overwhelming numbers of patients and work overload as a hurdle to conducting regular meetings and added to the perceived *complexity* of maintaining previously established ASP activities during the pandemic.

> "*Unfortunately, the Covid consumed most of our time, this is the point. We left behind our meetings; we skipped some meetings also the Microsoft meetings were not accessible for all the members. We already arranged for many meetings, but unfortunately many of us were busy with different issues so we cannot even have our regular meeting for the committee*." [P14, Nephrologist, ASP member]

Attempts made at *adapting communication* to maintain networks, that were well established pre-pandemic, were emphasised and involved the use of WhatsApp© to support conducting medical rounds. These were, however, perceived to be less effective than usual daily rounds.

> "*I think it [COVID-19] affected [ASP] a lot because the interaction itself between us as clinical pharmacist and the physician and the patient, everybody trying to work virtually to reduce contact with others, even our rounds, we used to do rounds, it's virtual rounds, we will do it through WhatsApp©. We will try to find a way, another way, but it will not be efficient as before*." [P1, Clinical pharmacist, ASP member]

Participants described efforts to support maintenance of pre-pandemic ASP activities including *adapting* the reporting infrastructure, for example, adopting digital systems with evolution of paper forms to online pre-authorisation forms to facilitate antimicrobial authorisation.

> "*First, we have this pre-authorisation form. During the COVID-19 time we change this form from paper form to electronic and it is sent through the email. So anyone who wanted to prescribe certain antibiotics from the restricted list of antibiotic, will fill this form and send it to the pharmacy to be approved before prescribing.*" [P14, Nephrologist, ASP member]

In an effort to reduce broad-spectrum antibiotic misuse, another participant highlighted successful restriction of the use of broad-spectrum antimicrobials for COVID-19 patients based on *patient needs*.

> "*I started and I was successful to chip meropenem out because these [COVID-19] patients who are coming to the hospital, usually they don't have Pseudomonas. At least on carbapenem sparing, I tried, and I was successful*." [P13, Infectious diseases physician, ASP member]

Physicians showed a desire to resume previously established ASP activities and this was perceived by ASP team members to be an endorsement of the importance of ASP implementation within the hospitals and physicians' *knowledge and beliefs* about ASP.

> "*I just had a conversation with my critical care head on Thursday. She was like, oh, I think we're gonna [are going to] restart our ASP rounds. I didn't even have to remind her. She reminded herself, she wanted it. That's what I mean by value [of ASP]*." [P2, Clinical pharmacist, ASP member]

ASP team members considered restoration to pre-pandemic level of ASP implementation a future priority at the time.

> "*So, my aim now is at least to go back to the level we were before and to continue the educational activities and to continue talking to our doctors of course*." [P9, Intensive care consultant, ASP member]

Many ASP team members observed a gradual decline in antimicrobial consumption, and this was perceived as evidence of success in restoration of pre-pandemic ASP activities. Multiple participants perceived that change in *prescribing behaviour* was due to *increased access to knowledge and information* about the pathophysiology of COVID-19 and antimicrobial requirements. According to those participants, this was gained through educational and awareness activities internationally and nationally as well as the contribution of ASP members to the management of COVID-19 patients.

> "*Many virtual conferences and virtual lectures released online at the national level and even the international level. This helped to change the mind of the physician that no need for all these antibiotics for management of COVID-19. For us as an ASP member in our facility, we provide a daily feedback for the doctor, especially in the critical care area regarding the treatment plan of COVID-19 patients, so it was a huge challenge at the initial phase of*

COVID-19, but now start to be stabilised and improved." [P6, Clinical pharmacist, ASP member]

Notably, subsequent changes in the national guidelines for the management of COVID-19 patients to recommend less use of antimicrobials in COVID-19 patients supported the downward trend in antimicrobial prescribing, as perceived by some ASP members.

"*Also, the doctors I noticed in the beginning, there was overuse of antibiotics in the beginning of the pandemic but after that maybe after one month or so, the [national] guidelines [for management of COVID-19 patients] changed and we came to prescribe less antibiotic, only when it is really required.*" [P1, Clinical pharmacist, ASP member]

"*Right now, we are settled. The guidelines, especially the national guidelines [for management of COVID-19 patients]. They played a very good role in regulating the management of COVID-19 positive and non-COVID-19 cases, in terms of antibiotic*." [P22, Surgeon, ASP member]

CFIR constructs identified as barriers or facilitators mapped to themes and sub-themes are illustrated in Table 5.2.

Table 5.2: CFIR constructs identified as facilitators or barriers for ASP practice under the influence of COVID-19 pandemic mapped to their corresponding themes and sub-themes

Impact on ASP practice	CFIR Domain	CFIR Construct	Corresponding overarching theme	Corresponding subtheme
Perceived facilitators	**Domain I Intervention characteristics**	Adaptability	Theme (2)	Adaptation of ASP activities to include management of COVID-19 patients.
			Theme (3)	Adaptation of networking to facilitate continuity of ASP implementation during the pandemic.
			Theme (3)	Adaptation of pre-authorisation forms to facilitate continuity of ASP implementation during the pandemic.
	Domain II Outer setting	Cosmopolitanism	Theme (3)	Cosmopolitanism and networking to support building national COVID-19 management guidelines.
	Domain III Inner setting	Network and communication	Theme (3)	Cosmopolitanism and networking to support building national COVID-19 management guidelines.
		Access to knowledge and information	Theme (3)	Gradual decline in antimicrobial prescribing.
	Domain IV Characteristics of individuals	Knowledge and belief about the intervention	Theme (3)	Desire to re-establish ASP implementation.
Perceived barriers	**Domain I Intervention characteristics**	Complexity	Theme (1)	Disruption of ASP implementation.
			Theme (1)	Delay in ASP plans under the impact of COVID-19.
			Theme (1)	Changes in antimicrobial resistance patterns.
	Domain II Outer setting	Patient needs and resources	Theme (1)	Seriousness of illness of COVID-19 patients.
	Domain III Inner setting	Implementation climate	Theme (1)	Changes in antimicrobial prescribing behaviour.
		Relative priority	Theme (1)	Change in priority under the impact of COVID-19 pandemic.

5.3 Discussion

5.3.1 Statement of key findings

Participants overwhelmingly perceived pre-pandemic ASP activities to be greatly disrupted by the complexity of COVID-19 together with the acute patient needs and lack of resources. These were viewed as putting an extreme strain on the healthcare system. ASP team members showed an ability to adapt and repurpose roles, responsibilities and processes. Interventions included developing national guidelines for management of COVID-19 patients and contributing to guideline management and monitoring by acting as a reference point. A gradual restoration to routine pre-pandemic ASP practices was perceived by participants, where enhancements of networking and technological adaptations were identified.

5.3.2 Strengths and limitations

To the best of our knowledge, this research is the first qualitative, theoretical exploration of the impact of COVID-19 on ASP implementation. A detailed discussion of strengths and limitations of this qualitative research has been provided in Chapter 4.

5.3.3 Interpretation of key findings

A UK based survey investigated the negative and positive impact of COVID-19 on ASP activities across hospitals (280). Similar to this research, positive outcomes included increased adoption of technology, while negative outcomes were; interruption of ASP rounds, meetings and a decline in acceptance of ASP team recommendations. Additionally, an increased reliance on procalcitonin testing and OPAT were reported (280), areas that were not discussed in our study.

A few CFIR constructs were identified as barriers to continuity of ASP activities during the pandemic. These were primarily complexity of the interventions, prescribing behaviour, implementation climate as well as complex patient needs and resources. ASP is a complex intervention that requires participation of individuals from multiple levels and its implementation was already challenged by multiple factors including lack of policies, limited funding, need for training and less time dedicated to ASP activities (216, 281). COVID-19 has added to this complexity given the strained healthcare system due to the pandemic being a higher priority, increasing urgency and an over-burdened healthcare task force. Within this

implementation climate, changes in prescribing behaviour were perceived by participants in this research to result in increased empiric prescribing of broad-spectrum antimicrobial for viral infections.

Increased empirical use of broad-spectrum antimicrobials in COVID-19 patients has been associated in the literature with causes such as lack of knowledge of COVID-19, complex pathophysiology, possibility of secondary bacterial infection and severity of illness (282). A survey, investigating causes of antimicrobial prescribing for COVID-19 patients in Italian hospitals, identified patient related clinical and radiological findings, worsening of symptoms, intensive care admission and tracheal intubation as causes for increased empiric prescribing of broad-spectrum antimicrobials as a result of COVID-19 (283). This study further explored the impact of the pandemic on prescribing behaviour. Unique findings clearly identified in our study were a fear of consequences, rapid changes in the international and national guidelines for management of COVID-19 leading to confusion and a lack of clear understanding of the disease, all of which caused increased empiric prescribing as perceived by our study participants.

Ongoing research and surveillance data are expected to explore the impact of COVID-19 pandemic on other ASP outcomes such as changes to antimicrobial resistance pattern, *Clostridioides difficile* infection rates and a potential increased use of anti-fungal agents secondary to increased broad-spectrum antimicrobial usage.

Adaptability, networking and communication along with cosmopolitanism, and knowledge and belief of the importance of ASP were the constructs that emerged in our study as collectively strengthening and supporting the repurposing process of ASP personnel, processes and infrastructure, which reinforced alteration of previously discussed barriers. The literature has also discussed the adaptability capacity within ASP in response to COVID-19 where processes such as prospective audit and feedback, pre-authorisation and formulary restriction, were all employed to guide and monitor the use of novel antiviral agents, in addition to the established role of optimising the use of antimicrobials (284, 285). Further roles have been identified in the literature in response to COVID-19, which did not emerge in our study, such as ASP members' roles in clinical trials of novel antivirals, vaccination and dealing with drug shortages (107). This research has clearly identified the complementary effect of cosmopolitanism with networking and communication, where networking between ASP team members and hospital healthcare providers as well as co-ordination with ASP members and healthcare leaders in different

hospitals supported the rapid response and development of COVID-19 specific management guidelines. Years of experience, knowledge and the reputation of ASP, as a successful initiative to control the use of antimicrobials, facilitated this transition of role and added to the impact of ASP during the pandemic.

5.3.4 Further research

Operating in COVID-19 pandemic is the new reality and this triggered rapid developments in healthcare delivery and implementation of services. As such, future research should be directed towards exploring successful ASP activities that can help foster and support this novel and accelerated development.

5.4 Conclusion

Despite the initial disruption of ASP implementation given the complexity of the intervention, due to the pandemic, successful restoration and evolvement of ASP services reflects the high value and adaptability of ASP implementation in UAE hospitals. This value further motivates for investment in such programmes to ensure readiness for future pandemics and to keep pace with global accelerated developments in healthcare systems.

This chapter summarised the impact of COVID-19 on ASP implementation in UAE hospitals. The next chapter will provide a summary for overall research conducted throughout the doctoral degree with emphasise on implications related to future research.

6

Chapter 6

Discussion

Chapter 6 Discussion

6. Introduction to the chapter

This chapter provides an overview of the overarching aim of the doctoral research and the key findings of each phase with emphasis on the originality and potential impact of the research. Potential future work related to ASP implementation in UAE is described.

6.1 Aims and key findings

The overall aim of this doctoral research was to explore ASP implementation in UAE with a special focus on acute care hospitals. The research was conducted over two phases, with a systematic review of the literature exploring ASP implementation in GCC states (Chapter 3) initially conducted, which reinforced gaps in the literature to be researched in the following phase. The second phase (Chapter 4 and 5) adopted a qualitative approach of semi-structured interviews underpinned by both CFIR as a theoretical framework and the findings of the systematic review. Data collection during the second phase was extensively impacted by the first wave of COVID-19, where participants reflected on practising ASP duties during the pandemic. Therefore, data related to impact of COVID-19 on ASP implementation were separately analysed and presented in Chapter 5.

6.1.1 Phase one: Systematic review (Chapter 3)

The background literature search, as discussed in Chapter 1, identified a number of systematic reviews exploring multiple aspects related to ASP implementation such as assessing effectiveness or efficiency of ASP interventions and exploring the impact of behavioural change techniques on improving antimicrobial prescribing. Only two systematic reviews reported studies conducted in GCC region; one focused on antimicrobial utilisation and prescribing behaviours (90) and the other focused on exploring the level of adoption of ASPs in GCC hospitals, including the facilitators, barriers, and outcomes of adoption (233). However, neither of these systematic reviews explored ASP implementation, specifically compared to a benchmark of international standards. ASP varies across different geographical regions due to the impact of culture on prescribing practice and variation in available resources and knowledge. Accordingly, the need for a systematic review exploring ASP implementation in relation to

international standards specifically exploring studies from GCC region was identified and led to the construction of the aim of the systematic review.

Systematic review aim and objectives

The aim of this systematic review was to critically appraise, synthesise and present the available evidence on ASP implementation in the GCC states. Review objectives were to:

1. Compare ASP interventions in GCC states with reference to the CDC framework (59).
2. Identify facilitators and barriers to effective ASP implementation in GCC states.

Systematic review findings

Seventeen papers were included in the final dataset for analysis: nine cohort studies, six before-after studies, one cross-sectional survey and one qualitative study. Studies were mainly from KSA (n=9), Qatar (n=3), UAE (n=2) and Kuwait (n=1), with none from Bahrain or Oman.

Mapping study findings to the seven core elements of CDC framework, identified heterogeneous and suboptimal ASP infrastructure despite describing implementation practices such as ASP actions, outcome tracking, reporting and education. Leadership support and programme accountability were seldom reported. A number of facilitators and barriers at multiple levels were identified, including those at regional or national levels, at hospital organisation levels and at the individual levels. None employed a theoretical underpinning to elucidate implementation facilitators and barriers. The systematic review has been published as a full paper (118).

6.1.2 Phase two: Qualitative study (Chapter 4 and 5)

The systematic review identified a deficiency in ASP implementation studies underpinned by theory and with limited focus on the identification of facilitators and barriers. This gap provided the basis for phase two of this doctoral research.

Aim and objectives

The overall aim of the research was to explore ASP implementation in UAE hospitals. The specific research objectives were to:

1. Explore the perspectives and experiences of key stakeholders regarding ASP implementation in UAE hospitals.
2. Identify key facilitators and barriers for ASP implementation.

Findings of the study

This study employed a phenomenological qualitative approach, where CFIR was integrated at each stage of research design, data collection, analysis and reporting of findings. Data saturation was achieved at thirty-one interviews with ASP team members and non-members. Multiple CFIR constructs were identified as facilitators or barriers for implementation. Facilitators included external policy mandates (local health authority and international accreditation bodies), leadership support, stakeholders' engagement, collaborative culture, effective communication and planning efforts. Barriers included blame culture, ASP complexity and shortage of expert ASP personnel.

This study contributed to the knowledge gap related to employing implementation theories to research ASP implementation. ASP team members need to seek early leadership engagement to support provision of required resources, together with effective planning and establishment of valuable communication with healthcare providers. This phase of the research has been published as a full paper (120)

As discussed earlier in Chapters 1 and 5, the disruption caused by COVID-19 to ASP implementation has been acknowledged in the literature but still to be explored in-depth. Participants in the phase two qualitative study were impacted by the pandemic, as reflected in their quotes. The sustainability of ASP services during the pandemic was presented separately in Chapter 5.

Thematic analysis of participants' quotes relevant to COVID-19 impact on ASP implementation led to the identification of the following themes: (1) increased complexity of ASP implementation and changes in prescribing behaviour influenced by COVID-19, (2) adaptations, networking and cosmopolitanism to enhance integration of COVID-19 management into ASP services and (3) adaptations and networking to support continuity of the ASP implementation process. A disruption to pre-pandemic ASP activities was reported with complexity of COVID-19 overwhelming the healthcare system. ASP team members and services showed an ability to adapt and repurpose roles to respond to the pandemic. Interventions included developing national guidelines for treatment of COVID-19 patients and contributing to guideline management and monitoring. A gradual restoration of ASP activities was perceived. Technological adaptations and enhancements in networking were reported as positive impacts

of the pandemic. These findings have been published as a full paper (122) and included in WHO COVID-19 research database (286)

6.1.3 Impact of updated CFIR on qualitative research findings

The original CFIR article released in 2009 by Damschroder et al., encouraged CFIR users to critique the framework while adopting it as a theoretical basis for implementation studies (158). The need to revise the CFIR domains and constructs was deemed necessary, given the continuous evolvement in implementation research, and multiple published studies using CFIR as an underpinning. Recently CFIR developers, Damschroder et al., sought CFIR feedback through: (1) review of the literature to abstract passages critiquing CFIR in published studies that used CFIR as a theoretical underpinning and (2) a survey of authors who used CFIR in these published studies. The intention was to align CFIR with updates in implementation frameworks. Several changes were introduced, yet constructs can still be mapped back to original CFIR to ensure consistency (287). The updated CFIR is termed CFIR 2.0. In addition to updating the main five CFIR domains, an additional addendum has been published to include variable implementation outcomes that can be used to evaluate implementation (288). A summary of major changes for the five domains are featured in Table 6.1.

Table 6.1: A summary of updates introduced to CFIR 2.0 domains and constructs in comparison to CFIR 2009 *(158, 287, 288)*

CFIR 2009 domains nomenclature	CFIR 2.0 domains nomenclature	Changes introduced to the domain
Intervention characteristics	**Innovation domain**	Same constructs were kept. Definitions of constructs were updated to reflect a specific focus. Complexity construct is now focused on the innovation in terms of scope, nature and number of steps involved to avoid confusion with complexity of implementation process.
Outer setting	**Outer setting**	Constructs have been updated to include "Critical incidents construct" that can capture large scale events such as COVID-19 and its impact on multiple healthcare services. Cosmopolitanism was renamed to become "Partnership and connection". Added construct of "Local attitude" and "Local conditions", which are especially important for innovations requiring support from community entities. External policy and incentives construct was reshaped to split up into: "Policies and law construct" and "Finances construct". Peer pressure was reshaped to be "External pressure construct" with multiple sub constructs "societal, market and performance-measurement pressures".
Inner setting	**Inner setting**	Structural characteristics updated to encompass several sub-constructs "Physical, Information technology and work infrastructure". Network and communication split up over two constructs "Relational connection construct" and "Communication Construct". The culture construct was considered too broad, and a set of sub-constructs were introduced, also taking in account equity issues. Implementation climate and readiness for implementation constructs were reformed so that the sub-constructs underneath promoted to be within the list of constructs. The two initial constructs were moved to the outcomes addendum.
Characteristics of individuals	**Individuals domain**	The domain was updated to include two main subdomains "Roles subdomain" and "Characteristics subdomain". "Roles subdomain" lists all the possible individuals at various levels starting from high-leadership roles to innovation recipients and deliverers. "Characteristics subdomain" include the behavioural theory Capability, opportunity, motivation and

CFIR 2009 domains nomenclature	CFIR 2.0 domains nomenclature	Changes introduced to the domain
		behaviour (COM-B) model.
Process	**Implementation process domain**	Given the absence of key constructs related to process in CFIR 2009, several constructs were added to expand the Process domain reflecting inclusion of best practices such as “teaming, assessing the need and context, planning, tailoring strategies and engaging constructs”.
Not available	**CFIR outcomes addendum**	Added as a separate addendum to help researchers clarify different types of outcomes measured to evaluate implementation.

The updates introduced to CFIR 2.0 and the associated addendum are unlikely to lead to any major changes in data analysis processes, findings and interpretation for this doctoral research. CFIR developers suggest operationalising the framework first prior to research inception through identifying the constructs which can be evaluated by the research aim and using language specific to the intervention being explored. This has already been applied as described in the methods section of Chapters 4 and 5. The majority of changes are considered minor and are a simple clarification for ambiguous definitions with the exception of the newly introduced constructs related to equity issues (Domain III), Capability, Opportunity, Motivation and Behaviour (COM-B) model (Domain IV), and outcomes addendum.

6.2 Interpretation of findings

This two stage doctoral research adopted a unique methodology that led to the generation of novel findings when compared to the literature that did not embrace a similar approach. The employment of an international ASP checklist - CDC framework - in the systematic review, enabled comprehensive evaluation of reported ASP implementation in published studies from GCC states. Also, employment of a theoretical underpinning – CFIR - for qualitative research, provided a comprehensive determinant framework to study the context of ASP implementation in UAE hospitals. Evidence from the literature supporting the benefits of the previously described approaches will be provided in the following sections, leading to implications for practice.

6.2.1 CDC checklist - a tool for optimum ASP implementation

As described in Chapter 1 and 3, despite the abundance of studies addressing multiple different ASP implementation aspects and the availability of systematic reviews drawing knowledge from these studies to date none of the systematic reviews have specifically mapped ASP implementation studies against any of the international standards. The systematic review conducted in this doctoral research grouped ASP implementation actions based on CDC core elements into: infrastructure elements (leadership support, accountability and pharmacy expertise) and implementation practices (actions, outcomes tracking and reporting, and education). The use of ASP international frameworks, as in the case of CDC core elements, has been encouraged by many published studies (see Chapters 1 and 3) since it outlines the required

elements for implementation of an effective ASP, helping to align expectations and used as a tool to monitor performance across multiple institutions (55).

An updated literature search on Medline database, using the search string (Antimicrobial stewardship AND systematic review), was conducted looking for recently published reviews for ASP implementation. Only a few reviews were detected that aimed to evaluate overall ASP implementation in hospitals for specific geographical regions (289, 290, 291, 292). Geographical regions included: a few Middle Eastern countries (292), African countries (289, 291) and South Africa (290). Although their aim was to provide a comprehensive overview of the current status of hospital ASP implementation to their specific region, none of them employed any of the ASP international frameworks for benchmarking of the available structure. Accordingly, the infrastructure elements for ASP implementation were overlooked in these systematic reviews, where no reference was made to leadership support, accountability or pharmacist expertise. This contrasts with the systematic review conducted in this doctoral research, which could successfully address infrastructure elements availability in addition to ASP practices and monitoring parameters.

The value of ASP infrastructure elements (ASP structure and governance) has been emphasised by ASP frameworks globally, not only by CDC core elements, including UK Start smart then Focus (106) and WHO practical toolkit for ASP implementation (47). In fact, CDC core elements have been highlighted as a reference in WHO toolkit while examining evidence of structure needed for successful ASP implementation. Also, a few studies have confirmed the value of ASP infrastructure. A modified Delphi consensus study by Pollack et al. including 20 ASP experts from European Union member states and USA, identified 33 indicators for comparison of ASPs across different countries and healthcare facilities. Indicators were characterised as infrastructure elements or activities for hospital ASP with majority of the final set of indicators related to structure rather than process (293). According to Pollack to al., establishment of a baseline infrastructure ensures that ASP is well integrated within the organisational practices rather than linked to a single person, leading to programme sustainability (293).

Future research exploring ASP implementation in an organisation or across multiple organisations needs to be underpinned by one of the ASP international frameworks, such as CDC, to facilitate characterising areas of deficiency in infrastructure, practices or monitoring parameters. Although the systematic review conducted in this doctoral research was limited to

GCC states, its unique methodology can be extrapolated to explore ASP implementation reporting in other communities, using ASP international frameworks, such as CDC core elements, as a tool to generate recommendations for effective ASP implementation.

6.2.2 Employment of theory in ASP research

As discussed in Chapter 4, despite the multitude of studies exploring facilitators and barriers to ASP implementation in hospital settings (273, 274, 294, 295, 296, 297, 298), a few had any theoretical underpinning. A literature search of Medline and Google Scholar databases was conducted using the search string (Antimicrobial stewardship AND implementation AND Theory) led to the identification of seven ASP related studies which included theoretical underpinning.

Only one study reported the use of Theoretical Domains Framework (TDF) adopting qualitative approach to determine barriers and facilitators to promoting intravenous to oral antimicrobials' switch by nurses. Interview guide was developed based on the fourteen domains of TDF and analysis of themes was conducted within TDF domains (272).

Another study adopted Promoting Action on Research Implementation in Health Services (PARiHS) framework as a theoretical underpinning to conduct a quantitative cross-sectional survey identifying organisational factors facilitating ASP design, development and implementation. Survey questions were categorised based on PARiHS domains, yet data analysis was based on descriptive and inferential statistics without reference to PARiHS domains (299).

The use of Capability, Opportunity and Motivation Behaviour (COM-B) model was reported by two qualitative studies. Lerano et al. aimed to determine health professionals' perspective of nurses' role in surgical ASP implementation, where interview guide and data analysis were both based on COM-B model (300). Chan et al. aimed to identify facilitators and barriers to implementing urinary tract infection-focused ASP interventions in a long-term care facility, where interview guide was based on literature review, yet data analysis was based on COM-B model (271).

CFIR use as a theoretical underpinning was detected in three studies. Legenza et al. combined the use of CFIR and Framework for Reporting Adaptations and Modifications to Evidence-based Implementation Strategies (FRAME-IS) framework, taking advantage of both frameworks. This

study aimed to develop a *Clostridioides difficile* infection (CDI) intervention in South African hospitals informed by the local context analysing the CDI intervention and implementation process. CFIR was used to describe the implementation process by determining CFIR constructs associated with the use and uptake of the intervention. FRAME-IS was used to present implementation adaptations (301). Barlam et al. adopted a qualitative approach using CFIR as a theoretical underpinning to examine perspectives of physicians and pharmacists who are ASP team members about the dynamics within their team and contextual factors that facilitate the success of their ASP. Interview guide was developed based on specific constructs of CFIR, including: characteristics of organisational culture, implementation climate, characteristics of the interventions, and ASP team members. Inductive data analysis was conducted leading to generation of major themes without reference to CFIR (270). Goedken et al. adopted a mixed methods explanatory sequential design, starting with quantitative cross-sectional survey followed by a qualitative study which was sampled based on survey responses. The aim was to determine which CFIR constructs could be targeted to improve Carbapenem-resistant Enterobacteriaceae (CRE) guideline implementation and understand how CFIR can be used to inform guideline implementation. Data analysis was based on CFIR domains and constructs (302).

Based on these seven ASP studies, theories were used at different stages of research such as: development of quantitative cross-sectional survey questions and qualitative interview guides as well as final data analysis. Compared to these, the employment of CFIR in this doctoral research allowed for a more comprehensive assessment of facilitators and barriers to ASP implementation for the following reasons:

1. TDF and COM-B model are theoretical frameworks targeting in-depth understanding of current behaviour and identification of contextual factors impacting behavioural change (303, 304) and FRAME-IS is used to document modifications to implementation strategies (305). Despite the suitability of these theories to the study aims, they are not considered appropriate for phase two study of this doctoral research since none of these implementation models/frameworks serves as a comprehensive determinant framework to identify complex variables impacting the implementation process as in the use of CFIR.

2. PARiHS is a multidimensional implementation framework which includes three core elements: (1) level of evidence, (2) context of research and (3) process facilitation. As discussed in

Chapter 2, CFIR was developed by reviewing 19 different theories related to dissemination, innovation, organisational change, implementation, knowledge translation, and research (158). PARiHS is one of the theories reviewed for CFIR formation, hence elements related to the three core elements of PARiHS were included in CFIR domains and constructs (159).

3. Studies that used CFIR as a theoretical underpinning only targeted specific aspect of ASP including implementing guidelines to treat Carbapenem-resistant Enterobacteriaceae (302) or *Clostridioides difficile* infection (301). This doctoral research adopted a broader scope for exploration of ASP implementation, thus all CFIR constructs were comprehensively addressed.

4. Barlam et al employed CFIR to explore the perception of ASP personnel regarding team dynamics and organisational factors leading to successful ASP implementation (270), yet focus was only on specific CFIR domains related to implementation culture, climate and characteristics of individuals and intervention. This study did not comprehensively examine all CFIR domains and constructs as in this doctoral research.

6.2.3 Using CFIR to evaluate context of ASP implementation

Context and implementation are two highly connected concepts. The context of implementation is defined as "*a set of characteristics and circumstances that consist of active and unique factors that surround the implementation effort.*" Accordingly, the context can interfere, modify, facilitate or constrain implementation process (306). While evaluating ASP in UAE hospitals, there was a need to adopt a theoretical framework that can link these two concepts (Context and implementation) and as discussed in Chapters 2, 4, 5 and 6, CFIR was adopted as a comprehensive determinant framework to study the context of ASP implementation in UAE.

Findings of the phase two study yielded a broad range of constructs that were considered facilitators or barriers for ASP implementation. A summary of CFIR constructs along with attached subthemes is provided in Table 6.2.

Table 6.2: A summary of CFIR constructs identified as facilitators or barriers to ASP implementation in this doctoral research

	ASP implementation in UAE hospitals	COVID-19 impact on ASP implementation in UAE hospitals

Perceived facilitators	• **External policy and incentives construct**
	  ○ ASP mandates by UAE health authorities and international accreditation bodies.
	• **Cosmopolitanism construct**
	  ○ Networking with other UAE hospitals for peer support to ASP implementation.
	• **Implementation climate (Tension for change) construct**
	  ○ The desire to standardise antimicrobial prescribing practices facilitating and motivating for ASP implementation.
	• **Implementation climate (Organisational incentives and rewards) construct**
	  ○ Leadership appreciation of ASP team-members' implementation efforts through various forms of recognition.
	• **Culture (Collaborative) construct**
	  ○ Collaborative culture to enhance acceptance of changing antimicrobial prescribing habits.
	• **Leadership engagement construct**
	  ○ Importance of engaging leadership using cost savings data.
	• **Network and communication construct**
	  ○ Establishment of effective formal and informal communication routes among ASP team members and healthcare providers.
	• **Planning construct**
	  ○ Effective future planning
		• **Adaptability construct**
		  ○ Adaptation of ASP activities to include management of COVID-19 patients.
		  ○ Adaptation of networking to facilitate continuity of ASP implementation during the pandemic.
		  ○ Adaptation of pre-authorisation forms to facilitate continuity of ASP implementation during the pandemic.
		• **Cosmopolitanism construct**
		  ○ Cosmopolitanism to support building national COVID-19 management guidelines.
		• **Network and communication construct**
		  ○ Networking to support building national COVID-19 management guidelines.
		• **Access to knowledge and information construct**
		  ○ Gradual decline in antimicrobial prescribing.
		• **Knowledge and belief about the intervention construct**
		  ○ Desire to re-establish ASP implementation.

	for ASP implementation through selection of suitable interventions tailored to the specific organisation. • **Engaging key stakeholders construct** ○ Engagement of healthcare providers through multiple engagement techniques.	

Perceived barriers	• **Complexity construct**
	  ○ Perceived complexity of ASP implementation.
	• **Culture (Blame) construct**
	  ○ Influence of blame culture on initial resistance to change antimicrobial prescribing behaviour.
	• **Available resources construct**
	  ○ Lack of sufficient human resources.
		• **Complexity construct**
		  ○ Disruption of ASP implementation.
		  ○ Delay in ASP plans under the impact of COVID-19.
		  ○ Changes in antimicrobial resistance patterns.
		• **Patient needs and resources construct**
		  ○ Seriousness of illness of COVID-19 patients.
		• **Implementation climate construct**
		  ○ Changes in antimicrobial prescribing habits.
		• **Relative priority construct**
		  ○ Change in priority under the impact of COVID-19 pandemic.

A recently published systematic review by Wu et al. in 2022 aimed to adopt an implementation research perspective to systematically synthesise evidence on facilitators and barriers to ASP implementation. CFIR was used as a framework for coding and synthesis of facilitators and barriers to ASP implementation reported in studies originating from low-middle income countries. Fifty-two eligible studies were identified from 17 Sub-Saharan African and 16 East Asian and Pacific countries. Almost all CFIR constructs emerged as facilitators or barriers. Major barriers were lack of national initiative (external policy construct), infrastructural constrains due to insufficient microbiological laboratory capacity and lack of data management technology (structural characteristics construct) and reluctance of physicians to change prescribing behaviour (individual characteristics construct). Major facilitators were stakeholder engagement construct and embedding intervention in routine practice (intervention characteristics construct) (307).

Both the phase two study of this doctoral research and Wu et al. systematic review used CFIR in a similar fashion to identify facilitators and barriers to ASP implementation, yet the subthemes attached to constructs are different given the different context of ASP implementation. For instance, in the phase two study, external policy emerged as a facilitator, not a barrier as in Wu et al. systematic review. In UAE, local healthcare authorities have placed emphasis in the past few years on ASP implementation. ASP mandates were released, and auditing activities came in place to follow up on execution of the mandates. On the contrary, Wu et al. systematic review findings depicted a lack of national initiative. Also, reluctance to change prescribing behaviour was another finding of Wu et al. systematic review, yet not identified in the phase two study of this doctoral research where blame culture was the cause of initial resistance that was overcome by engagement of leadership and stakeholder. Similarly, infrastructure constrains were not a problem for UAE hospitals given the availability of microbiological laboratories and information technology support systems.

This comparison clearly reflects that the influence of context on healthcare service implementation varies from one geographical location to another. CFIR constructs identified in phase two of this doctoral research are uniquely describing practice in UAE and accordingly have clear implications on ASP implementation in UAE hospitals. As previously discussed in Chapters 4 and 5, transferability of findings has been enhanced by provision of a detailed description of participants' and hospitals' demographics. Also, the study sample represented the diversity of migrant healthcare workers leading to representing perception of different education and training backgrounds and enhancing transferability of findings.

6.2.4 Implications for practice

As discussed in Chapter 2, qualitative approach has a few limitations such as: subjectivity of data collected and limited transferability, all of which have been addressed through establishment of trustworthiness (151) to ensure rigor and robustness of findings.

While accepting the limitations of the qualitative methodological approach, findings of this doctoral research can provide recommendations to promote effective and sustainable ASP implementation in UAE hospitals, as presented in Table 6.3. Recommendations will provide guidance for healthcare authority leaders, hospital leaders, as well as ASP personnel who are starting ASP in their respective hospital. ASP stakeholders' consensus on the suitability of these recommendations will be required through a systematic measurement of collective agreement. Further details are provided later in this thesis in the future research section (Section 6.5).

Table 6.3 Key recommendations deduced from doctoral research

First level of recommendations: Local healthcare authorities		
1.	Enforcing ASP mandates through auditing activities.	
2.	Arranging educational events.	
3.	Supporting cosmopolitanism (external networking) across multiple ASP team members from different hospitals.	
Second level of recommendations: Hospital leadership		
1.	Early engagement of hospital leadership in ASP implementation process.	
2.	Availing required resources (human resources, information technology and access to knowledge and information).	
3.	Support proper antimicrobial prescribing culture.	
4.	Enforce ASP mandates and regulations within the hospital.	
5.	Provide incentives and acknowledgment for ASP implementation champions.	
Third level of recommendations: ASP team members		
1.	Effective planning for ASP implementation	A. Baseline analysis of available resources (human resources, information technology and access to knowledge and information).
		B. Engage individuals with previous ASP implementation experience.
		C. Explore hospital prescribing culture.
		D. Establishment of required resources (human resources, information technology, access to knowledge and information) according to hospital infrastructure.
		E. Select intervention which suits the hospital organisational structure and culture.
2.	Adaptation of required resources (human resources, information technology and access to knowledge and information).	
3.	Gradual stepwise implementation of ASP.	
4.	Continuous education to change antimicrobial prescribing culture.	
5.	Support leadership engagement through continuous feedback on ASP outcomes.	
6.	Effective networking and communication skills.	
7.	Promoting for ASP driven prescribing culture at different opportunities such as celebrating World Antimicrobial Awareness Week.	
8.	Continuous feedback on ASP outcomes to healthcare providers to support their engagement.	
9.	Acknowledgment of efforts and provision of incentives for implementation champions.	

Abbreviations: ASP, Antimicrobial Stewardship Programme.

6.3 Originality of research

Evidence of novelty in systematic review

As discussed in Chapter 3, the systematic review explored ASP implementation in GCC region through uniquely mapping evidence of ASP implementation to the seven core elements of CDC. This allowed benchmarking of study findings to international standards to identify gaps in reporting implementation studies. No previous systematic review has explored ASP implementation with reference to the CDC framework. Findings of the systematic review were disseminated at multiple international and local platforms before publishing the review (See external output section).

Evidence of novelty in theoretical exploration of ASP implementation

As discussed in Chapter 4, CFIR was adopted as a theoretical underpinning for the qualitative research. A few previous studies had adopted a theoretical underpinning and were either targeting behavioural change or focused on limited CFIR constructs. The value of using theory has been discussed in Chapters 2, 4 and 6. Other UAE based studies did not adopt any theoretical underpinning and had a limited sample from only a few sites. This doctoral research study adopted maximum variation sampling to provide representation from governmental and private hospitals, of different bed sizes and governed by the three UAE health authorities. Although qualitative research offers limited transferability, a detailed description of study context was provided to allow readers to examine the applicability of findings to their own practice. This study added to the body of knowledge on ASP implementation through dissemination of findings at local and international platforms and was published in a peer-reviewed journal. See external output section.

Evidence of novelty in COVID-19 related research

As discussed in Chapter 5, COVID-19 related research within this doctoral research is the first published qualitative study addressing ASP implementation experiences and ASP sustainability during COVID-19.

This study added to the body of knowledge concerning the impact of COVID-19 on ASP implementation through dissemination as conference proceedings at UAE national and international levels (see external output section) and published in a peer reviewed journal (122) as well as being cited in the WHO COVID-19 research database (286).

Abstracts from phase two study (Chapter 4 and 5) were both granted awards at regional conferences. This reflects the relevance and importance of the research to the UAE healthcare context. Details are available in external output section.

6.4 Impact of research

Impact is about creating a change or seeing a difference that can produce its effect at an individual, local or global level (308). Multiple institutions have defined impact. For example, the Research Councils UK (RCUK) defines impact as "*the demonstrable contribution that excellent research makes to society and the economy*", whereas the Research Excellence Framework (REF2021) defines it as "*an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia*". These definitions demonstrate that impact is an effect which reaches far beyond academia (309).

In view of the definition provided by REF2021, the impact of this doctoral research will be considered at the levels of: (1) Scientific knowledge and research activities, (2) Undergraduate training, use of acquired knowledge and enhancing curricula and (3) Health system and public health. All will be presented in terms of individual, local, and global context where applicable.

6.4.1 Impact on scientific knowledge and research activities

The doctoral research journey impact multiple skills development for the doctoral student. These skills spanned a number of areas including those related to specific research methods, critical thinking, active listening, academic writing, and professional networking. The ability to gain transferable skills and transfer those skills was particularly valuable, with experiences of publication, conference presentations and arranging workshops (See external output section).

6.4.2 Impact on undergraduate training and enhancing curricula

The doctoral student is currently working as a lecturer in a pharmacy school in Dubai – UAE, Higher Colleges of Technology (HCT), and is responsible for teaching an 'Introduction to research methods' course for pharmacy students. This is a research preparatory course that encompasses selecting a research area, conducting literature review based on the topic area, followed by formulation of a research proposal before advancing to the graduation research project involving data collection culminating in a final report. The doctoral student successfully supervised three undergraduate research projects, which have been disseminated as conference presentations nationally and internationally. Table 6.4 describes these endeavours.

Table 6.4: Undergraduate research projects supervised by the doctoral student

Undergraduate research project title	Dissemination at an international level	Dissemination at a national level
Pharmacists' perceptions regarding the implementation of automated pharmacy dispensing systems in the United Arab Emirates' hospitals: a qualitative study.	The research abstract has been presented as poster presentation in 49th Symposium of European society of Clinical Pharmacy, Virtually, April 2021. Abstract published as conference proceeding (310)	None
Healthcare provider's perspective of real-time telemedicine as a clinical management option: a systematic review	None.	Poster presentation locally at Dubai International Pharmaceutical and Technologies Conference and Exhibition (DUPHAT), Dubai, UAE, February 2022. **(Second place, best display – Pharmacy student poster).**
Theoretical exploration of healthcare providers' perceptions regarding the effectiveness of real time telemedicine implementation in United Arab Emirates.	The research abstract has been presented as oral communication in 50th Symposium of European Society of Clinical Pharmacy, Prague, Czech Republic, October 2022. Abstract published as conference proceeding (311)	Poster presentation locally at: 1- Dubai International Pharmaceutical and Technologies Conference and Exhibition (DUPHAT), Dubai, UAE, January 2023. 2- Higher Colleges of Technology International Conference on Advancements in Health Sciences (ICAHS), Dubai, UAE, March 2023. **(Third place, best student poster award).**
Patients' experience with the use of real-time telemedicine as a clinical management option: a cross-sectional survey.	The research abstract has been presented as poster presentation in 50th Symposium of European Society of Clinical Pharmacy, Prague, Czech Republic, October 2022. Abstract published as conference proceeding (312).	Poster presentation locally at: 1- Dubai International Pharmaceutical and Technologies Conference and Exhibition (DUPHAT), Dubai, UAE, January 2023. 2- Higher Colleges of Technology International Conference on Advancements in Health Sciences (ICAHS), Dubai, UAE, March 2023.

6.4.3 Impact on health system and public health

The impact of this doctoral research on health system and public health can be addressed at national and international levels.

At a national level, conducting qualitative interviews with healthcare providers potentially enhanced their awareness about the topic of ASP, leading to a better collaborative approach towards successful implementation. Also, interviews with ASP team members supported reflection on elements of success and failure that impacted their ASP experience, highlighting factors related to the context of implementation that could have been missed out of their implementation plan, leading to a more streamlined approach to ASP implementation.

NAP-AMR report (2019-2023) (77), issued by UAE Higher Committee for AMR in collaboration with WHO-EMRO, emphasised on the fact that ASP is viewed by many of UAE hospitals' leadership as part of infection prevention and control programmes, thus less attention and resources are availed for ASP implementation. This doctoral research shed light on valuable evidence-based findings related to requirements for successful ASP implementation, thus supporting UAE national efforts.

Also, this doctoral research provided evidence based new insights for national health authority individuals concerned with ASP implementation. It emphasised on the organisational factors that can impact implementing ASP regulatory mandates such as leadership support, required resources including recruitment of ASP experts, financial support and protected work time for ASP activities. These factors can be directly addressed by the national health authority with hospitals' leadership to enhance successful ASP implementation.

A before-after quasi experimental study from UAE aimed to identify the impact of ASP implementation on clinical and microbiological outcomes, identified a significant reduction in length of hospitalisation, readmission and mortality rates. Also, a drop in the number of MRSA and MDR-M blood stream infections was noticed (251). Such positive outcomes of ASP implementation in UAE can be maximised through paying attention to findings of this doctoral research. Continuous ASP research and adding to the body of knowledge about ASP is expected to reflect positively on antimicrobial consumption and microbiological surveillance data collated at a national level by health authorities (See Chapter 1).

Findings of this doctoral research can be used to inform future research to produce an ASP implementation framework especially suited for UAE practice. This framework can then be disseminated and implemented through UAE National Committee for ASP and other ASP stakeholders including WHO focal point in UAE, Dr. Najiba Abdulrazzaq, who was also part of this research team. Further information on future research is available in the following section.

At an international level, dissemination of research findings through international conferences and publishing in peer reviewed journals provides valuable perception for other researchers. Detailed description of study population and hospital demographics was provided to enhance transferability of findings to a similar context. Also, other researchers can adopt a similar approach to explore their own context for ASP implementation.

WHO places great emphasis on the role of academia in research through generation of findings that supports transition of theoretical knowledge into practice, including studies related to effective ASP implementation (33). Given the acknowledged impact of COVID-19 on healthcare system, WHO attempted to gather multi-lingual international scientific findings on COVID-19 through comprehensive literature search. Studies were cited in WHO COVID-19 research database (286). This helps to bring researchers and healthcare professionals together to accelerate research and development process, aiding containment of pandemic infections. The COVID-19 published findings generated in this doctoral research has been cited by WHO COVID-19 research database. This is considered a testimony of the impact and quality of research carried out throughout this doctoral degree. These findings provide valuable input about complexity and adaptability of ASP when interventions were practised during the pandemic.

6.5 Future research

Recently WHO issued a report summarising a global research agenda for AMR in human health. Forty research topics were prioritised for evidence generation to inform AMR policies and interventions with great impact on mitigating AMR risk in human health sector. This also coincided with objective two of AMR-GAP, as discussed in Chapter 1, which promotes addressing research gap in relation to AMR (313). The following five themes are promoted: prevention, diagnosis, treatment and care, AMR epidemiology and drug resistant tuberculosis. Theme four related to treatment and care promotes ASP related research including: investigating context

specific successful combinations of ASP interventions, identifying pharmacists' activities related to ASP and regulatory frameworks that leverage ASP implementation in community practice and investigating criteria for optimising antimicrobial empiric prescribing.

In line with the WHO global research agenda and based on key findings of this doctoral research, the following research proposals have potential to support streamlining ASP implementation in the UAE healthcare context (and beyond), thus addressing gaps in relation to mitigating AMR risk to human health.

6.5.1 Study 1: A Modified-Delphi study to determine consensus on recommendations supporting ASP implementation in UAE hospitals

Research aim

The aim is to determine the level of consensus amongst ASP key stakeholders on recommendations to support ASP implementation in UAE hospitals.

The research objectives are:

1. To develop and validate a series of statements providing recommendations supporting ASP implementation in UAE hospitals.
2. To determine the level of consensus amongst ASP key stakeholders on these statements.
3. To determine additional recommendations based on key stakeholders' feedback.

Research philosophy

The positivist philosophical paradigm is deemed most suitable given objectivity of data that will be collected through adopting a quantitative consensus approach, to enhance reliability and robustness of results and applying logical statistical mathematical calculations (124).

The consensus approach selected for this study is Delphi technique. Although the philosophical stance of Delphi technique can be attributed to both positivist and constructivist approaches (314), for this study it is considered positivist philosophical paradigm since a modified Delphi rather than classical Delphi will be employed. In a classical Delphi approach, the first round is a qualitative generation of ideas through discussion with experts, whereas in the modified Delphi the first phase of developing Delphi statements is reliant on other information sources such as literature review and findings of other studies (315).

Methodology and methods

A modified Delphi method is considered the most appropriate consensus approach in comparison to other techniques such as nominal group technique. The Delphi approach allows gathering opinions from ASP key stakeholders using emails for easy communication and minimal logistical arrangements. It also ensures anonymity of participants to eliminate risk of bias and uses an iterative process allowing controlled feedback (315). Nominal group technique requires face to face gathering of stakeholders which places geographical limitations that can lead to a lack of participation of ASP stakeholders (316) .

The Delphi statements are recommendations to support ASP implementation in hospitals and will be derived from key findings of the systematic review (Chapter 3), the qualitative study (Chapter 4) and an updated literature search. CFIR will provide the theoretical basis of Delphi statements to ensure comprehensive inclusion of all contextual factors impacting implementation. The CDC framework will be consulted in the development of Delphi statements as well as the expertise of research team. Draft statements will be revised by experts in ASP (excluding those included in the expert panel) to enhance face and content validity.

An expert panel will be recruited from ASP key stakeholders including members of local healthcare authorities concerned with ASP implementation at a national level, hospitals' leadership and ASP team members. There is no agreement in the literature on the ideal sample size for Delphi panel of experts and it is typically in the range of 10 – 100 members. Appropriate size depends on research aim, complexity of the research problem and availability of resources (317). Therefore, for this potential study, sample size will include the minimal number of participants which will address research needs, taking in consideration availability of ASP stakeholders.

After obtaining the required ethical approval, the Delphi statements questionnaire will be emailed to members of the expert panel in round one. Participants will be required to provide a rating for the statements on a Likert scale (level of agreement/disagreement) and provide comments to justify their ratings. They will also have the opportunity to recommend additional statements to be included in future rounds. Responses from round one will be used to form questionnaire statements for round two. The literature does not provide a specific number of

Delphi rounds, yet usually a minimum of two is required, with some studies using up to four rounds. More than four can lead to significant panellist attrition (loss of interest) (316). For this potential study two Delphi rounds will be conducted to ensure appropriately addressing all aspects of the research topic and to prevent panellist attrition.

Since determining consensus is the primary outcome of the Delphi technique, the stopping criterion for percentage of agreement has to be defined prior to start of Delphi rounds. Usually, a percentage of agreement ranging from 50 – 97% has been accepted in the literature, with 70% considered the standard cut-off value (317). Therefore, a 70% percentage of agreement will be accepted for this study.

Numerical voting will be analysed using mathematical calculation and presented descriptively as frequencies and percentages. Open comments and feedback will be analysed thematically using content analysis to determine specific themes relevant to research aim and objectives (314).

Results of the study will be communicated to the UAE National ASP committee and other national ASP stakeholders in addition to publication in peer reviewed journals for dissemination at an international level.

6.5.2 Study 2: Quantitative cross-sectional survey to investigate ASP implementation in UAE hospitals, mapped to CDC Framework

Research aim

The aim of this study is to map and compare ASP implementation in UAE hospitals in relation to the CDC framework.

The research objectives are:

1. To determine currently available infrastructure elements (CDC core elements 1 – 3) and implementation practices (CDC core elements 4 – 7) in UAE hospitals.
2. To determine views and experience of ASP team members regarding level of success of implementation practices (CDC core elements 4 – 7).

Research philosophy

A positivist approach will be adopted since the study will use quantitative methodology for objective data collection. The researcher will adopt an objective stance and data will be analysed using a statistical mathematical approach.

Methodology and methods

A quantitative approach will be adopted using a cross-sectional questionnaire for data collection. The study population includes ASP team members from UAE hospitals representing both governmental and private sector governed by the three regulatory UAE health authorities across the seven Emirates.

The questionnaire will be based on the CDC assessment tool which is appended to the updated version of CDC framework released in 2019 (59). The assessment tool is comprised of sets of questions addressing each of the CDC core elements. Questions will be revised to suit the research aim and objectives and will include a combination of close ended questions with Likert scale fixed choices and open-ended questions. The questionnaire will be reviewed for face and content validity by ASP experts identified from the network of the research team, to determine appropriateness of content and identify any ambiguity (143). The questionnaire will then be piloted with 10 individuals representing the study population to enhance reliability through initial evaluation of accuracy of questions and to eliminate any vague questions that can impact data analysis (124). A consent form will be included in the introductory statement of the questionnaire.

The questionnaire will be administered online and will be disseminated through members of UAE National ASP committee to potential participants across the seven Emirates. Since ASP has been mandated by the three national health authorities, a non-probability convenience sampling technique (135) will be adopted where the questionnaire will be forwarded to ASP key person in every hospital in UAE (a total of 157 hospitals, according to UAE statistical annual report 2020 (19)). Those potential ASP key participants will be determined by members of UAE National ASP committee.

Quantitative data will be analysed using a statistical analysis software such as IBM SPSS (318). Two types of statistical data analysis will be employed: descriptive and inferential analysis according to the type of variables (135). Responses to open-ended questions will be analysed using content analysis to aggregate themes (144). Results of the study will be shared with members of the UAE National ASP committee to inform implementation of ASP in UAE hospitals, in addition to international dissemination through conferences and peer-reviewed journal publications.

6.5.3 Study 3: National point prevalence survey of antimicrobial use at a hospital level

According to Global Antimicrobial Resistance and Use Surveillance System (GLASS) report issued by WHO in 2021 (73), UAE has committed to provision of antimicrobial consumption data along with other 33 countries from three different WHO regions. The Point prevalence survey of antimicrobial use (PPS-AMU) at a hospital level was established by WHO, in 2016, to collect baseline data about antimicrobial consumption in hospitals using convenience sampling method at a specific point of time. Further details regarding the methodology for data collection have been released in 2019 in Version 1.1 of "WHO Methodology for Point Prevalence Survey on Antibiotic Use in Hospitals" technical document. This document supports comparability of data worldwide by unifying data collection method (319).

Results of this survey is currently monitored by UAE National Antimicrobial Resistance Committee and will be released in future WHO reports.

6.6 Conclusion

This two stage doctoral research generated original, rigorous, and robust findings in terms of exploring ASP implementation in acute care hospitals in UAE. That was based on the adoption of high-quality research methodology design, data analysis and reporting as well as dissemination at national and international levels. Phase one, through the employment of a rigorous systematic review, pointed out the need to pay attention to ASP international checklists such as CDC framework while developing, implementing and reporting ASP. It also laid the basis for phase two of this doctoral research and the need for adopting theoretical underpinning to explore factors related to the context of ASP implementation in UAE healthcare system. In phase two, the choice of a comprehensive meta-theoretical framework, CFIR, led to the identification

of the most salient constructs impacting ASP implementation. ASP key persons need to seek early leadership involvement to support ASP establishment and required resources. The value of effective planning along with embracing effective communication skills and engagement techniques with healthcare providers has been highlighted. Accordingly, a set of recommendations was generated that has implications on ASP implementation in UAE. These recommendations can guide healthcare providers to promote collaborative culture for ASP implementation and sustainability of the programme.

ASP is a complex intervention that requires participation of multiple individuals at different levels. Studying ASP implementation within the context of COVID-19 pandemic reflected the high value and adaptability of the programme. Thus, investments in such programmes is encouraged to keep pace with continuously evolving healthcare services.

Future research should focus on seeking consensus of ASP stakeholders in UAE regarding an optimum framework to ASP implementation. Specific factors related to healthcare system in UAE identified in this unique two stage doctoral research will feed into the establishment of such framework specifically suited for practicing ASP interventions in UAE.

This doctoral research was in alignment with WHO global strategy to combat AMR through addressing research gap in relation to studying context of ASP implementation in different communities. It is hoped that streamlining and supporting sustainability of such programmes can help curb the increasing burden of AMR at UAE level. Similar approach can be adopted in other communities to leverage ASP implementation internationally. Further research in UAE is encouraged especially in determining the most successful bundles of ASP interventions in view of the contextual factors identified in this doctoral research.

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Appendices

Appendices

Appendix 3.1: PRISMA-P checklist for protocol development

Section/topic	#	Checklist item
TITLE: A systematic review of the implementation of antimicrobial stewardship programmes in hospitals in Gulf Cooperation Council States		
Title	1	Identify the report as a systematic review, meta-analysis, or both.
ABSTRACT		
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.
INTRODUCTION		
Rationale	3	Describe the rationale for the review in the context of what is already known.
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).
METHODS		
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).

Section/topic	#	Checklist item
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.
RESULTS		
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).
DISCUSSION		
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.
FUNDING		
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.

Appendix 4.2: Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist – completed for the research study

No	Item	Guide questions/description	Page
		Domain 1: Research team and reflexivity	
		Personal Characteristics	
1.	Interviewer/facilitator	Which author/s conducted the interview or focus group?	133
2.	Credentials	What were the researcher's credentials? *E.g. PhD, MD*	136
3.	Occupation	What was their occupation at the time of the study?	136
4.	Gender	Was the researcher male or female?	Not mentioned
5.	Experience and training	What experience or training did the researcher have?	136
		Relationship with participants	
6.	Relationship established	Was a relationship established prior to study commencement?	133
7.	Participant knowledge of the interviewer	What did the participants know about the researcher? e.*g. personal goals, reasons for doing the research*	133
8.	Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? e.g. *Bias, assumptions, reasons and interests in the research topic*	136
		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*	121
		Participant selection	
10.	Sampling	How were participants selected? *e.g. purposive, convenience, consecutive, snowball*	125
11.	Method of approach	How were participants approached? e.*g. face-to-face, telephone, mail, email*	133
12.	Sample size	How many participants were in the study?	136 and 137
13.	Non-participation	How many people refused to participate or dropped out? Reasons?	136 and 137
		Setting	
14.	Setting of data collection	Where was the data collected? e.*g. home, clinic, workplace*	133
15.	Presence of non-participants	Was anyone else present besides the participants and researchers?	133
16.	Description of sample	What are the important characteristics of the sample? *e.g. demographic data, date*	136 and 137
		Data collection	
17.	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	126 - 132
18.	Repeat interviews	Were repeat interviews carried out? If yes, how	Not

		many?	mentioned
19.	Audio/visual recording	Did the research use audio or visual recording to collect the data?	133
20.	Field notes	Were field notes made during and/or after the interview or focus group?	134 and 135
21.	Duration	What was the duration of the interviews or focus group?	133
22.	Data saturation	Was data saturation discussed?	125
23.	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	133
		Domain 3: analysis and findings	
		Data analysis	
24.	Number of data coders	How many data coders coded the data?	134 and 135
25.	Description of the coding tree	Did authors provide a description of the coding tree?	134 and 135
26.	Derivation of themes	Were themes identified in advance or derived from the data?	134 and 135
27.	Software	What software, if applicable, was used to manage the data?	134 and 135
28.	Participant checking	Did participants provide feedback on the findings?	134 and 135
		Reporting	
29.	Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? e.*g. participant number*	139 - 147
30.	Data and findings consistent	Was there consistency between the data presented and the findings?	139 - 147
31.	Clarity of major themes	Were major themes clearly presented in the findings?	139 - 147
32.	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	139 - 147

Appendix 4.3 Ethics approval letter from Robert Gordon University

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 11th June 2019

Dear Nortan

Re.: A theoretical exploration of development and implementation of antimicrobial stewardship programs in the United Arab Emirates: a qualitative study of the perspectives of key stakeholders and health professionals

The School Research Ethics Committee has assessed your application and the overall decision is that there are no ethical issues with your project.

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 4.4 Ethics approval letter from Ministry of Health and Prevention, UAE

UNITED ARAB EMIRATES
MINISTRY OF HEALTH & PREVENTION

الإمارات العربية المتحدة
وزارة الصحة ووقاية المجتمع

Ministry of Health and Prevention

Research Ethics Committee

Study Title: A Theoretical Exploration of Development and Implementation of Antimicrobial Stewardship Programs in the United Arab Emirates: A Qualitative Study of the Perspective of Key Stakeholders and Health Professionals.

Subject: Approval Reference No: **MOHAP/DXB-REC/JAANo.32/2019**

Dear Dr. Najiba Abdulrazzaq and Ms. Norton Hashad,

In regards to the above mentioned Study protocol, this is to confirm that on the meeting dated (**29/8/2019**), the Ministry of Health and Prevention Research Ethics Committee has reviewed the study protocol as well as all the documents submitted in the submission file from the ethical point of view and has approved the conduct of above mentioned study.

Opinion: Approval

Please find below a list of approved documents:

Document	Version/date
Application Form	Ministry of Health and Prevention Application Form-amended version
Protocol	Research Summary, Research Protocol _ Amended version
Information sheet and Informed	Participant Consent Form, Participant Information Sheet-English_ Amended version

TEL +971 4 2710000 هاتف ◆ FAX +971 4 2731757 فاكس ◆ DUBAI, UNITED ARAB EMIRATES دبي، الإمارات العربية المتحدة ◆ P.O.BOX 22241 ص.ب
www.moh.gov.ae

Consent Form	
Data Collection	The Semi-Structured Interview form, English version Amended
Investigator/s CV	CV/s of Principal Investigator/s
GCP Certificate/s	GCP Certificate/s of Principle investigator/s

The MOHAP Research Ethics Committee is organized and operated according to guidelines of the International Conference on Harmonization and constituted according to ICH-GCP requirements.

This Ethical approval applies for the following study sites only:

- Kuwait Hospital –Dubai ,Kuwait Hospital, Sharjah, Al Amal Hospital, AL Dhaid Hospital, Al Qassimi Women's & Children's Hospital, Al Qassimi Hospital, Kalba Hospital, Khorfakkan Hospital,Masafi Hospital/ Fujairah Hospital, Dibba Hospital, mm Al Quwain Hospital, SAQR Hospital,IBHO Hospital ,Shaam Hospital, Abdulla Bin Omran Hospital, OGH Hospital

- **This approval is subject to the following conditions:**

1. The MOHAP research ethics committee approval does not imply that the researcher is granted access to data, medical records or biological samples from the MOHAP health care facilities neither the Private MOHAP licenced health care facilities. Researchers must seek permission and follow the policy and procedure from the concerned directories after the approval from the Research Ethics Committee
2. Please note that it is the Principal Investigator's responsibilities, to immediately inform the Committee of any changes in the research protocol and/or the research Methodologies, should the need for those changes arise prior to or during the conduct of this research study

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3. The approval is valid for up to **1year** from the date of approval. If the study extends beyond this date, a progress report must be sent to the research ethics committee to renew the approval **30 days prior the expiry date.**

4. The research ethics committee must be informed when the research has been completed and a copy of the final research report must be submitted for our records.

Yours sincerely,

Dr. Haifa Hannawi
Deputy Chairman
Dubai REC - MOHAP

Date: 29 / 08 / 2019

Appendix 4.5 Ethics approval letter from SEHA

SEHA Research Ethics Committee - SEHA Reseach Oversight Committe

Date: 23/Jan/2020 **Ref. No.:** SEHA-003

To: Dr. Dhyaneethie Perumal
Principal Investigator: Dr. Dhyaneethie Perumal
Department: Associate professor (PhD local supervisor)
Institute: Fatima College of Health Sciences

Subject:	■ **New Research Study** ☐ Amendment ☐ Extension ☐ Revision	
Research Title:	A theoretical exploration of development and implementation of antimicrobial stewardship programs in the United Arab Emirates: a qualitative study of the perspectives of key stakeholders and health professionals.	
Study Type:	Qualitative study	
Decision:	■ Favorable ☐ Unfavorable	☐ Favorable with Conditions
Progress Report Submission Requirement:	☐ Annual	■ 6 Months
Study Expiry Date:	**31/05/2021**	

Dear Dr. Dhayaneethie Perumal,

The Research Proposal was reviewed by the Ethics Committee members and voted towards the ethics approval.

Any ethical concern arising from the study in due course, should be informed. Annual report plus a terminal report are necessary and the Committee would appreciate receiving copies of abstracts and publications.

Studies approved can't be continued beyond the expiry date mentioned above. In case continuation of study is anticipated, extension request in the prescribed form should be submitted to the committee prior to 60 days of expiry date.

The Research Committee has been organized and operates according to the Good Clinical Practice (GCP) guidelines and the Department of Health, Abu Dhabi (DOH).
It's mandatory to be compliant with the regulatory requirements of SEHA research standards whenever required.

Yours sincerely,
Dr. Asma Al Nuaimi
Chair, SEHA Research Oversight Committee
Note: primary investigator using data collectors from outside SEHA facilities are required to obtain HR department approval as visitors.

Email: seharesearch@seha.ae Tel: +971 2 4102000 PO Box: 109090 Abu Dhabi

Appendix 4.6 Ethics Approval letter from Zayed Military hospital

General Head Quarters Armed Forces

Medical Services Corps Command

ZMH

القيادة العامة للقوات المسلحة

سلاح الخدمات الطبية

مستشفى زايد العسكري

NOTIFICATION OF APPROVAL OF A PROPOSED RESEARCH STUDY

20 / July / 2020

Ms Nortan Hashad
Clinical Pharmacist / Lecturer
Zayed Military Hospital
United Arab Emirates

Ethics Approval Reference NO:	2020.10
Research Title:	A theoretical exploration of development and implementation of antimicrobial stewardship programs in the UAE; a qualitative study of perspectives of key stakeholders and health professionals.

Dear Ms Nortan Hashad,

The Committee has given a favorable ethical opinion for the above project based on the application form, protocol and supporting documentation that comply with the conditions and principles established by (ICH GCP) according to DOH regulations.

On behalf of the ERC members, we wish you and the research team all the best towards smooth accomplishment of this project.

Yours Sincerely

20/07/2020

Dr. Mouza al Kuwaiti

Chairman Abu Dhabi Region Ethics and Research Committee / Chief Medical Officer

Zayed Military Hospital Abu Dhabi

Page 1 of 3

ERC will keep a copy of the research document

General Head Quarters Armed Forces

Medical Services Corps Command

ZMH

القيادة العامة للقوات المسلحة

سلاح الخدمات الطبية

مستشفى زايد العسكري

Researcher:

I hereby accept and agree to the Ethics and Research Committee decision and I confirm that I will abide with all specific instructions as requested by the Ethics and Research Committee.

Name: Nortan Hashad

Position: Lecturer - Pharmacy - Fatima College of Health Sciences

Signed: Nortan Hashad

Date: 06/08/2020

ERC will keep a copy of the research document

MEDICAL SERVICES CORP

Version 0.2 Dated 19 September 2013

Ethics and Research Committee

Zayed Military Hospital

Dear Researcher,

In regards to your Research you are required to acknowledge the following:

1- It is the ultimate responsibility of the primary investigator to report to the Research ethical committee any amendments to the research proposal.

2- It is the ultimate responsibility of the primary investigator to report any encountered side effects

3- The approval is only valid for 2 years period from the start date, in case of extension or delay, a submission of a new request with an explanation will be required.

4- You are required to submit a report on your progress on your study every 6 months

5- The financial benefits or grants for the study will be deposited to your Department through the Head of department or ZMH Administration

6- The Research ethical committee has the authority to suspend your study if breach of regulations were encountered

7- We would advise you to be familiar with DOH research regulations available at www.haad.ae/research

ERC will keep a copy of the research document

Appendix 4.7 Ethics approval letter from Saudi German hospital

المستشفى السعودي الألماني دبي | SAUDI GERMAN HOSPITAL DUBAI

Date 19th July 2019

Dear Nortan,

Replying to your request about your research entitling: A theoretical exploration of development and implementation of antimicrobial stewardship programs in the United Arab Emirates: a qualitative study of the perspectives of key stakeholders and health professionals.

The SGHD Ethics Committee has assessed your application and the overall decision is that there are no ethical issues with your project.

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

We wish you success in your research project and future endeavors.

Regards,

Dr. Mazin Alsaidi
Chief Medical Officer
Chairman of Ethics Committee
Saudi German Hospital Dubai

Dr. Mazin Alsaidi
Chief Medical Officer

Appendix 4.8 Participant information sheet

UNITED ARAB EMIRATES
MINISTRY OF HEALTH & PREVENTION

A study of the development and implementation of antimicrobial stewardship programs in the United Arab Emirates: an interview study of the perspectives of key stakeholders and health professionals

Participant information sheet

Nortan Hashad, Dr Dhayaneethie Perumal, Dr Najiba M Abdulrazzaq, Professor Derek Stewart, Dr Antonella Tonna

You are invited to take part in a study to explore the development and implementation of Antimicrobial Stewardship Programs in United Arab Emirates

Before you decide to take part, it is important that you understand why the research is being done and what it will involve. Please ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

This research aims to explore antimicrobial stewardship program (ASP) development and implementation in hospitals in the United Arab Emirates (UAE) to enable characterization of key facilitators, enablers, barriers and solutions.

The research is being carried out by Nortan Hashad who is based in the UAE. This study is being conducted as part of a PhD at Robert Gordon University (RGU) in the UK. She is supervised at RGU by Professor Derek Stewart and Dr Antonella Tonna. Supervisors in the UAE are Dr Dhayaneethie Perumal from Ministry of Education; and Dr Najiba M Abdulrazzaq, Head of Infection Prevention and Control, Ministry of Health and Prevention (MOHAP); and World Health Organization (WHO) focal point in the UAE.

Why have I been invited?

You have been invited as one of several key individuals and health practitioners in the United Arab Emirates. We are particularly interested in hearing about your own perspectives, views and experiences.

Do I have to take part?

No. It is up to you to decide whether or not to take part. If you do, you will be given this information sheet to keep and will also be asked to sign a consent form which will allow researchers to use quotations from interview recording. Participation is entirely voluntarily. If you do agree to take part, you are still free to withdraw at any time and without giving a reason. If you do not wish to take part, or decide to withdraw, please note your relationship with the research team or any third parties will not be affected.

What will happen to me if I take part?

If interested, you will be invited to take part in a face-to-face interview which will be held at a convenient date, time and place for both participant and interviewer. All information provided during the interview will be anonymous and confidential. Your name will not appear on any report of the research. The interview should take approximately 45 minutes.

Will my taking part in this study be kept confidential?

Yes, we will respect your confidentiality throughout the study. No identifiable data will be reported in any outputs from the study. The study will follow the standard operating procedure of Robert Gordon University. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it according to the requirements of the General Data Protection Regulations 2018. Robert Gordon University will keep identifiable information about you for 18 months after the study has finished. You can find out more about how we use your information by contacting Robert Gordon University using the details below. Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally identifiable information possible. You can find out more about how we use your information by contacting the researchers using the contact details below.

Are there any expenses or payments with regards to my participation in the study?

It is not expected that you will incur any additional costs due to this study. Convenient interview date, time and place will be selected without additional costs.

What are the possible benefits of taking part?

There are no direct benefits to you by taking part in the study. However, your participation may assist in the future optimisation of implementation and development of ASP in the UAE.

What are the possible disadvantages and risks of taking part?

It is not anticipated that there will be any disadvantages or risks associated with the study.

Who is organising and funding the research?

This study is being conducted as part of a self-funded PhD. There is no specific funding for the study.

Who has reviewed the study?

The study has been reviewed and approved by Robert Gordon University as well as Ministry of Health and Prevention, Fatima College of Health Sciences and SEHA ethics committees.

What if I have a complaint?

Any complaint about the way you have been dealt with during the study will be addressed. If you have any complaints or would like further information about the study, please contact:

Dr. Antonella Tonna

School of Pharmacy & Life Sciences

Robert Gordon University

Aberdeen

AB10 7GJ

Scotland

+44 (0)1224 262578

a.tonna@rgu.ac.uk

Where can I get further information about the study?

If you have any questions about this study, please contact the following:

Nortan Hashad
Primary researcher
School of Pharmacy & Life Sciences
Robert Gordon University
Email: n.hashad @rgu.ac.uk

Tel: +971(0)56 125 4754

Dr. Antonella Tonna
Principal supervisor
School of Pharmacy & Life Sciences
Robert Gordon University
Email: a.tonna@rgu.ac.uk

Tel: +44 (0)1224 262578

Appendix 4.9 Participant consent form

UNITED ARAB EMIRATES
MINISTRY OF HEALTH & PREVENTION

A theoretical exploration of development and implementation of antimicrobial stewardship programs in the United Arab Emirates: a qualitative study of the perspectives of key stakeholders and health professionals

Participant Consent Form

Researcher
Nortan Hashad
PhD Student
Robert Gordon University
UK
E-mail: n.hashad@rgu.ac.uk
Participant Study Number.....

Please initial each box

I confirm that I have read and understand the information for the above study and have had the opportunity to ask questions.	☐
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.	☐
I grant copyright to allow my anonymised quotes to be used in research dissemination activities e.g. articles, abstracts, conference presentations.	☐
I agree to the interview being video and audio recorded.	☐
I agree to take part in this study.	☐

_____	_____	
Name of Participant	Date	Signature
_____	_____	
Name of Researcher	Date	Signature

Appendix 4.10 Cover letter for research application

UNITED ARAB EMIRATES
MINISTRY OF HEALTH & PREVENTION

COVER LETTER

Dr Najiba M Abdulrazzaq
Head of medical and cardiology department, Al Kuwait Hospital
TEL: +971506451881
Email: najiba.abdulrazzaq@moh.gov.ae

Attention: Research Ethics Committee Chair
Ministry of Health and Prevention
Dubai
United Arab Emirates

Dear Dr

RE: Request to start a research study on Antimicrobial Stewardship

I would like to kindly ask to start data generation for a research study on Antimicrobial Stewardship in Al Qassimi hospital. MOHAP ethics committee have granted approval for research to be undertaken on development and implementation of antimicrobial stewardship programs in the United Arab Emirates in MOHAP hospitals (Approval reference number: MOHAP/DXB-REC/JAANo.32/2019).

Title of Research: A theoretical exploration of development and implementation of antimicrobial stewardship programs in the United Arab Emirates: a qualitative study of the perspectives of key stakeholders and health professionals.

Research Team: Dr Najiba M Abdulrazzaq, Nortan Hashad, Dr Antonella Tonna, Dr Dhayaneethie Perumal and Professor Derek Stewart

In support of my request, I attach the following documents:

- Study protocol.
- MOHAP ethics approval.
- Fatima College of Health Sciences ethics approval.
- Robert Gordon University ethics approval.
- Consent forms and Participant information sheet in English.
- Data generation form (interview guide) for groups A, B and C.

This research has been prompted by global recognition of the consequential development of antimicrobial resistance (AMR) as a result of the increase and often inappropriate use of antimicrobials. The WHO launched the Global Action Plan in 2015, with five key objectives, of which objective four focuses on the optimal use of antimicrobials through the introduction of antimicrobial stewardship programs (ASPs).

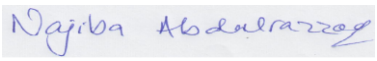
In the UAE, the global threat of AMR has been recognized by authorities and many efforts are in place. Developing a UAE national action plan for AMR is of high priority and is currently being drafted by UAE infection control experts.

This study aims at exploring ASP development and implementation in hospitals in UAE to enable characterization of key facilitators, enablers, barriers and solutions. Findings of this research will provide in-depth rich data on issues that can impact on the implementation and development of ASPs in UAE. It will aid key decision making, inform healthcare policy on the development and improvements of ASP and highlight findings on the facilitators and barriers encountered in current ASP practice.

We therefore seek your approval to start data generation for this study and willing to provide any further information that you may require.

We thank you in advance and look forward to hearing from you.

Yours sincerely



…….

Principal investigator

Dr Najiba M Abdulrazzaq
Head of Infection Prevention and Control central committee, MOHAP.
Head of medical and cardiology department, Al Kuwait Hospital.
World Health Organization (WHO) focal point in UAE
Dubai, UAE
TEL: +971506451881
Email:
najiba.abdulrazzaq@moh.gov.ae

……..

Co-coordinating investigator

Ms. Nortan Hashad
Instructor Fatima College of Health Sciences
PhD researcher, Robert Gordon University, Aberdeen, Scotland, UK.

Al Ain, UAE
Tel: +971561254754
Email: n.hashad@rgu.ac.uk

Appendix 4.11 Conflict of interest declaration form

UNITED ARAB EMIRATES
MINISTRY OF HEALTH & PREVENTION

A theoretical exploration of development and implementation of antimicrobial stewardship programs in the United Arab Emirates: a qualitative study of the perspectives of key stakeholders and health professionals

Conflict of Interest Disclosure Form

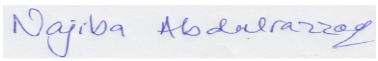
Nortan Hashad, Dr Antonella Tonna, Dr Dhayaneethie Perumal, Dr Najiba M Abdulrazzaq, Professor Derek Stewart

Investigators of this research hereby declare the COMPLETE ABSENCE of any source of competing financial or non-financial interest with any party that might influence the ethical conduction or publication of this research.

Principle Investigator (PI) Name	PI Signature	Date
Dr. Dhayaneethie Perumal		03/09/2019

Student Investigator Name*	Student Investigator Signature	Date
Ms. Nortan Hashad		03/09/2019

Co-Investigator Name	Co-Investigator Signature	Date
Prof. Derek Stewart		03/09/2019

Co-Investigator Name	Co-Investigator Signature	Date
Dr. Najiba Abdulrazzaq		03/09/2019

Co-Investigator Name	Co-Investigator Signature	Date
Dr. Antonella Tonna		03/09/2019

Appendix 4.12 Confidentiality form

UNITED ARAB EMIRATES
MINISTRY OF HEALTH & PREVENTION

A theoretical exploration of development and implementation of antimicrobial stewardship programs in the United Arab Emirates: a qualitative study of the perspectives of key stakeholders and health professionals

Confidentiality Form

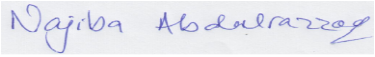
Nortan Hashad, Dr Antonella Tonna, Dr Dhayaneethie Perumal, Dr Najiba M Abdulrazzaq, Professor Derek Stewart

Investigators of this research hereby agree to keep the confidentiality of all the information that will be collected throughout the research and to anonymize the identity of all participants.

Principle Investigator (PI) Name	PI Signature	Date
Dr. Dhayaneethie Perumal		03/09/2019

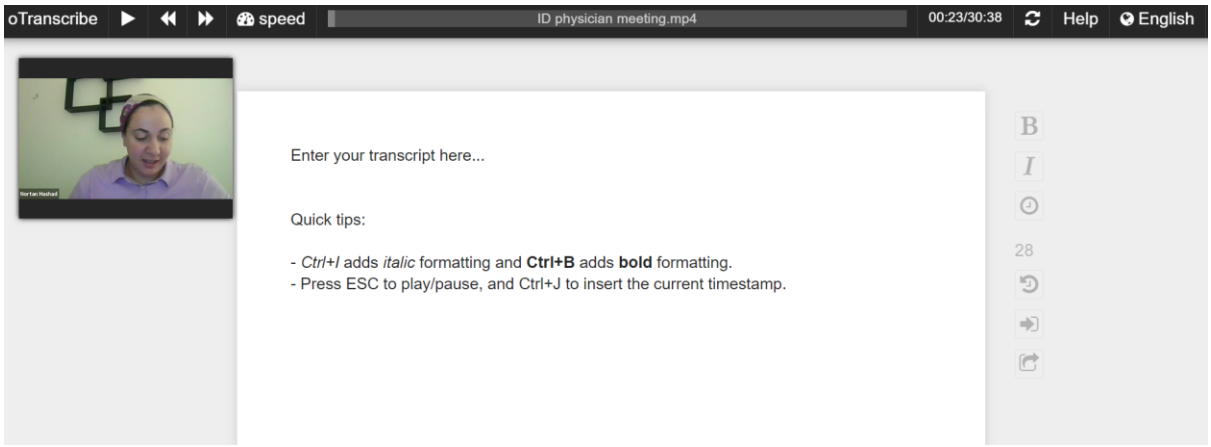
Student Investigator Name*	Student Investigator Signature	Date
Ms. Nortan Hashad		03/09/2019

Co-Investigator Name	Co-Investigator Signature	Date
Prof. Derek Stewart		03/09/2019

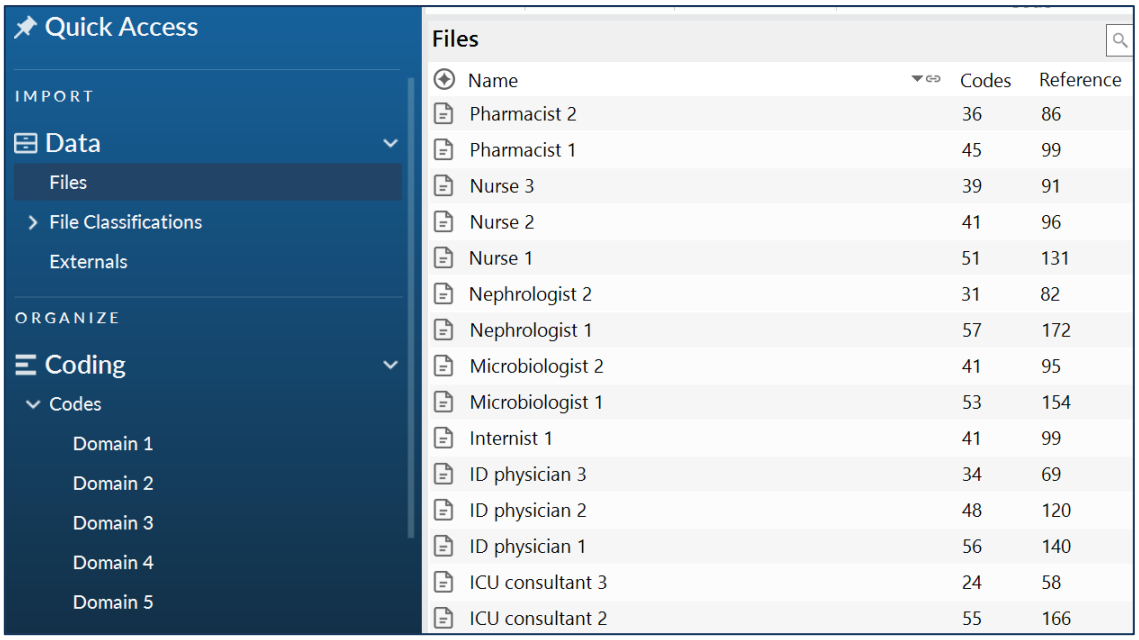
Co-Investigator Name	Co-Investigator Signature	Date
Dr. Najiba Abdulrazzaq		03/09/2019

Co-Investigator Name	Co-Investigator Signature	Date
Dr. Antonella Tonna		03/09/2019

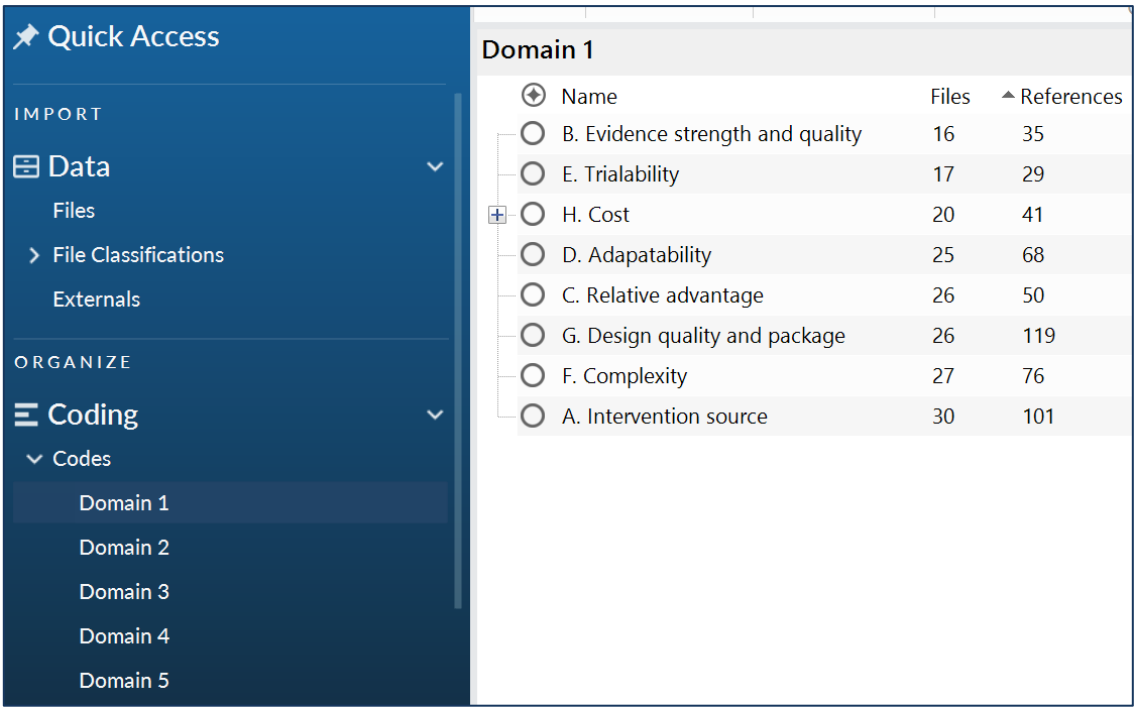
Appendix 4.13 Transcribing software tool interface



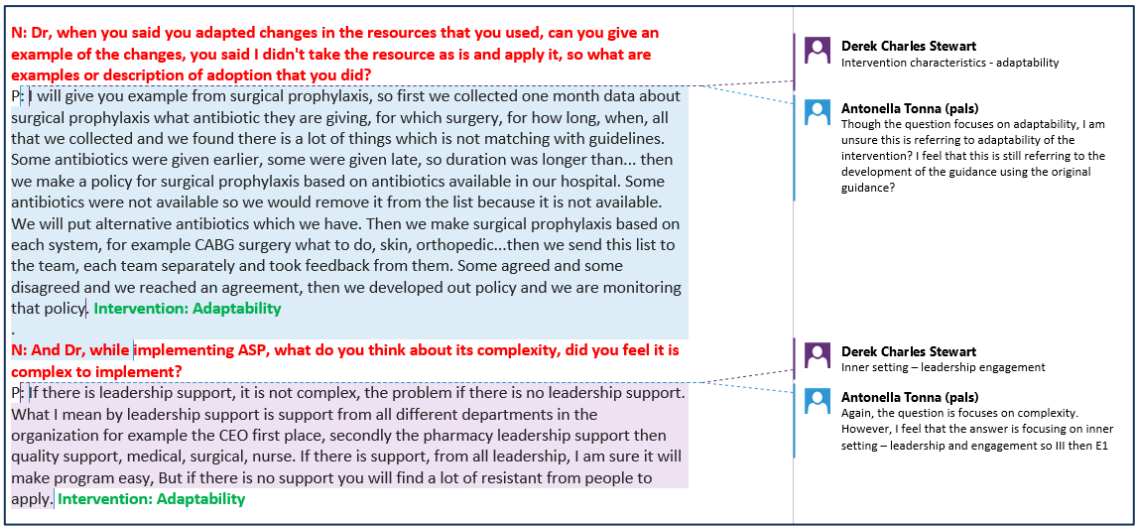
Appendix 4.14 All transcripts transferred to NVivo software



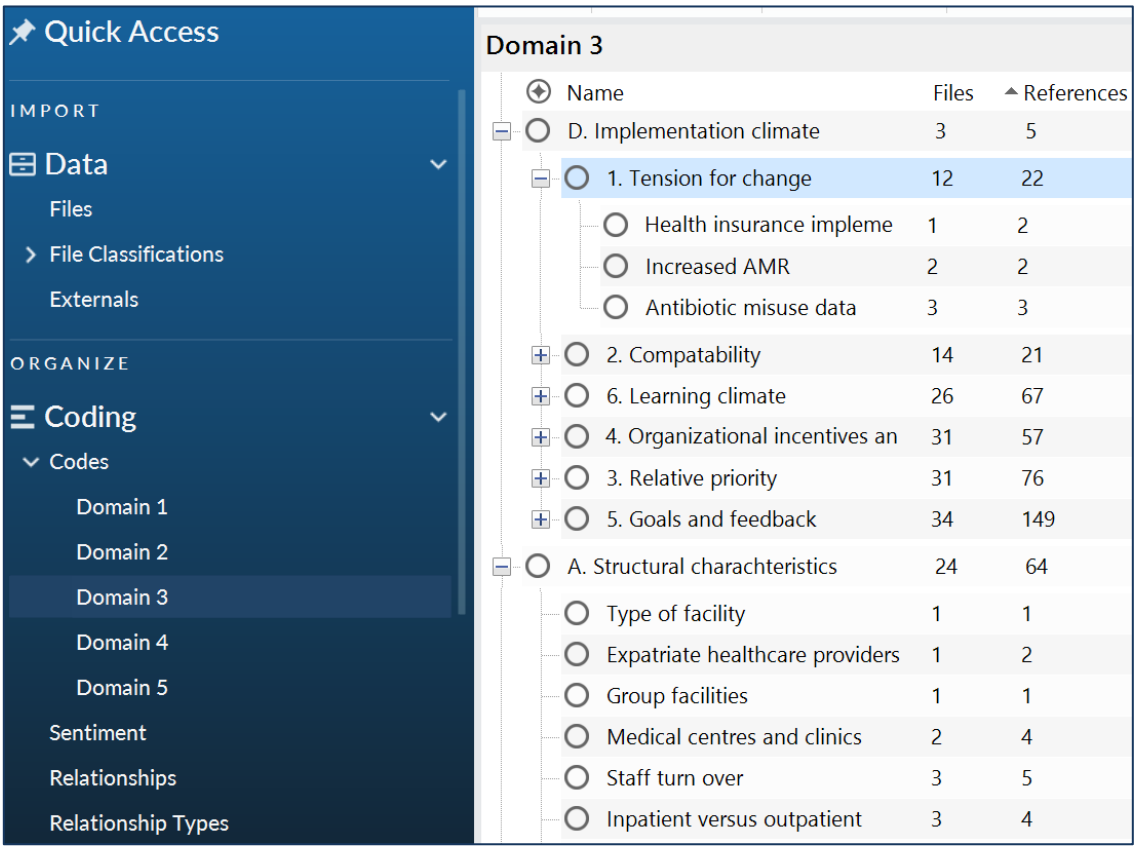
Appendix 4.15 Developing coding framework using CFIR domains on NVivo software



Appendix 4.16 First interview coding merged on Microsoft Word



Appendix 4.17 Inductive analysis for emerging themes within each CFIR construct using NVivo® software



Appendix 4.18 Grouped quotes exported from NVivo to Microsoft word

<Files\\Clinical pharmacist 2> - § 5 references coded [6.57% Coverage]

Reference 1 - 2.01% Coverage

I think the culture is very collaborative. I think that we don't leave the ASP strategy to be one person's job. I think everybody understands that it takes a village, you know, and everyone's role is appreciated, and I think that's when we rolled it out, we make sure that the responsibility aspect of the policy was very clear to show what the verification promises have to do in seeking approval of ID pharmacists, to show what physicians have to do when they're thinking about ordering, to show what nurses what they have to do in the monitoring and help into reminding physicians of the washout period and the ID approval, to show what the pharmacist really ought to do, to show who's responsible for keeping the data and track in events. So I think the culture in one word will be, If I had to swap it with one word will be collaborative

Reference 2 - 1.80% Coverage

I think it was difficult in the beginning when people were not aware of how the human capital was going to be sufficient, but when people saw the value in what it actually brings and how it can stream line decision-making, I think it was generally accepted. As long as the responsibilities was clear. So we didn't have a lot of resistance. I think it was well welcomed. only apprehension was where will the work will come from, and once you have shown it in terms of who was responsible for what people were appeased, so I think we haven't had that much of a problem. It's just getting the momentum and making sure people feel inspired to feel that it's worth it and that everybody is pulling their weight. So, I think it it's been received very well.

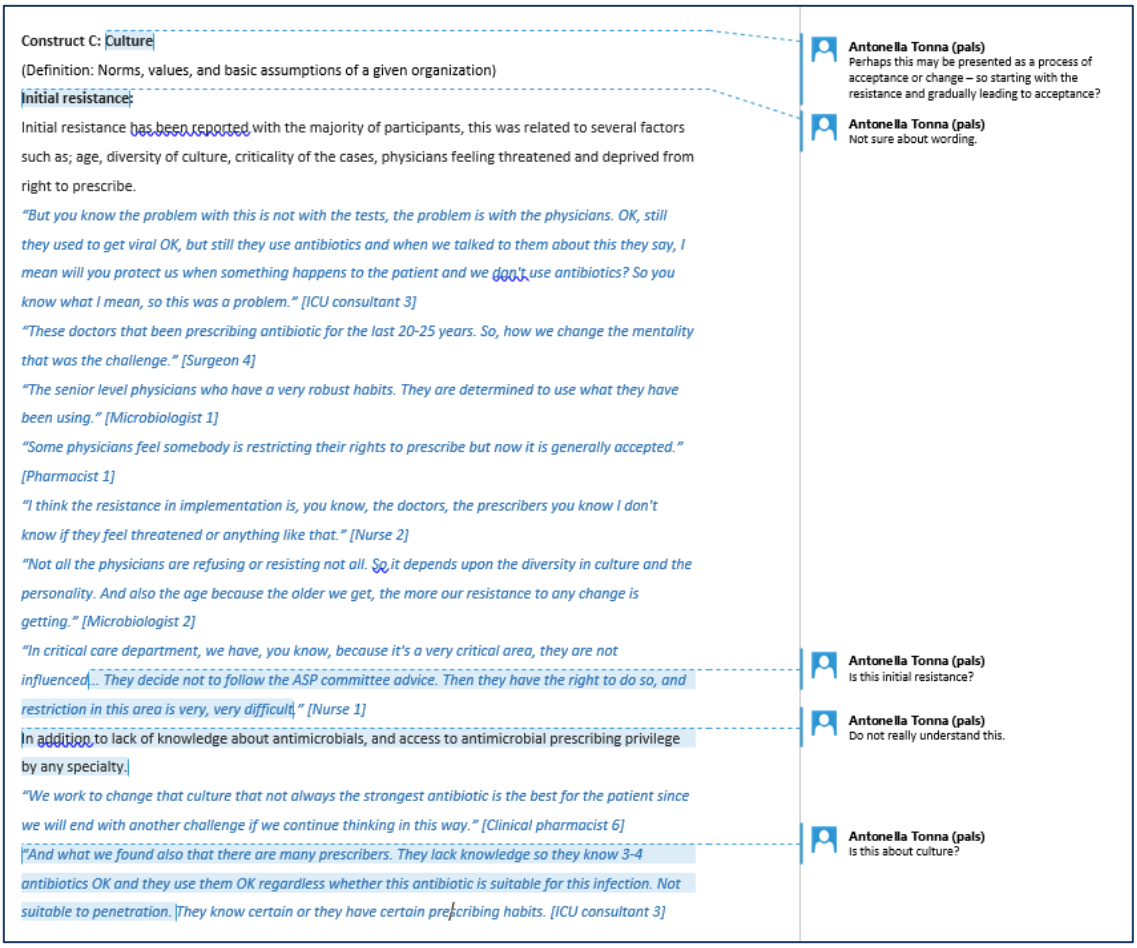
Reference 3 - 0.61% Coverage

I think the culture of each unit is important. When there is resistance from the top, So for example, if you have a unit and the head consultant is not very sold on ASP, or they don't see the value you need to get them on board and let them see the value.

Reference 4 - 1.59% Coverage

Because if the top and the people making the decisions are utilizing and making encouraging their are not sold, then the culture would be that they don't understand or they don't value ASP so it's very important to see what the culture at the top is for each Department. So if you're dealing with an oncology Ward, make sure that the Oncologist see the value in ASP, if you're dealing with Internal Medicine make sure that the internists are really that bothered about it. Make sure that people are aware, make sure they know the value of it. When people see the value in it, they want to participate and they want to give their time to it. Same with pharmacist.

Appendix 4.19 Data analysis and interpretation through continuous iterative approach



Construct C: Culture

(Definition: Norms, values, and basic assumptions of a given organization)

Initial resistance:

Initial resistance has been reported with the majority of participants, this was related to several factors such as; age, diversity of culture, criticality of the cases, physicians feeling threatened and deprived from right to prescribe.

"But you know the problem with this is not with the tests, the problem is with the physicians. OK, still they used to get viral OK, but still they use antibiotics and when we talked to them about this they say, I mean will you protect us when something happens to the patient and we don't use antibiotics? So you know what I mean, so this was a problem." [ICU consultant 3]

"These doctors that been prescribing antibiotic for the last 20-25 years. So, how we change the mentality that was the challenge." [Surgeon 4]

"The senior level physicians who have a very robust habits. They are determined to use what they have been using." [Microbiologist 1]

"Some physicians feel somebody is restricting their rights to prescribe but now it is generally accepted." [Pharmacist 1]

"I think the resistance in implementation is, you know, the doctors, the prescribers you know I don't know if they feel threatened or anything like that." [Nurse 2]

"Not all the physicians are refusing or resisting not all. So it depends upon the diversity in culture and the personality. And also the age because the older we get, the more our resistance to any change is getting." [Microbiologist 2]

"In critical care department, we have, you know, because it's a very critical area, they are not influenced... They decide not to follow the ASP committee advice. Then they have the right to do so, and restriction in this area is very, very difficult." [Nurse 1]

In addition to lack of knowledge about antimicrobials, and access to antimicrobial prescribing privilege by any specialty.

"We work to change that culture that not always the strongest antibiotic is the best for the patient since we will end with another challenge if we continue thinking in this way." [Clinical pharmacist 6]

"And what we found also that there are many prescribers. They lack knowledge so they know 3-4 antibiotics OK and they use them OK regardless whether this antibiotic is suitable for this infection. Not suitable to penetration. They know certain or they have certain prescribing habits. [ICU consultant 3]

Antonella Tonna (pals)
Perhaps this may be presented as a process of acceptance or change – so starting with the resistance and gradually leading to acceptance?

Antonella Tonna (pals)
Not sure about wording.

Antonella Tonna (pals)
Is this initial resistance?

Antonella Tonna (pals)
Do not really understand this.

Antonella Tonna (pals)
Is this about culture?

Appendix 4.20 Inductive analysis within each CFIR construct using Mindmanager® software