

Exploration of how a mobile health (mHealth) intervention may support midwives in the management and referral of women with pre-eclampsia in rural and remote areas of highland Scotland.

WHITE, A.

2018

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Exploration of how a mobile health (mHealth) intervention may support midwives in the management and referral of women with pre-eclampsia in rural and remote areas of Highland Scotland

A thesis presented for the degree of Master of Research (part-time) in Nursing and Midwifery by Research at the Robert Gordon University

by

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ABSTRACT

Background:

Other authors have described how mobile health (mHealth) interventions can support midwives in the early identification of complications in pregnancies in rural and remote locations.

Aims:

This qualitative descriptive study investigates whether a mHealth intervention might:

1. Be acceptable and useful to rural midwives in detecting, managing and making timely referrals in respect of women presenting with possible pre-eclampsia.

and

2. Offer any advantage and/or improvement over current practice.

Rationale:

Globally, hypertensive disorders account for 12% of all maternal deaths. In the UK, pre-eclampsia affects up to 6% of pregnant women. Severe cases of eclampsia progressing from pre-eclampsia develop in up to 2% of these pregnancies.

The early identification of pre-eclampsia and its appropriate management before the onset of eclampsia is recognised as a way to prevent complications and to mitigate the worst effects of pre-eclampsia.

This study draws on the growing body of evidence of the efficacy of mobile health (mHealth) interventions. It explores whether such interventions could support midwives in the management of women with pre-eclampsia in rural and remote settings in Highland Scotland

Methods:

The study gathered and analysed data from midwives (n=18) at three focus groups in Highland Scotland during June and July 2017. These midwives were asked to consider whether a new mLearning/ mHealth toolkit might support their practice with women presenting with pre-eclampsia.

Findings:

Geographic and digital isolation are real challenges and most of the midwives in the study saw advantages in an intervention that requires no internet connectivity. They welcomed being able to work on their continuous professional development (CPD) whilst on the move as well as the inclusion of an audio-visual module to explain pre-eclampsia to women.

There was less congruence around the value to midwives of an intervention that provided advice on how to diagnose pre-eclampsia, although it was thought that this could be of value to healthcare practitioners with less experience of pre-eclampsia.

Implications for practice:

This study contributes to the emergent body of knowledge concerning the need for and efficacy of mHealth interventions in Reproductive, Maternal and Child Health (RMCH) and may help inform future initiatives in other regions and cultures.

The study has informed the parallel development of a prototype device. This is being tested, at the time of this thesis submission with multidisciplinary healthcare teams in Highland Scotland. There is the potential to develop a tool to assist in building psycho-social resilience and support retention among midwives and other healthcare workers in rural and remote areas of Scotland and other locations.

Limitations:

The scope of this study is limited in as much as participants were recruited from only one health board and that it focuses only on pre-eclampsia. To widen the scope of the study would be very difficult to achieve within the time allowed to complete a Master of Research study.

Key search words included: pregnant women, pre-eclampsia, midwives, mHealth, mobile devices and remote and rural.

Declaration of Authorship

RESEARCH STUDENT'S SELF DECLARATION (RDDECL) FORM



Name: **Alan Hamilton White**

Degree for which thesis is submitted: **MRes (part time)**

Thesis title:

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(mHealth) intervention may support
midwives in the management and referral
of women with pre-eclampsia in rural and
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Date 23rd January 2018

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My undertaking of this part-time study, after a very long absence from the world of academia has been an interesting, sometimes challenging and ultimately illuminating journey for me. A number of people have shared this journey and supported me over its course. I could not have completed this thesis without them – thanks to all of you.

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This study is dedicated to my wife who twice lived through pre-eclampsia and to my two children who have grown up as healthy adults.

Glossary and Definition of Terms

2G phones	2 nd generation mobile phones, most have SMS (text messaging), basic email functionality and most can play video from SIM cards, they are sometimes also known as feature phones.
3G smartphones	3rd generation enhanced smart phones that enable full mobile internet connectivity via broadband. This connectivity is often slow.
4G smartphones	4th generation enhanced smart phones that enable fast full mobile internet connectivity.
App	The Oxford English dictionary defines an app as: <i>a (software) application, especially as downloaded by a user to a mobile device.</i>
Android	Google's operating system for mobile devices including Galaxy and Sony.
CHW	Community Health Worker
CPD	Continuous Professional Development
DfID	(UK) Department for International Development
DHI	Digital Health and Care Institute
eBooks	eBooks are digital versions of printed books and can be downloaded from various sources on the internet onto mobile digital devices. There are now interactive eBooks that incorporate similar features to those of apps including quizzes and longer videos.
HIDB	Highlands and Islands Development Board

HIE	Highlands and Islands Enterprise
HMISS	Healthcare Information and Management Systems Society
IHL	Interactive Health Limited
IOS	Apple's operating system
LMIC	Low or Middle Income Country
MVP	Minimum Viable Prototype
native app	An app downloaded from an "app store" Once downloaded, most operate without any connection to the internet, though more complex apps, for example those that contain videos, do require users to link to the internet in order to play them.
NES	(Scotland) NHS Education for Scotland
NICE	(UK) National Institute for Health and Care Excellence
NPP	Northern Peripheries Project
MOOC	Massive Online Open Course
mHealth	Akter et al. (2010) defined mHealth as using mobile communications—such as personal digital assistants (PDAs), and mobile phones for health services and information.
mLearning	The Collins English dictionary defines mLearning as: <i>a form of e-learning designed for mobile phones or tablet computers</i> In this study I have combined the terms mLearning/mHealth as hybrid of the two terms.

Mobile devices	For the purposes of this study this term refers to mobile phones and tablets. It can also refer to smart glasses and Virtual Reality (VR) headsets.
PIH	Pregnancy Induced Hypertension
Preloaded apps	Apps (and/or eBooks) which are loaded on to mobile devices onto mobile devices by organisations and provided to users as a stand-alone applications that requires no internet connectivity.
RGU	The Robert Gordon University
RMCH	Reproductive, Maternal and Child Health
RRHEAL	(Scotland) Remote and Rural Healthcare Alliance
TNO	Netherlands Organisation for applied scientific research
web app	An app that can be downloaded from a website. These are usually cross-platform and require internet connectivity

CHAPTER 1 – Introduction

Other authors including Lim et al. (2015) have contended that mobile health (mHealth) interventions using smartphones and tablets using apps and eBooks, may potentially support midwives in the early identification of women with pre-eclampsia in rural and remote settings and improve management and referrals of women who present to midwives in rural and remote locations with symptoms of pre-eclampsia.

This chapter introduces the background to my study and what has led me as a lay-person to be drawn to investigate the role that a mLearning/mHealth toolkit could have in supporting the practice of midwives working in rural and remote areas of Highland Scotland.

1.1 Background

More than half a million women and infants die each year from pregnancy related causes across the globe. The high incidence of pre-eclampsia and its complications (in these deaths) makes its prevention and effective management important.

(Rudra et al. 2011 p.1)

Rudra's quote reminds us that childbirth continues to be dangerous for some women and highlights the extent of this pregnancy related pathology globally and the need to ensure the most robust healthcare infrastructure is available. Pre-eclampsia has a complex pathophysiology and is part of the spectrum of conditions that can arise as a result of pregnancy-induced hypertension (PIH) (Mustafa et al. 2012). Globally, hypertensive disorders account for 12% of all maternal deaths (McDougall et al. 2016). These unnecessary deaths are a factor that has led to the United Nations Development Programme to include maternal health in its Sustainable Development Goal 3 targets with the aims to:

- *By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births*
- *By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births*

In the UK, pre-eclampsia has been estimated as 5/1000 pregnancies (Rudra et al, 2011). Severe cases of eclampsia develop in up to 2% of these pregnancies (National Institute for Health and Care Excellence (NICE) Guideline, CG107. 2011).

Therefore, early identification of pre-eclampsia and its appropriate management before the onset of eclampsia is recognised as a way to prevent complications and to mitigate the worst effects of pre-eclampsia and improve outcomes for mothers and newborns (Rudra et al. 2011).

1.2 Personal interest and pre-understandings

My interest in pre-eclampsia stems from my own very frightening experience of how at lightning speed, my wife's delivery of our first child in a Scottish general hospital turned into a full scale medical emergency when she was suddenly diagnosed with pre-eclampsia when she was at an advanced stage of labour. The professionalism of her midwife, obstetrician and nurses probably saved her life and meant that she gave birth to a healthy baby girl. My experience of being present at her birth is something that I will never forget. That experience combined with what I encountered in Kenya and Rwanda whilst filming and conducting interviews for a MOOC (Massive Open Online Course) on sustainable development in sub-Saharan Africa for the Open University's *Future Learn* channel, is what brought me to first conjecture that an mLearning toolkit that was independent of any connection to the internet might support healthcare practitioners in their care of pregnant and post-partum women in remote and rural areas in both

developed countries and Low and Middle Income Countries (LMICs). This very personal interest in pre-eclampsia is why I have chosen to write my study in the first person.

I am not a healthcare practitioner. My professional and academic life has been largely in the areas of fine art, the creative (corporate) communication and educational filmmaking sectors. I now combine this experience to develop and deploy mobile learning (mLearning) using smartphones and tablets to inform both citizens and practitioners in the field of healthcare. I do not attempt to provide any depth of understanding of the biomedical needs of pregnancy, childbirth and postnatal care and have no schooling in pathophysiology. I come to this study from the perspective of the partner of a woman who was twice diagnosed with pre-eclampsia and the father of two very healthy adult children. That first hand and frightening experience of pre-eclampsia combined with my research experience and inquisitiveness as a filmmaker enabled me to empathise with the midwives who participated in the focus groups that are integral to this study.

1.3 Rationale for the study

Boulos et al. (2014) sets the scene for this study. They describe smartphones as the most common personal computer (PC) and how, since the launch of the Apple iPhone in 2007, smartphones have revolutionised the way that we communicate and access information. Boulos et al. (2014) also postulate that mobile devices have much to offer users in the areas of education, healthcare and medicine. Boulos et al. (2014) describe smartphones in particular as pocket sized, hand-held and easy to use on the move. As such I would suggest that mobile devices could be particularly useful to healthcare professionals, such as rural midwives, who serve scattered communities in remote and rural locations.

Speciale and Freytis (2013) explain the ubiquity of smartphones and focus on how mobile phones increasingly are used by women and midwives. Speciale and Freytis (2013) also advocate that midwives should be encouraged to become proactively involved in this mHealth revolution to help inform new and innovative mHealth initiatives that are relevant to the midwifery profession and can support the women midwives work with.

Speciale and Freytis (2013) point out how as a result of this development there are unprecedented opportunities for mobile devices to improve the outcomes for women and newborns. At the same time, Speciale and Freytis (2013) highlight how very few midwives are ever consulted in shaping how these technologies can be applied in the area of maternal healthcare. Speciale and Freytis, (2013) attribute this to mHealth initiatives being proposed from outside rather than from within the midwifery profession. They urge project leads on any mHealth introduction to ensure midwives play a more proactive role in the development of new mHealth interventions.

Based on an initial scoping review (Appendix B) of literature and apps and mHealth interventions in the area of maternal health and prior to developing of a research proposal and ethics application, I identified two research questions:

1. Might a solution such as an mLearning/mHealth toolkit be acceptable and useful to rural midwives in detecting, managing and making timely referrals in respect of women presenting with possible pre-eclampsia?
2. Whether a solution such as an mLearning/mHealth toolkit, offers any advantage and/or improvement over current practice?
3. As a result of the initial scoping review of the literature, I developed a literature review protocol (Appendix B) and began work on a research proposal and ethics application. This indicated a qualitative approach, as being the best suited to answer my research questions. It brought a naturalistic lens to the study, whereby I was able to focus my research within the context of the participating midwives' practice and locations. Moreover it

was a methodology that was feasible within the time and resource constraints of a Master of Research study.

Rural Scottish community midwives in three separate locations were recruited within the NHS Highlands board area. The data was gathered through three focus groups. Each focus group recording was transcribed and then thematically analysed and discussed in relation to the published literature and current maternity policy drivers from within the Scottish government's current policy review of healthcare provision in remote and rural areas in the context of a possible introduction of multidisciplinary healthcare teams.

1.4 Outcomes of this study

The ubiquity of mobile devices is connecting people in a way that creates opportunities to develop new approaches to healthcare. This small pilot study sought to contribute to an emergent body of knowledge around the efficacy of mHealth interventions in the area of maternal and newborn health.

The principal outcome from this study has been to ascertain whether a new mHealth tool that requires no internet connectivity is acceptable to both midwives and expectant mothers and other healthcare practitioners and whether it can mitigate the challenges of both geographical and digital isolation. From an NHS Highland perspective, it was assumed there would be potential benefits in ensuring optimal, timely and appropriate referrals of women to hospital services, reduce women spending unnecessary time in travelling between their rural homes and the hospital and supporting rural midwives in their practice settings to make informed and timely decisions.

This small pilot study seeks to contribute to an emergent body of knowledge around the efficacy of mHealth interventions in the area of maternal and newborn health. What the study found was:

- Both geographic and digital isolation are real challenges for midwives working in remote and rural locations in Highland Scotland.

- Most participants in the focus groups saw advantages in a mLearning/mHealth toolkit that requires no internet connectivity.
- The potential to work on Continuous Professional Development (CPD) whilst on the move was particularly welcomed by the participants in the focus groups.

1.5 Future outcomes

An additional outcome from this study has been to initiate a further feasibility study in Highland Scotland to test whether a prototype mLearning/mHealth toolkit that requires no internet connectivity is acceptable to both midwives and expectant mothers and other healthcare practitioners and whether it can mitigate the challenges of both geographical and digital isolation.

This study informs further research and contributes to the developing evidence-base of sustainable and affordable mHealth solutions in rural maternity services. This small study does not claim to report definitively on the cause and effect of this technology. Instead, it provides evidence, collected from focus groups, from which it may be possible to develop a prototype of a mLearning /mHealth toolkit.

This study provides an evidence base from which to develop a proof of concept through further research. It recommends a further larger study that could demonstrate the potential benefits of this technology and how it, or similar interventions, might improve the quality of safe and effective maternity care to remote and rural communities.

1.6 Chapter Summary

I have explained the reasons that drew me to carry out this study and how other authors have described how mobile health (mHealth) interventions can support midwives in the early identification of complications in pregnancies such as pre-eclampsia in rural and remote locations. I have also set the scene for the location of the study and how it may lead to further research.

I conclude this chapter by outlining the structure of the study.

1.7 Structure of the study

Chapter one provided a brief background and outline of the research study along with an introduction as to why I was drawn to undertake this study.

Chapter two elaborates on the context of this study and describes some of the ecosystems in which mLearning/mHealth are said to thrive.

Chapter three is a review of literature that examines and critiques the existing knowledge base to provide a setting in which to frame the context of the research.

Chapter four describes the philosophical underpinnings of the study design. The study design (methods) is explained and ethical considerations are explored.

Chapter five is a thematic analysis of the data acquired from the focus groups.

Chapter six is the discussion of my findings in relation to the literature. It highlights both divergent and convergent themes and the significance of the findings in terms of new insights, novel understandings and originality.

Chapter seven is the concluding chapter. It includes commentary on the strengths and challenges of this study, recommendations for practice, possibilities for further research and future projects. I also reflect on what I have learnt through the process of working on this Master of Research thesis. The next chapter places this study within the context of the global environment of mLearning and mHealth ecosystems and links the rationale for this study.

CHAPTER TWO – Context

2.1 Introduction

In this chapter I will reflect further on my personal context as it relates to this study before going on to set the study within the wider contexts of mHealth ecosystems and the perceived trustworthiness and acceptability of mHealth interventions.

2.2 Pre-understandings

After graduating in Fine Art from RGU, my first job was as the Art Director of a team producing audio-visual programmes to teach French and German to pupils in Scottish schools. It was the start of a life-long career in the creative industries sector with a common thread running through the field of distance learning via educational filmmaking, eLearning and now mobile learning or as it is often referred to mLearning. This work took me all over the world (often to sub-Saharan Africa). It has always involved observing, listening to and recording what people are saying around an eclectic mix of topics. Without realising it, I was developing some of the skills required for qualitative research.

This experience fused together when I came to lead the team that developed the award winning “Well@Work” suite of lifestyle and wellbeing apps for NHS Health Scotland. It kindled a new passion in me whereby I realised that I could build on my experience to do something that might improve people’s lives. This in turn provided an opportunity in 2015 to work with Professor Hilary Homans and her *One Health* team at the University of Aberdeen to develop a MOOC (Massive Open Online Course) on sustainable development in sub-Saharan Africa for the Open University’s *Future Learn* distance learning channel. This included interviewing the then Minister of Health in

Rwanda, Dr Agnes Binagwaho, who spoke passionately about the desperate need to improve maternal and new-born health in sub-Saharan Africa. That is when I began to investigate whether a mLearning/mHealth toolkit could be part of the solution to meet a need that spans several of the United Nations' Sustainable Development Goals (SDGs). It was the genesis of an idea that I have described as:

...having been conceived in Africa, currently gestating in Scotland and to be delivered globally.

2.3 International context

There are challenges to rural and remote maternity services globally including across Highland Scotland, the context of this study. Harris et al. (2010) undertook research to explore and understand the challenges around providing midwifery care in rural and remote locations in Scotland. They noted how midwives' perception of what is "rural", can vary from the semi urban to very remote locations where the added challenges of ambulance response time, ferry times and the weather prevail.

Gilkison et al. (2017) describe:

The complex and challenging nature of rural midwifery as a global issue.

Gilkison et al. (2017) go on to explain how in their view, rural midwifery practice is underpinned by the resourcefulness and resilience of midwives serving rural communities in Scotland and New Zealand. Four years prior to Gilkison et al. (2017)'s study, a Scottish government report (NHS Education for Scotland [NES] Board Paper 2013) noted that:

Each of the remote, rural and island areas has different education and training support needs. However these areas share an urgent and ongoing need to redesign the community and hospital workforce to ensure delivery of improved and sustainable services.

By 2016 mobile technologies were developing that might help to meet these needs. In particular, ever more powerful and increasingly multifunctional smart phones had larger higher definition screens that are much easier to read. This allowed Engmann et al. (2016) to confidently predict that over the next 20 years, continuing innovation in the area of mHealth will have the potential to result in transformational changes in the area of RMCH.

Engmann et al. (2016) suggest that where these new developments are supported by enabling environments (for example affordability and a willingness by health care professionals to adopt mobile technologies) and when that is combined with the political will to fund organisations such as the NHS with sufficient investment to incubate the fast-track development of mHealth interventions, that could result in progress towards training and equipping highly proficient cadres of mHealthcare professionals.

If Engmann et al. (2016) are correct in their vision of how mhealth will develop, then wherever such environments can be cultivated, these ever-changing ecosystems will be fertile ground upon which to grow opportunities for transformational real-time interactions such as peer to peer learning and the exchange of advisory and diagnostic interactions between healthcare practitioners and the citizens in their care.

Some low-and middle income countries (LMICs) such as Kenya and South Africa are already leading the field when it comes to implementing mHealth solutions. Indeed, evidence presented in 2017 at the Africa Health Agenda International Conference (AHAIC, 2017) suggests that in sub-Saharan Africa (most notably Kenya,) Engmann et al (2016)'s vision of the future already exists. In his opening remarks Dr Githinji Gitahi, Chairman of the AHAIC Organising Committee stated that a key aim of the conference was to:

... bring together health development professionals and researchers to share and evaluate evidence that can contribute to generating home

grown-grown solutions to the health problems faced by the African Continent.

At a session at AHAIC 2017 Mbindyo and Mutuku (2017) described their evaluation of a mobile health intervention in rural Kenya and Uganda involving 7000 community health workers (CHWs). This provided an account of how locally developed mHealth tools can support CHWs to provide enhanced care to rural women who present with complications in their pregnancies.

However, since attending AHAIC, I have been unable to find any literature (peer reviewed or otherwise) that supports the claims made by Mbindyo and Mutuku (2017). Nonetheless it is with the possibility of such interventions very much in mind that Engmann et al. (2016) postulated that future generations of mobile devices would be capable of operating in any telecommunications infrastructure. It is likely that these will utilise various new types of mobile phone networks, ranging from but certainly not limited to local intranets; fibre optic cable and ultra- high-speed broadband delivered via satellite beams. Based on the advances in mobile technologies that have taken place over the last decade, it is reasonable to assume that new ways of linking mobile phones to the internet will continue to be invented. These, Engmann et al. (2016) suggest will usher in an era where evidence based mHealth interventions can be accepted as a safe and cost effective alternative to current health care practices. The triage of women with pre-eclampsia is potentially one such area.

Speciale and Freytis (2013) highlighted how very few midwives are ever consulted in shaping how these technologies can be applied in the area of RMCH. This was despite how, according to Hoop-Bender et al (2014) in many parts of the world including Australia, New Zealand, the Netherlands, the United Kingdom and Ireland, midwives are the primary providers of care for childbearing women are ever consulted in shaping how these technologies can be applied in the area of RMCH.

Speciale and Freytis (2013) argued that the relationship between mHealth interventions and midwives could be more mutually beneficial if midwives were able to contribute, at an early stage, to how new mHealth interventions in the area of RMCH. Tripp et al. (2013) support this view with primary research in Australia that highlights how smartphones and tablets are widely used by women of childbearing age as their primary means to access information from the internet. Tripp et al. (2013) also argue that it is important for healthcare professionals to be in tune with this trend and for them to consider that mobile devices have the potential to take over some aspects of maternity care from healthcare professionals. Furthermore Tripp et al. (2013) support Engmann et al. (2016)s' view that political will needs to co-exist with sufficient investment and a well-trained work-force to create an environment where policy-makers as well as healthcare professionals are aware of the transformative potential of mobile devices and interventions such as apps and interactive eBooks to alter the way that maternal care is sought and delivered.

2.4 Why Highland Scotland?

Several speakers at the University College London (UCL) mHealth Institute for Global Health conference that I attended in January 2015 (Appendix P), were critical of the large number of pilot mHealth projects being aid donor funded in LMICs and how the majority of these projects were no longer sustainable after the donor funding came to an end. Barkman and Weinehall (2017) argued that mHealth pilot projects would better serve the supposed beneficiaries if they took account of their needs from the outset and were based on sound financial models that can support mHealth interventions from inception to taking them to scale. Barkman and Weinehall (2017) emphasised the importance of the need to improve the education of healthcare practitioners in their knowledge and understanding of what mHealth is and then applying that knowledge to their practice.

It was following on from the UCL Conference that I first engaged with Professor Hilary Homans at the University of Aberdeen. She encouraged me to seek funding to progress a feasibility study as to whether a mLearning/mHealth toolkit might help to improve maternal and new-born health in LMIC's and particularly in Rwanda. That led to me working on a collaborative bid with the School of Nursing and Midwifery at RGU that resulted in us being shortlisted for a project in Kenya. Unfortunately we did not go on to be awarded the project.

In formulating my application to undertake this study, I took on board the theme of pilot-fatigue in LMICs that emerged from the UCL conference and a perceived decline in donor confidence in the social return on the investment (SRoI) in mHealth interventions in LMICs. That led me to conclude that it would be more ethical, and indeed more cost effective, to carry out initial research on the acceptability and efficacy of a mLearning/mHealth toolkit in Highland Scotland.

Highland Scotland shares similar challenges, albeit in the context of a high-income country, in respect of geographic and digital isolation with many LMICs. Transport in Scotland might be more comfortable and the road surfaces better maintained but the journeys of many pregnant women from remote locations in the Highlands and Islands of Scotland are lengthy and just as likely to be disrupted by periods of adverse weather. It is evident that road conditions and travel challenges constantly confront Scottish rural midwifery (Kensington et al. 2018).

Moreover Highland Scotland has a cadre of well-educated and trained midwives able to challenge my ideas and to inform what might be required from a mLearning/mHealth toolkit such as I envisaged.

Staff in the RGU School of Nursing and Midwifery, with whom I had worked with on the Kenyan bid, encouraged me to progress this by applying for

Digital Health and Care (DHI) funding to enable me to study part-time for a Master of Research (MRes) degree at RGU. That funding has enabled me to carry out this study and to greatly enhance my understanding of the role that mLearning and mHealth can sometimes play in supporting healthcare practitioners at rural and remote locations and improving patient outcomes.

2.5 mHealth ecosystems

mHealth thrives in a variety of ecosystems or Information Communication Technology (ICT) infrastructures that are constantly evolving. There may not always be time for new mHealth interventions to be evaluated, peer reviewed or published in any professional journals. Some of these new mHealth interventions might for commercial reasons be deemed to be confidential and as such are not yet in the public domain.

Such ecosystems range from numerous donor funded pilot studies in LMICs in sub-Saharan Africa and south Asia, through patient centric projects in the USA that aim to bring the hospital home; to apps aimed at the over 50s in Scotland to encourage them to exercise and live life to the full (*Living It Up*: <https://www.nhsinform.scot/campaigns/living-it-up>). There are apps that turn smartphones into medical devices such as, for example, to aid diabetics to control their dosage of insulin, whilst some apps simply provide advice (Well@Work: waw.aptlearning.co.uk).

2.6 Trustworthiness of mHealth interventions

There is also broad agreement that citizens' and indeed healthcare practitioners' trust in health apps is likely to be increased if the development and content of an app is evidence-based (Albrecht and von Jan 2017). mHealth app developers signing up to the new European Union (EU) voluntary codes of conduct and guidelines that were published in 2016, could still further enhance this trust (European Commission 2016). These draft

guidelines are part of the EU's single market strategy and advocate the adoption of a Privacy Code of Conduct for mHealth apps. The code suggests the need for:

...covering the topics of privacy and security. The objective of this code is to foster citizens' trust in mHealth apps, raise awareness of and facilitate compliance with EU data protection rules for app developers.

The preamble on the Europa web portal reports that whilst there is a large number of healthy lifestyle apps that are aimed at citizens, in many instances there is no evidence base for their content or of their efficacy. This lack of evidence limits the potential for many such apps to benefit public health (European Commission 2016).

Albrecht and von Jan (2017) comment on the EC's draft guidelines in general but acknowledge that many developers, like myself, do not have a professional background in healthcare. They need to understand and respect the needs of the end-user.

2.7 Acceptability of mHealth interventions

For mHealth interventions to be acceptable to end-users they must, according to Speciale and Freytis (2013) be firmly based on the needs of the women and the midwives who provide their care. It is therefore vital that mHealth interventions in the area of RMCH are introduced in a way that is relevant and acceptable both to women and midwives.

2.8 Chapter summary

This chapter described how my study in Highland Scotland sits within a global environment of mHealth and mLearning ecosystems. It also illustrated how despite cultural differences, healthcare practitioners in Highland Scotland face similar challenges in respect of geographic and digital isolation to their counterparts in less developed countries.

The next chapter explores, analyses and critiques literature that reports on the main issues and trends associated with the fast moving and constantly evolving landscape of mHealth. In particular it looks at how these trends pertain to supporting the practice of midwives working in rural and remote locations in their management of women with pre-eclampsia.

CHAPTER 3 – LITERATURE REVIEW

3.1 Introduction

This chapter reports on the findings of an integrative literature review. The review aimed to validate my research questions through a critique, analysis and synthesis of primary source published studies on mHealth interventions in the area of RMCH that explore the experience of midwives and community health workers in remote and rural areas globally.

My literature review is based on a protocol (Appendix E) and the findings of an initial scoping review of primary and secondary sources (Appendix B). It examines issues around the acceptability and efficacy of mHealth interventions in the area of RMCH. In particular I examine how in both High Income Countries and Low and Middle Income Countries (LMICs), trends in mHealth interventions and associated mLearning programmes pertain to supporting the practice of rural midwives and frontline health workers in their management and support of women with pre-eclampsia.

3.2 Integrative review

Whittemore and Knafl (2005) advise that evidence-based research such as this study can only be effectively addressed by first undertaking an integrative review of primary source literature on the topic that is being investigated. An integrative review is a specific framework to capture diverse research designs to develop a holistic understanding of topic of interest (Whittemore and Knafl 2005). My review process follows Whittemore and Knafl (2005)'s five-stage approach: problem-identification; literature search; data evaluation; data analysis and presentation.

3.3. Stage 1: Problem identification

Studies, since the mid 1990s, have suggested that there is a role for mHealth interventions in the area of RMCH (Lee et al.2016). However, it seemed unclear as to their efficacy and the acceptability by end users. Another issue

is that mHealth interventions are developed within numerous fast-moving ecosystems. Studies/information on new interventions may not have been published in any peer-reviewed journals.

3.3.1 Aim and review questions

Whittemore and Knafl (2005) recommend that the healthcare issue being addressed by any review method, is clearly identified at the outset of the review. Based on this, I used the SPIE (Setting, Perspective, Intervention and Evaluation) acronym framework (Hunt et al, 2015) to formulate the questions for the review (Table 1).

Table 1: Formulation of review questions

Acronym description	Formulation of questions
S - Setting	Rural and remote areas
P - Perspective	Midwives' experiences and perspectives in managing pregnant women with pre-eclampsia
I - Intervention	mHealth interventions using mobile devices, mobile applications
E - Evaluation	Experiences, perceptions, opinions, views and attitudes

Aim:

To assess the evidence of how midwives manage and support pregnant women presenting with pre-eclampsia in rural and remote locations and whether there was any evidence of midwives using mHealth interventions in relation to how they dealt with pre-eclampsia.

The following three questions are the basis for this review:

- Is there a need for end-users to be involved in developing new mHealth interventions?
- What evidence is there of the acceptability and effectiveness of mHealth interventions?
- What are the barriers and facilitators to the adoption of mHealth interventions?

For the purpose of this review I have used the term *mHealth tool* to refer to apps, interactive eBooks, interactive pdfs and text messaging (SMS). Table 2 summarises acronyms and technical terms used throughout my review.

Table 2: Summaries acronyms and technical terms

Term	Definition
2G phones	2 nd generation mobile phones, most have SMS (text messaging), email functionality and most can play video from SIM cards. They are sometimes also known as feature phones.
3G phones	3rd generation enhanced smart phones that enable full mobile internet connectivity via broadband. This connectivity is often slow.
4G phones	4th generation smart phones that enable fast mobile internet connectivity (subject to operators' networks).
App	A software application downloaded by a user to a mobile device.
Android	Google's operating system for mobile devices including Galaxy and Sony.

CHW	Community Health Worker – I have used this as a generic term, in some countries these frontline health workers are known by other terms e.g. HEWs (Health Extension Workers (in Ethiopia and ASHAs (Accredited Social Health Activists) in India
IOS	Apple’s operating system
mHealth	Using mobile communications—such as personal digital assistants (PDAs), and mobile phones for health services and information.
Mobile devices	Mobile phones and tablets
SMS	SMS – Short Message Service, normally referred to as text messaging. This can be used on all types of mobile phones.
UCD	User-centred design

3.4 Stage 2: Literature search

It is recommended that the integrative review process must be clearly documented and include search terms, the databases that were searched, any additional search strategies and the criteria adopted to include or exclude literature for review (Whittemore and Knafl (2005). The reporting of the search process follows the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Moher et al. 2009) (Figure 1).

3.4.1 Search strategy and search terms

Four online databases were searched - CINHALL, MEDLINE, Pubmed and Google Scholar - to identify published studies for inclusion in this review. Combinations of MeSH (Medical Subject Heading) terms and key words were

identified (Table 3). These were grouped in three categories: perspectives (pregnant women, midwives, CHWs); interventions (mHealth in the area of RMCH) and evaluation (studies that evaluated mHealth interventions in the area of RMCH). This ensured that all potentially relevant articles were retrieved.

The search terms were then piloted on MEDLINE database and this was later adapted to the other databases. Boolean operators 'OR' and 'AND' were used to narrow down the search. The searches were limited to articles from 2007 to January 2017 and only articles published in English were selected. The rationale for only searching for articles from 2007 onwards was that 2007 was the year that Apple launched its iPhone and the year that the general population first began to use smartphones. The searches were later updated from 2007 to January 2018.

Table 3: key words and terms

Key words and terms	Interchangeable terms
Pregnant women	Pregnant women, pregnant mothers, pregnancy.
Pre-eclampsia	Eclampsia, pregnancy induced hypertension, gestational hypertension.
Midwives	Community Midwives, Community Health Workers, rural midwives, birth attendants, healthcare professionals, rural health care providers, frontline health workers, midwife, midwifery.
mHealth	Mobile health, m-Health, eHealth,

	e-Health, mobile applications, mobile applications.
Remote	Rural, isolated.
Mobile devices	Smart phones, tablets, iPads, iPhones, personal digital assistant

3.4.2 Inclusion and exclusion criteria

Articles were assessed and included in this review based on the following criteria:

- Articles reporting primary research such as quantitative, qualitative and mixed methods.

Excluded articles include:

- Editorial, commentary, discussion papers and systematic reviews.
- Articles published prior to the launch of the iPhone in 2007.

The results of the searches were exported to RefWorks (Legacy Version) and duplications of articles were removed.

3.4.3 Screening of titles and abstracts

I screened the potential titles and abstracts based on revisiting the SPIE framework that I had used to formulate my aims and review questions. My supervisor (SHL) and I reviewed these again before I went on to use a template suggested by Russell (2005) (Table 4) to systematically screen and extract the primary source studies that I went on to review.

Table 4: Example of data selection template

Author, year	Topic	Methods	Outcomes
Chipps et al. (2015)	Using mobile phones and social media to facilitate education and support for rural based midwives in South Africa	Quantitative: Survey via structured questionnaire	41 (73.2%),of respondents felt that the technology was essential for learningMore investment required in the technology

3.4.4 Eligibility of studies

This eligibility selection process excluded any article that did not meet the study criteria. Full texts of potentially relevant studies were reviewed for inclusion if they contained information that met the criteria of this study.

3.5 Stage 3: Data evaluation

According to Whitemore and Knafl (2005), an integrative review deals with a diverse sampling frame. Therefore the quality appraisal tools used will vary. For this review data were extracted from the primary studies and analysed to provide an overview of the application of mHealth in the area of RMCH and in particular to the practice of midwives. Study data extracted includes: author, country, research design, data collection methods, participant characteristics, findings and key messages.

3.5.1 Quality appraisal

I adopted the CASP (Critical Appraisal Skills Programme) checklists (CASP 2017) to screen each of the qualitative and RCT studies selected for review. This enabled consideration of three broad issues:

- Are the results of the study valid?

- What are the outcomes from the study?

and

- Are the outcomes from these studies relevant to this study?

Because CASP does not include mixed methods and quantitative studies checklists, I chose to use McGill University's Mixed Methods Appraisal Tool (MMAT) as described by Jagosh et al. (2012) to appraise these studies.

The results of my appraisals are included as Appendix F check and the level of evidence has been coded using the Scottish Intercollegiate Network (SIGN 2015) grading system where "1++" represents the highest level of evidence down to the lowest level of evidence at "4". I also added these SIGN codes to my table of evidence summary in Appendix F.

I subsequently rejected a mixed methods article (Knoble et al 2015) because its focus was much more on predictive analytics than on providing answers to my research questions. I do however return to cite Knoble et al (2015) in my discussion in Chapter 6.

3.6 Stage 4: Data analysis

Whittemore and Knafl (2005) suggest that this is the most difficult part of an integrated review. In order to overcome this obstacle and from the perspective of someone who is new to academic research, I found it very useful to read and re-read my selected studies in tandem with appraising the studies. The extracted data were summarised in Table 5 (Appendix G). The initial development of themes was based on the review questions and this was further refined and presented in the next stage.

3.7 Stage 5: Findings of the integrative review

3.7.1 Characteristics of included studies

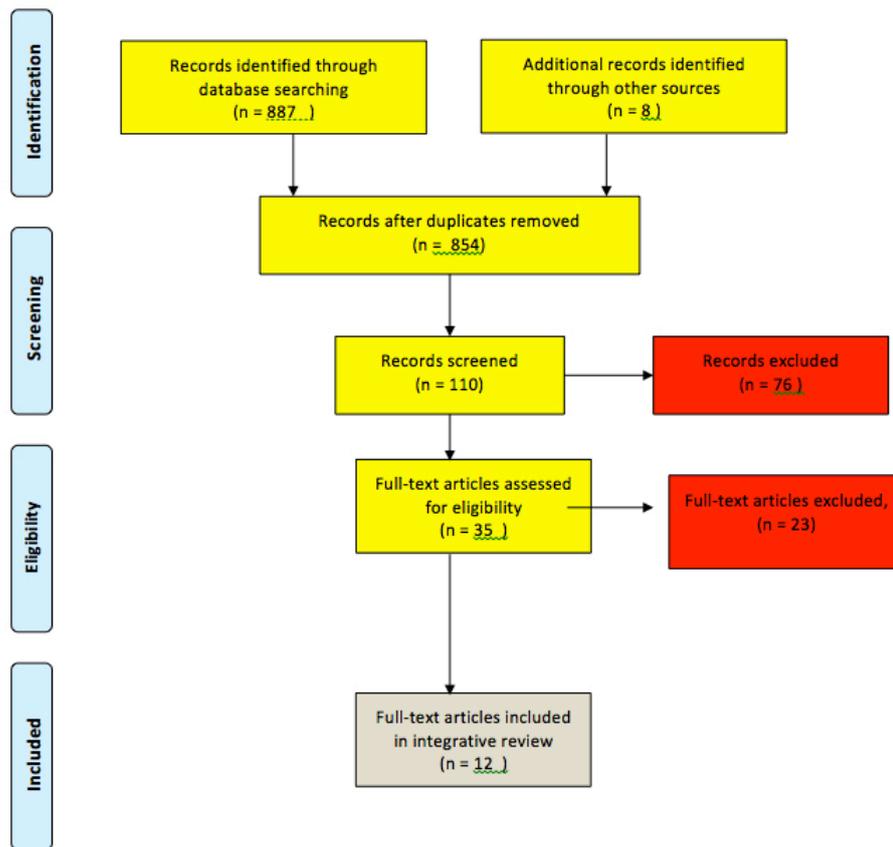
A search of databases revealed 857 relevant articles:

Table 5: Search results

Databases	Number of hits
<u>MEDLINE</u>	<u>462</u>
<u>CINAHL</u>	<u>85</u>
<u>PubMed</u>	<u>91</u>
<u>Google Scholar</u>	<u>249</u>
<u>Other sources</u>	<u>5</u>
<u>Total</u>	<u>892</u>
<u>Duplicates</u>	<u>- 35</u>
<u>Total titles and abstracts for screening</u>	<u>857</u>

The primary source articles are presented as a PRISMA summary (Figure 1) (Moher et al. 2009) and as an analysis of the articles reviewed (Appendix E)

Figure1: PRISMA summary



3.7.2 Types of studies

12 primary source articles were reviewed. They included four qualitative studies ($n=4$) (Medhanyie et al. 2015, Modi et al. 2015, Rothstein et al.2016, and Schoen et al. 2017); five mixed methods studies ($n=5$) (Coetzee et al. 2017, Dalton et al. 2014, Knoble et al. 2015, Lim et al. 2015 and Velez et al 2014); two quantitative studies ($n=2$) (Chipps et al. 2015 and Kaphle et al. 2015) and one RCT (randomised controlled trial) ($n=1$) (Lund et al. 2016).

3.7.3 Country settings

The included studies refer to studies in both high income countries: Australia ($n=1$) (Dalton et al. 2014) and low and middle income countries: Brazil ($n=1$) (Schoen et al. 2017); Ethiopia ($n=2$) (cite the authors); Ghana ($n=2$) (Rothstein et al.2016 and Velez et al 2014); India ($n=2$) (Kaphle et al. 2015 and Modi et al. 2015); South Africa ($n=3$) (Chipps et al. 2015, Coetzee et al. 2017 and Lim et al. 2015). None of the studies identified was conducted in Scotland or the U.K.

3.7.4 Themes

The findings of the literature are: involvement of end-users in developing new mHealth interventions; the acceptability and effectiveness of mHealth interventions and barriers and facilitators to adoption of mHealth interventions.

3.7.5 Involvement of end-users in developing new mHealth interventions

If any product (for example a mHealth intervention) is to be successful, it is important that the intended users are involved in the development stages as early as is practicable.

Four studies advocate midwives and other end-users to be involved in developing mHealth applications (Coetzee et al. (2017); Dalton et al. (2014); Schoen et al. (2017) and Velez et a.l (2014).

Velez et al. (2014, p.130) in particular note that, based on their study of the efficacy of *mClinic* in Ghana: "The design of usable mHealth systems in Ghana and around the world requires input and feedback on needed functionality and an in-depth understanding of the realities of day-to-day clinical practice."

In a mixed methods study in South Africa to examine the use of audio-visual materials on tablets by CHWs to support health promotion in the area of RMCH, Coetzee et al. (2017) make reference to how, despite the ubiquity of the use of mobile devices to deliver what are perceived to be innovative mHealth interventions, there is a very poor level of understanding of both the appropriateness, acceptability (by CHWs and the women in the care) and efficacy of such interventions. The audio-visual materials were generalised across the spectrum of RMCH conditions and not specific to pre-eclampsia.

Coetzee et al. (2017, p.5) found that whilst the intervention described in their study was found by the CHWs to be acceptable in facilitating home visits, there was some frustration and resentment that they (the CHWs) had not been consulted in what they wanted from an mHealth intervention. Coetzee et al. (2017) do not however go so far as to recommend that CHWs are involved in the development of mHealth interventions. Instead they attribute the CHWs frustrations to insufficient training and conclude that in order to improve the efficacy of mHealth interventions it is essential that the training of CHWs is improved.

In the context of a high-income country (Australia) Dalton et al. (2014) conducted a mixed methods study in an urban general hospital about the use of ICTs by midwives. Dalton et al. (2014) describe how their study found that, whilst most participants (midwives) were open to adopting ICTs into their practice, they were at the same time fearful of doing so due to self-perceived lack of skills in the use of ICTs in their practice. This was despite high levels of personal internet use. Like Coetzee et al. (2017), Dalton et al. (2014) attribute this fearfulness to a need for midwives to be better trained in how to use ICTs in their practice rather than involving midwives in the design and development of mHealth interventions.

However, Schoen et al (2017) in their qualitative study explored community health workers' use of mHealth tools in home visits. The authors argued that it is only by having CHWs involved in the design and development of new

mHealth interventions that developers will arrive at user-centred design (UCD) solutions. Furthermore, Schoen et al. (2017) contend that it will only be by developers adopting a UCD methodology that new mHealth interventions can be culturally appropriate to meet the needs and expectations of users.

This preponderance of studies in LMICs may reflect the high levels of investment by Aid Donors (e.g. DfID, USAID and the Gates Foundation) in mHealth interventions. Frotell et al (2014) attribute this investment to a combination of many developing countries having embraced mobile telephony ahead of developed countries and a widely held belief that mHealth interventions can transform healthcare in LMICs in ways that are not required in developed countries. Frotell et al (2014) do however caution that too many pilots of mHealth interventions in LMICs are not followed up by rigorous evaluation.

In summary, the analysis of this theme bears out the need for end-users, midwives and other healthcare practitioners to be involved in developing mHealth interventions.

3.7.6 The acceptability and effectiveness of mHealth interventions

All twelve authors of the studies reviewed, wrote of the need for end users of mHealth interventions to find such interventions to be acceptable before, in turn they could be effective.

In their mixed methods a South African study on the "Usability and feasibility of PIERS on the move (PotM): an mHealth app for pre-eclampsia triage", Lim et al. (2015) state that in their view, the ease of use of mHealth tools is very important in how they are perceived and likely to be used by the healthcare practitioners at whom they are aimed. The authors described the acceptability by CHWs of the *PotM* app as a low-cost, easy-to-use, mHealth application that has been designed to accurately predict the risk of the

adverse outcomes associated with pre-eclampsia in pregnant women. The developers of *PotM* applied UCD methodology to test it and run a clinical evaluation with midwives in an urban hospital setting. No CHWs were involved in that process. However the objective had been to adopt an iterative development schedule to introduce the tool to CHWs.

Lim et al. (2015.) describe *PotM* as a cross platform (Apple IOS and Google Android) app that has been designed to run on CHWs' own smartphones. The majority of the participants, all of them women, in the *PotM* study were aged between 31 and 50 years of age. Most were experienced users of mobile phones. Lim et al. (2015) report a number of challenges around the usability of *PotM*. These were mainly associated with the size of screens and touch screen controls and were in line with the experience that many people have when first using a new type of smartphone. These challenges were largely overcome as the participants (midwives) became more experienced and adept in the use of the technology and the participants rated the usability of *PotM* as "high".

Yet, Lim et al. (2015) caution that *PotM* was not tested with the user group that it was designed to support – less well-educated CHWS in rural settings in South Africa. As such Lim et al. (2015) concede that this crucial omission may place limitations on the generalisability of their findings.

Another South African quantitative study by Chipps et al. (2015), "Using mobile phones and social media to facilitate education and support for rural-based midwives in South Africa". The targeted end-users comprised 56 midwives who were studying advanced midwifery at a university, reported that:

- 23 (41%) midwives found the technology easy to use.
- 43 (76.8%) respondents reported that laptops were effective for learning, followed by 41 (73.2%) for SMS.

- *Only 22 (39.3%) respondents reported phones were effective for learning.*
- *41 (73.2%) respondents said technology was essential for learning.*

Chipps et al. (2015) ascribe these statistical paradoxes, whereby over 70% of respondents said that technology was essential for learning yet only some 40% reported that mobile phones were effective for learning, to tensions around the widespread personal use of mobile phones by the participants and the way that they were being asked to assess mobile phones as a technology that might support their practice. This would enable access to relevant learning materials, such as may be available on a number of eLearning platforms or by internet searches.

Chipps et al. (2015) also noted that some participants were confused about the differences between “traditional” 2G mobile phones and smartphones. Chipps et al. (2015) conclude their study with the suggestion, that for the technology to be fully understood and therefore more acceptable, that training on the use of mHealth interventions (using smartphones) requires to be embedded in educational institution courses.

Lund et al. (2016)’s RCT study in five rural districts in Ethiopia investigated the association between the safe delivery and quality of care and perinatal survival. Their study describes the introduction of the app to the practice of CHWs. Lund et al. (2016)’s main aim was to assess the effect of the *Safe Delivery* app on the number of perinatal deaths. They found that the intervention made an insignificant difference across their control groups.

Although as an unintended outcome of their study, they found that the introduction of the *Safe Delivery* app improved the CHWs knowledge and understanding of the skills described in the “*safe delivery app*”. I would deduce that that finding is still relevant to the current study despite the

neutrality of Lund et al. (2016)'s overall findings and the significant contextual differences.

By comparison, Rothstein et al. (2016) conducted a qualitative assessment of the feasibility, usability and acceptability of a Mobile Client Data app for a community-based maternal, neonatal and child care project in rural Ghana, and are explicit in their conclusion that: the use of mobile devices has the potential to help to mitigate the inequalities in access to and the provision of primary health care.

The authors' unequivocal assertion is based on their value judgement that health care workers will respond better to new mHealth interventions if they have been involved in the design and development of such interventions. Moreover Rothstein et al. (2016) argue that developers of new mHealth interventions need to build on the confidence that they discovered among CHWs to ensure that new mHealth interventions meet the needs and expectations of users.

In summary, the above theme describes how if the confidence in the use of mHealth tools noted by Rothstein et al. (2016) can be built among end-users, then such confidence could do much to allay some of the barriers to the adoption of mHealth tools described in this study.

3.7.7 Barriers and facilitators to adoption of mHealth interventions

This theme describes some of the barriers and facilitators to the adoption of mHealth tools and how these can vary in different cultural and socio-economic contexts.

Lim et al. (2015) noted that the major barrier during the testing of the *PotM* app by CHWs related to the ease of use of the touch-screen features on their own smartphones. These difficulties were attributed to the small size of the touch-screen controls and navigation buttons. This was largely overcome with training and practice that led to much improved dexterity on the part of the

CHWs. This issue would be far less likely to occur using tablets with their larger touch-screens.

Kaphle et al. (2015) conducted a qualitative study in India on the "Adoption and usage of mHealth technology on quality and experience of care provided by frontline workers: observations from rural India". This study describes the development of a framework to assess whether the introduction of a mHealth intervention (the Comcare app) could affect the quality of care provided by CHWs and whether the introduction of a mHealth tool might be acceptable to the CHWs. All the participants were women with a low level of education. Kaphle et al. (2015) acknowledge a number of limitations, not least a small sample size and that their measure of the quality of the home visits by the CHWs (ASHAs) was able to capture data with minimum bias.

Kaphle et al. (2015) cite the main barriers to the adoption of mHealth interventions in LMICs as poor education among practitioner groups such as CHWs (ASHAs), an unfamiliarity with using smartphones and like Lim et al. (2015), they note that users reported that the size of the controls and navigation buttons made the app difficult to use. Significantly, Kaphle et al. (2015) also point to the poor supervision of the CHWs (ASHAs) as a fundamental barrier to the successful implementation of mHealth interventions.

Another qualitative study within the Indian context by Modi et al. (2015), developed and evaluated an innovative mHealth intervention for improving coverage of community based maternal, newborn and child health services in rural areas of India. They evaluated the InTeCHO app that was introduced to help bridge the gaps in care that resulted from the poor supervision of CHWs (ASHAs) described by Kaphle et al. (2015). This raises the issue that supervision of CHWs (ASHAs) would seem important to any successful implementation of a mHealth intervention.

Modi et al. (2015) also report that in order to facilitate the introduction of InTeCHO, it was first necessary to provide in-depth training for the CHWs (ASHAs) in how to use InTeCHO. A further barrier was that none of the CHWs (ASHAs) owned smartphones and that these required to be purchased for them. Dual SIM smartphones were chosen to separate professional and personal usage. Modi et al. (2015) point out that a permanent solution to this dual problem of the cost of providing smartphones and paying for data must be overcome for projects such as their study reports on, are to be sustainable.

Modi et al. (2015) also point out that despite the use of mHealth interventions becoming common, the literature on their efficacy is sparse. Modi et al. (2015) suggest that there is a need to ensure that there is robust evidence that interventions are being developed to meet a real need in the area of RMCH and not as a means to an end in itself. The lack of such evidence is in itself a barrier to the adoption of mHealth solutions.

In Medhanyie et al. (2015)'s quantitative study, 23 CHWs (HEWs) were tasked with and evaluated on submitting at least three electronic health records of pregnant women over a six-month period using smartphones. A key facilitating and motivational factor was that the CHWs were able to use these smartphone for both professional and personal purposes. The main barrier to adoption of the intervention that Medhanyie et al. (2015) recorded, was that most of the participants in the study found the process of filling out electronic forms to be too time consuming and reverted to filling out paper forms. Additional barriers included the smartphones freezing, difficulties with user name and password settings and running out of money to top up pay-as-you-go time on the phones. In addition, Medhanyie et al. (2015)'s analysis showed that the CHWs (HEWs) were using 90.2% of the value of their top up vouchers on (personal?) voice calls. These resource barriers could seriously impair the efficacy and sustainability of the mHealth intervention if it was taken to scale.

In Medhanyie et al. (2015)'s qualitative study of the same intervention, similar findings in respect of facilitators and barriers to adoption were found. However in their second study, Medhanyie et al. (2015) added that as a prerequisite for taking the intervention to scale, the mobile network coverage would need to be improved at considerable cost.

In summary, this theme illustrates how good or poor design, affordability or unaffordability of mobile devices and mobile data costs are the major barriers and facilitators to the successful adoption and scalability of mHealth interventions.

3.8 Chapter summary

The integrative literature review has found several consistent themes emerging from the literature:

The ubiquity of mobile devices is connecting people in a way that creates opportunities to develop new approaches to healthcare. There is however a need to base these new mHealth interventions on well-researched evidence that has been monitored and evaluated. Importantly, there is a need to involve end-users (practitioners and women) from the outset in the development of any mHealth interventions.

The review of the literature found little evidence of mHealth interventions in the area of RMCH where midwives are cited as being members of any development teams. The literature search revealed only *PotM* as having been the subject of peer reviewed primary research.

An additional search of the grey literature was undertaken. This found a website of the Danish Maternity Foundation which describes the *Safe Delivery* App. The Danish Maternity Foundation has developed the app in association with leading Danish specialists in obstetrics and paediatrics to support CHWs in LMICs. During the time of this study it had not been designed to support midwives at remote locations in a developed country. Nor does the website

make any mention of the intended end users in Sub Saharan Africa as having been involved in its design. This may explain Lund et al (2016)'s neutrality around the efficacy of the *Safe Delivery* app in their RCT in Ethiopia.

I found no references to any peer reviewed evidence-based studies in Scotland or elsewhere in the UK on the introduction of mHealth interventions to support midwives in rural and remote locations. This current study aspires to fill some of these gaps in the literature.

Following this integrative review of the literature, the research questions, methodology and methods will be addressed in the next chapter.

CHAPTER 4 – Research methodology

4.1 Introduction

The previous chapter provided a critical examination of the literature and highlighted gaps in the published literature generating questions that required further research. This provides the justification for this study. Based on the research questions the conceptual framework was developed to inform the methodology and subsequent research design. This chapter reports on this process and also presents details of the ethics approval process and measures undertaken to ensure trustworthiness and rigour to this study.

4.2 Conceptual framework

This study is about the ways in which midwives practice within a complex, ever changing contextual reality – the who, the what and the where of their practice in rural and remote Highland Scotland. Following discussions with my supervisors, it was decided to adopt a qualitative descriptive approach. As a project focussed on human inquiry, a qualitative descriptive methodology was deemed to be the best fit for this study. The methods adopted were designed to ensure that the voices of the participants in the focus groups would be clearly evident throughout my findings, discussion and conclusions.

From a philosophical perspective I have based this study on a methodology that is empirical, based on evidence that I both observed and recorded. I wanted to find out whether the adoption of a mLearning/mHealth toolkit such as described in Chapter One, might both meet a healthcare need and be acceptable to midwives in rural settings where there is no internet connectivity. I sought to open up conversations with the midwives whereby they would share their experience of practising in remote and rural settings to expose me to new knowledge that would in turn provide answers to my research questions.

Deery et al. (2015) place their own qualitative research into midwifery practice within a sociological context and caution researchers to always aim to place no value judgements on participants and to remain emotionally detached from the feedback they receive from participants.

Thus whilst facilitating my focus groups I required to be sensitive to participants and to the relevance of my presence in the room facilitating the conversations. Moreover, it was important for me to acknowledge the life experiences of the participants and that they had the right not to cooperate. I needed to honour and be non-judgemental in respect of any differences of opinion. It was important to minimise contamination by introducing any bias resulting from my own experiences as a lay researcher or indeed as the potential developer of a mLearning/mHealth toolkit such as was the subject of my conversations with the focus group participants. I go on to describe and analyse these in Chapter Five.

4.3 Aim and research questions

The aim was to discover whether a new mLearning/mHealth toolkit that is designed to support midwifery practice in remote and rural locations in Highland Scotland could:

1. Be acceptable and useful to rural midwives in detecting, managing and making timely referrals in respect of women presenting with possible pre-eclampsia?

and

2. Offer any advantage and/or improvement over current practice?

4.4 Methodology

The decision to adopt a qualitative descriptive methodology was based on the blend of empiricism and reflexivity previously described. It is supported by

Sandelowski (2000) who describes qualitative descriptive research as a methodology that frees researchers from the encumbrance of pre-existing theories and philosophies. As such it can be considered eclectic. Nonetheless qualitative descriptive research requires to be firmly grounded in a well-thought-through process of sampling, data gathering and analysis (Sandelowski, 2000). That is to say, it needs to be based on verifiable empirical evidence, acquired from primary research in the field.

In a subsequent editorial (Sandelowski, 2008, *Research in Nursing and Health*, 31, 193-195) the author reflects on how she justifies her approach to qualitative descriptive research and how:

Modes of inquiry have no strengths or weaknesses except in relation to specific standards or definitions of strong and weak.

Instead Sandelowski, (2008) advises researchers to avoid any ranking of data or bias in their studies.

In this study I needed to ensure that a qualitative descriptive approach would be the best suited to address the research questions and that any conclusions drawn from the gathered data would accurately reflect the participant accounts. I required to reflect on the evidence I gathered in order to extract data that would answer my research questions.

Brockbank and McGill (2007) conjecture that the essentials of reflection are:

1. A genuine situation or experience within that situation – in the instance of this study, stories told by the midwives about outcomes relating to women who have presented to midwives as being possibly pre-eclamptic.
2. A genuine problem within that situation – there are dual challenges of geographic and digital isolation, exacerbated by the midwives in the study having to travel to see the women in their care.

3. Information and observation about the situation - qualitative evidence gathered from the recording of conversations at focus groups.
4. Suggested solutions for which the researcher will be responsible – discussion (Chapter Six) based on analysis of the data gathered at the focus groups.
5. The opportunity and occasion to test ideas by application, to make the meaning clear and discover for oneself their validity. This may provide opportunity for further study based on that discussion. In Chapter Seven, I describe the development of the prototype of a mLearning/mHealth toolkit and the opportunity to test this with a multidisciplinary team of healthcare practitioners in a very remote area of Highland Scotland.

As such this study engages with each of Brockbank and McGill (2007)'s "essentials".

4.5 Ethics

To protect participants and ensure robust research governance, ethical approval of this study was required by, sought from, and granted by RGU's (RESSA) and School of Nursing and Midwifery Review Panel (SERP) (Appendix C). Ethics approval was also subsequently gained from NHS Highland R&D (Appendix D). This also involved an application for and granting of, an NHS Research Passport since I was not an NHS employee.

As part of my learning about ethics application processes, I participated in Aberdeen University and NHS Grampian ethics CPD course in September 2016. In addition, in November 2016, I attended the Good Clinical Practice (GCP) for Researchers (non-drug) and was awarded 1 (external) CPD credit.

Given my background as a lay researcher, attendance at both these courses provided me with valuable insights as to how I required to conduct my research within an ethical framework.

In consideration of the ethical implications on this research, a number of factors needed to be taken into consideration in order to protect both the participants and me.

The fair and ethical treatment of all participants was ensured through honesty and transparency even where this might have turned out to be detrimental to the objectives or completion of the study. All the participants were provided with an information leaflet prior to recruitment (Appendix I). The information sheet outlined the scope of the project and explained how personal information would be kept confidential; their personal details anonymised and only held on a secure computer at RGU. The information sheet was provided to participants with ample time (2 weeks) to allow for reflection before signing a written consent form. (Appendix K.4).

Once they had agreed to participate in the study, had read the information sheet and agreed to participate, an informed consent form was signed by each participant prior to any audio recording of the focus groups.

The recorded data was solely for the use of this study and although confidentiality cannot be absolutely assured, all identities have been anonymised in the transcriptions of the feedback and study by using alphabetic place names and use of alpha-numeric pseudonyms. The recordings have subsequently been deleted and the new transcribed information has been stored on a password-protected computer at RGU. RGU data policy recommends all research data be kept on a secure data base on the university server and be password protected for 10 years. No data was kept on any mobile device (recording equipment, memory stick, external hard drives, mobile phones or lap top computers). Only my supervisors and I had access to this data during the study.

The research has been conducted in compliance with the General Principles of the World Medical Association (WMA) Declaration of Helsinki with particular regard that,

The right of research subjects to safeguard their integrity must always be respected. Every precaution should be taken to respect the privacy of the subject and the confidentiality of the patient's information"

(Bulletin of the World Health Organisation, 2001 p. 374).

The study has also adhered to the core principles of the Economic & Social Research Council (ESRC) (ESRC Framework for Research Ethics, 2015) that, participant in research studies must be informed fully about the methods, purpose of the research and what, if any, risks, are involved. Importantly participation must be free from any coercion.

It was also possible that I might have come across examples of poor or insensitive practice by midwives in their management of women with pre-eclampsia. I did not encounter any such instances. Had I done so, I would have sought advice primarily from my research supervisors at RGU and then, as needed, from the Supervisor of Midwives in NHS Highland.

There is a joint commercial interest based on an Agreement between NHS Highland R&D and my employer, Interactive Health Ltd. This is in respect of both the potential for licensing any tool that may be developed (as an outcome of this study) to the NHS in England and Wales and the NHS in Northern Ireland and taking it to scale globally (Appendix H). This was made explicit in my ethics applications and to managers in NHS Highland and to the midwife participants.

4.6 Methods

I expected that variables that might affect my findings could arise from the locations where I chose to conduct my research. Highland Scotland may be largely rural and remote but the nature of this rurality and remoteness is not homogenous. Variables include remote communities that are accessed over high mountain passes on single track roads as well as 23 inhabited islands that can be cut off from the mainland for days at a time by severe gales during winter.

I choose to use focus groups as my method of collecting data and to compensate for the variable nature of the geography of Highland Scotland, I selected three quite different locations in which to hold my focus groups. Thus I would avoid a particular topography, such as remote islands, skewing my findings.

4.6.1 Recruitment of participants for focus groups

Pajares (2007) suggests that focus groups can be considered as interactive social gatherings. As such focus groups can initiate conversations that elicit a diversity of views that enable researchers to gather a large amount of information in a short period of time. Focus groups were thus adopted as the optimal way to gather data for this qualitative descriptive study. After discussion with my supervisors it was decided that there should be a minimum of five and a maximum of 10 midwives in each focus group.

At each focus group, some midwives would be present in person and others participated via video conferencing (V.C). In the event between 2 – 3 participated in person and 2 – 5 via V.C. (Table 6, p. 65)

My adoption of focus groups as the means of gathering the data for this study, involved recruiting and engaging with three groups of midwives from different rural locations across the NHS Highland area.

Because of the complexity inherent in engaging with an on call professional group that works on the move in a rural and remote region, the recruitment of midwives in Highland Scotland required several steps. I began by eliciting the support of the Research and Development Manager in NHS Highland and the Head of Midwifery in NHS Highland. Their support enabled me to run an initial "town hall" meeting followed by two video-conference (VC) sessions based at NHS Highland Research and Development's offices in Inverness. These were followed up with the circulation (via email) of flyers and posters to all midwives working in NHS Highland (Appendix J&K).

4.6.2 Focus groups and setting

I held the focus groups at three geographically and demographically diverse locations. In selecting the locations from which to draw participants and thence where to hold the focus groups, I wanted to choose areas with quite different geographies. Thus Location "I" is rural, yet within a 60 minute drive from centre of population of more than 10,000 residents. Location "O" is more than a 60 minute drive from any town with a population of more than 10,000 people and includes 23 inhabited islands. Location "S" is a large geographic area that is made up of scattered villages and small towns, all of which are more than a 60 minute drive away from any towns with populations of over 10,000 people. These varied locations avoided a particular topography, such as remote islands, skewing my findings.

These different geographies each brought a different dynamic to the conversations at the focus groups. Location "I" for example was within a 60 minute drive from a general hospital; midwives at location "O" could sometimes spend much of a working day travelling on ferries whilst those working at location "S" could be faced with journey times of up to 4 hours for patient transfers and sending blood and urine samples to be tested.

I also required to take account of how Barbour (2007) describes the strengths and weaknesses of using focus groups as being able to quickly elicit

a variety of views on a topic, whilst at the same time recognising that these eclectic points of view can give rise to some confusion around how researchers classify the data gathered from the participants at focus groups.

The Focus Groups took place at NHS Highland premises at the three locations that were mutually agreed with participants at suitable times within their working days on the 13th June 2017 the 22nd of June 2017 and on the 23rd June 2017. I have anonymised the locations. This is on the basis that not doing so could easily identify participants who work in a region in which health care providers are highly visible.

The sample size was 18 out of a population of 332 midwives. The midwives who had agreed to participate in the study, work across a challenging geography. As such not all were able to attend the focus groups in person. All these midwives were, however, familiar with using NHS Highland's video conferencing (VC) system within their rural practice roles. This was successfully utilised to enable midwives from more remote locations to join the focus groups.

Table 6: Distribution of Focus Groups

Location	Geography	Total number of midwives	Number present at location	Number present via video conferencing
Location I	Semi Rural	4	2	2
Location O	Remote and Island	5	3	3
Location S	Remote	8	3 + 1 student observer 1 participant left to attend a woman in her care	5
Totals		18	8	10

Planning for the focus groups required:

- Preparing examples from the Well@Work suite of NHS Healthy Working Lives apps in order to introduce participants to mHealth
- Developing indicative questions for the groups based on the literature review that comprises Chapter Three of this study (see below)
- Agreeing venues/locations of the focus groups
- Agreeing what time was available to enable midwives to participate during their working day

It was agreed in advance with the participants that I would be responsible for arranging:

- Venue
- Time – in line with participants' working days

- Refreshments + sandwiches if at lunch time
- Preloaded ppt and examples
- Projector (HDMI cable)
- White wall for projection purposes
- Local administrators would set up VC to enable midwives to participate remotely

I was conscious that by taking on the role of sole facilitator, I might be perceived by some participants as incompatible with my position as someone with a commercial interest in developing a mLearning/mHealth toolkit as an outcome of this study. Moreover it could have affected the dynamic of each focus group in a way that impacted negatively on the data.

I was therefore very careful not to allow any personal bias to affect the neutrality of way in which I facilitated each of the focus groups. I believe that was able to maintain this outcome agnostic position throughout this study.

In advance of the focus groups, I prepared indicative questions to facilitate conversations and to ensure congruence in the feedback from the three focus groups:

1. What are the main challenges to your practice in a remote/rural area?
2. What do you understand by the terms mobile health or mHealth (Showing some examples, including an outline of what the tool might contain based on IHL's award winning Well@Work programme that was developed for NHS Healthy Working Lives)?
3. Do you think that an mHealth intervention such as is envisaged, could be of any help to you in your practice in managing and supporting women who present with symptoms of pre-eclampsia. If not why not?
4. What concerns or fears might you have about using something

like a mLearning/mHealth toolkit in your practice?

5. What features /functions might you most like to see in such a toolkit?
6. How might you see yourself using such a tool in your practice?
7. Is there anything else that I have not covered you would like to raise?

To help facilitate these conversations, I showed the participants examples of the health and wellbeing apps that I have been involved in developing for NHS Health Scotland. I considered introducing the participants to the *Safe Delivery* app, but on further reflection, I decided that the graphic style (depicting CHWs in Sub Saharan Africa/South Asian contexts) might skew the conversations due to not being contextually specific to the participants in Highland Scotland. This in turn helped to establish common ground around the participants' understanding of what constitutes mobile health and mobile learning.

4.7 Data management and analysis

The focus groups were recorded and the data transcribed, coded and thematically analysed to determine what the participating midwives found useful and wanted from a tool such as is envisaged.

Barbour (2007) advises that excerpts from transcriptions should not be taken out of context or presented in isolation. Barbour, (2007) also recommends that researchers, as part of managing the data that they gather from focus groups, should reflect on their own reactions to that data before going on to analyse the data.

Krueger (1998) suggests that the analysis of data from focus groups differs from the way in which data collected using other qualitative methodologies is analysed. Analysing this data poses challenges for researchers, not least the amount of data that it generates. For example, a recording that lasts for one-

hour can easily take up to six hours to exactly transcribe. Forward planning and posing the “right” questions helped to mitigate any problems that could have arisen from these challenges.

I adopted Thematic Analysis as the means of analysing the collected data. This was based on Braun and Clarke (2014)’s phased approach to Thematic Analysis:

1. *Searching for themes*: coding of the data enabled me to develop five themes that were relevant to my research questions and then to collate the coded data that related to each theme. At this stage, I provided a PowerPoint presentation (Appendix R) to my supervisors that led to further interrogation and refinement of the themes as
 - Working in isolation
 - Recognising and dealing with women with pre-eclampsia in rural and remote settings
 - Learning on the move
 - Using audio visual resources
 - Feeling uneasy with advances in technology
2. *Coding*: I coded every data item and ended this phase by collating all the codes and relevant data extracts. This was frequently discussed with the supervisory team until consensus was reached amongst the research team (Appendix M). Further trustworthiness of the final themes was obtained through presentation of study findings within postgraduate research forums where others could pose further questioning about the themes as they emerged. This helped refine how they were finally presented in the thesis.

Throughout the Thematic Analysis, I posed myself the following questions:

- What have I discovered?
- Are the findings something I knew already, or is it new?
- If not, how does this information alter my perspective?

- What else do I need to know?
- What insights have I gained?

These questions helped me to integrate the data systematically and draw out new understandings. I discuss my answers in Chapter Six.

4.8 Trustworthiness

Shenton (2004) contends that researchers must be able to demonstrate that they are presenting a true picture of the phenomenon they are investigating. Shenton (2004) also argues that research findings should be presented in such a way that another researcher could replicate it as the basis for future research.

Transcripts of the recorded data are available and can be scrutinised upon request by bona fide academic researchers to RGU.

The recorded data was solely for the use of this study and although confidentiality cannot be absolutely assured, all identities have been anonymised in the transcriptions of the feedback and study by using alphabetic place names and use of alpha-numeric pseudonyms. The recordings have subsequently been deleted and the new transcribed information has been stored on a password-protected computer at RGU. RGU data policy recommends all research data be kept on a secure data base on the university server and be password protected for 10 years.

Particular care was taken to ensure that my findings in this study stem only from the data collected at the focus groups and not from my own pre-understandings and commercial interests.

All findings, themes and sub-themes were discussed with the supervisory team and debated. The themes and sub-themes were developed and repeatedly refined through an iterative process until the final themes and sub-themes were a plausible representation of the practice reality and voices

of the midwife focus groups. For example the theme of “Working in Isolation” and the sub themes of geographic and digital isolation were based on the participants’ responses to the question,

What are the main challenges to your practice in a remote/rural area?

Their answers about both digital and geographic isolation being real challenges to their practice, provided trustworthy evidence to support my findings.

Barbour (2007) cites Macnaghtan and Myers (2004) as reflecting that such trustworthiness is underpinned by:

the sense of authenticity conveyed by the colloquial words on the page and supported by an audit trail of coded transcriptions and audio recordings.

The key was to ensure the findings were supported by the data and that any insights and conclusions were plausible and directly derived from the descriptive data: that is to say they provided trustworthy empirical evidence to support my findings.

4.9 Chapter summary

In this chapter, I have explained how I developed the methodology and put into practice the methods I used to underpin the integrity of this study. I also presented details of the ethics approval process and measures undertaken to ensure trustworthiness and rigour in the study.

In the next chapter the findings of the study are presented. Each theme and corresponding sub-theme is presented along with supporting data from the focus groups.

CHAPTER 5 – Findings

5.1 Introduction

This chapter presents the findings from the three focus groups each of which comprised between 5-8 midwives. The total number of rural practice midwives was 18, all of whom were female. Their age was not recorded and was not deemed relevant to the aims of the study. All participants were currently working across three remote areas in Highland Scotland and employed by NHS Highlands. The length of midwifery practice among the participants ranged from 5 to 25 years.

Analysis of the data highlighted five main themes: 5.1) Working in isolation; 5.2) Encountering women with pre-eclampsia in remote and rural settings; 5.3) Learning on the move; 5.4) Using audio-visual resources and 5.5) Feeling uneasy with advances in technology. Each of the themes was further divided into subthemes as shown in Table 7.

Table 7: Themes and sub-themes

Theme	Sub-Theme
5.1 Working in isolation	5.1.1 Geographic isolation
	5.1.2 Digital isolation
5.2 Encountering women with pre-eclampsia in rural and remote settings	5.2.1 Recognising pre-eclampsia
	5.2.2 Assessing and dealing with pre-eclampsia
5.3 Learning on the move	5.3.1 Facility to study on the move
	5.3.2 Staying updated
5.4 Using audio-visual resources	5.4.1 Making pre-eclampsia less scary
	5.4.2 Stimulating the senses
5.5 Feeling uneasy with advances in technology	5.5.1 Feeling professionally compromised
	5.5.2 Fear of change

5.1 Working in isolation

It is unsurprising, given the population being studied, that the first major theme to be highlighted in the data was concerned with working at a distance from substantive infrastructure and concerns about access to robust digital connectivity. Working in isolation can be described as a social phenomenon. In the case of the participants it was a sense of being cut off from specialist obstetric clinicians' support. This sense of disconnection revealed two sub-themes: Geographic isolation (5.1.1) and Digital Isolation (5.1.2).

5.1.1 Geographic isolation

The sub-theme of "geographic isolation" was described by participants as difficulties in referring pregnant women with pre-eclampsia for specialist care. For example a midwife working at a remote location in the north west of Scotland describes the challenges of this physical distance from the hospital:

For us it's distance. I would say, you know, your transfer times and things like that to a general hospital and distances between visits sometimes as well cause it's a wide geographical areas so, that's one of my thoughts anyway.

(Midwife 2, Focus group S)

The above account highlights how midwives working in remote and/or rural settings found that it took much more time than in urban locations, to transfer pregnant women to the nearest hospital or to carry out home visits.

Another midwife working at a similar location further highlights this sense of professional isolation when describing the challenges of communicating with others in the maternity care team who are working at a distance from her:

Yeah, I'd also add that it's difficult sometimes to communicate your concerns effectively to the clinicians that you're talking to on the phone. Obviously you've got the patient in front of us and we're

telling them what our findings are but sometimes it's difficult to get across exactly what's going on to somebody on the phone who doesn't appreciate it but what kind of area, remote and rural you are.

(Midwife 4, Focus group S)

This suggests that midwives sometimes found communicating their concerns to the specialist obstetrics team to be difficult due to their colleagues, based at an urban location, not having worked at a remote location and perhaps never having visited such a location. This highlights the sense of inadequate support that some midwives have reported.

Midwives require 24/7 access to tertiary services for obstetric and neonatal specialist services. It is therefore crucial that pathways of communication remain constantly open for consultation and referrals to be done with ease. However at times this can be challenging for rural midwives. One of the midwives describes her experience:

Yeah, I was just saying that the main challenges we have is, you know, if we pickup somebody with symptoms of pre-eclampsia, is communicating with the medical staff and, so, nine out of ten the woman does have to attend the day unit for review. There's not really, we're kind of limited to what we can, can actually do in the community cause, you know, even transporting bloods in is not, you know, doesn't happen quickly so...

(Midwife 2, Focus group I)

This midwife's narrative highlights the challenging process of assessment and referral of pregnant women in a rural setting with pre-eclampsia to a specialist centre. Her frustration is evident. Yet it is only the beginning of what can be considerable ongoing challenges for remote and rural midwives to expedite effective care when local resources are limited. The quote emphasises the degree of inconvenience that results when blood samples

cannot be tested near to the woman's home, or the midwife's base and have to be transported long distances to be tested in specialist laboratories.

The concerns around geographic isolation are highlighted repeatedly throughout the data. Descriptions are given about transport and travel difficulties being constant challenges. A midwife from another location described how she faced such challenges:

Decision making is a big challenge because it's not just about your clinical assessment you're making. It's all of these elements, you know, yeah, the best made plans, you want to get her from here to here but it's all of these elements that you have to take on board to make that happen and it could be that your road's closed and you're having to go another 60 miles along a diverted route, and our colleagues in the referral centres don't get that concept and the geography of and, so that's a challenge.

(Midwife 3, Focus group O)

This account indicates that midwives have to make decisions and that these decisions may have to be changed at very short notice due to unforeseen circumstances. Road traffic accidents and landslides, for example, are not uncommon and can lead to road closures with long diversions on single-track roads with passing places. Such incidents may often be outwith the experience of colleagues in the specialist teams in urban centres, who might not consider the implication that a 60 mile diversion in such conditions could add more than two hours to a journey.

The same midwife then went on to express her concerns how the distance from specialist centres can affect the ongoing management of the women who are referred to these centres:

I think where the challenges are is the distance to our specialist centres and that, you know, if it's on going management of these

women once they're diagnosed, it's then, you know, feeding back and forward to the consultant cause quite often they could be diagnosed in a big unit and then they come back to the local communities and then they're managed to a point where they're either delivered or whatever, so that's probably where the challenges are...

(Midwife 3, Focus group O)

This midwife is emphasising how distance can continue to be a challenge throughout the remaining weeks of a woman's pregnancy after she has been diagnosed with pre-eclampsia. This ongoing challenge of distance is likely to affect a decision by the midwife and the specialist team as to whether the woman's condition is managed in a hospital or at home with regular trips to the hospital for check-ups. An assessment of the woman's family circumstances may also affect the decision.

Unpredictable weather can cause further challenges for rural midwives when attending or referring women who require specialist care. In particular snow and gale force winds can leave women (and indeed the midwives who are attending them) cut off on islands. A midwife working in an area that includes a number of islands sets the scene:

...but everything's dependent, if you're transferring somebody, on actually being able to access a means of transport. Whether it's ambulance, different areas have different challenges with being able to access that but, for example, in one coastal town there's only two ambulances, one for the town, and one that will go and transfer so there is always that, that can always be a challenge and again, for the islands, you're looking at air transfer so again it's, that while they are very good at responding, the air transport, it depends on availability, weather and everything else so that can mean that things can longer than you would like."

(Midwife1, Focus group O)

That account reflects how the unpredictability of the challenges faced by midwives depends on where they are based. Some of the challenges include travelling long distances, road conditions, sea conditions and the availability of ambulances or transport by air. The same midwife pointed out that severe weather could sometimes lead to a series of unintended consequences:

Weather, weather is part of the transport challenges, especially if it's an air transport, they can only fly if the weather's permitting, they can only land if the weather's permitting so, obviously that's a challenge, I mean that can be, and even if they do get in there it's, you know, we'll have transfers that are aiming to end up in Glasgow but they end up in Ayrshire and getting transported in by road, which adds to the delay.

(Midwife 1, Focus group O)

This account further highlights why rural midwifery decision making is crucial when dealing with life threatening conditions such as pre-eclampsia in remote and rural areas. Assessment in such circumstances requires midwives to take account of the obstacles that could require to be overcome in respect of accessing the emergency services and transport that could add to the delay in women receiving the most appropriate treatment.

The sub-theme of geographic isolation illustrates how the challenges faced by midwives working in rural and especially in remote locations, face challenges that are over and above those faced by their peers who work in or close to urban centres. In particular these challenges include lengthy journey times associated with the distance from hospitals, extreme weather and variable road conditions. These challenges are exacerbated by a perception among the midwives that their colleagues in urban-based specialist centres have little personal experience of these challenges and that therefore they do not fully understand the clinical implications that arise as result of the challenges.

5.1.2 Working in digital isolation

For the purposes of this sub-theme, the term digital isolation refers to the challenges around connecting to mobile phone networks as midwives predominately work in the community and are constantly on the move by car, often many miles away from their base. One midwife expressed her views on mobile phone connectivity in Highland Scotland as:

Mobile reception is patchy at best, I would say.

(Midwife 5, Focus group S)

Her comment is short and to the point. It is stated as if this is a truth which is self-evident to anyone who has travelled around Highland Scotland. It is certainly the experience, over many years, of my friends and colleagues.

Some of the participants in the study expressed concerns that the digital (ICT) technology (VC and mobile phone connectivity) to support their frequent non-face to face professional collaborative communications might fail. As two these midwives explained:

...I think there's black spots everywhere you go, you know, I imagine that's the same for the majority of places but, yeah, you would just use the woman's landline.

(Midwife 3, Focus group I)

Another midwife suggests:

Or a GPs surgery

(Midwife 4, Focus group I)

These are ad hoc solutions that can, on occasions, meet an immediate need. Midwives should not have to depend upon using the landline in the home of a woman in her care. For instance there may be issues of confidentiality that might embarrass the woman if discussed within earshot of others in the

house or there may be no GP surgery within a reasonable distance. Such options are not always available.

Digital isolation was particularly challenging for many of the participants in respect of real time online support from specialists during medical emergencies.

Another midwife at the same location reiterated the issue of the patchiness of mobile phone reception and describes how she might deal with that:

It can be, based on mobile signal, you know, if we're seeing a woman, particularly in B 'cause there's no service on any telephone in the B surrounding area, for me anyway, then you're kind of relying on their landline, or their Wi-Fi, if your phone connects to their Wi-Fi then you can do a Wi-Fi call.

(Midwife 1, Focus group I)

Although this highlights the resourcefulness and adaptability of rural midwives, it is still far from ideal. It neither reflects best practice nor does it remove the issues of privacy and patient confidentiality. A further consequence of the "patchiness" of mobile phone reception means that midwives are denied 3G and 4G access to the internet and adding to a sense of digital isolation.

A midwife at a more remote location described the advantages of having information on a device that required no connection to the internet as:

I think it'd be useful for us when we're on the road and, you know, just having something that is just in our hands that was current and up to date rather than trying to come back to the unit and access the intranet, you know.

(Midwife 3, Focus group S)

This reiterates the challenge faced by Highland midwives in their need to access information whilst on the move in areas with poor mobile phone connectivity. A midwife based at another remote location grasped the advantages of using a tool that was preloaded onto a digital device:

It's a bit reassuring that this is not something that's going to have to rely on signal on Wi-Fi or not, because that is a challenge.

(Midwife 2, Focus group O)

Based on the findings in this sub-theme, it appears that as far as the midwives who participated in the focus groups are concerned, digital isolation can be equated to the inconsistency of mobile phone signals in Highland Scotland. A mobile device that held information that could be accessed without any need to connect to the internet might therefore be viewed as beneficial.

This theme, 'working in isolation' has revealed particular challenges around how rural midwives communicate with colleagues in labs and obstetric units based in general hospitals and around lengthy travel times that can be aggravated by severe weather. These combined with "at best patchy" mobile phone connectivity can have implications when rural midwives encounter pre-eclampsia. Having access to up-to date information without the need for constant connectivity, was viewed as helpful by some of the midwives.

5.2 Encountering women with pre-eclampsia in rural and remote settings

This theme explores how midwives working at remote and rural locations in Highland Scotland diagnose and manage women with pre-eclampsia. According to the Head of Midwives in NHS Highland, there have been no recent deaths as a result of pre-eclampsia. This is much to the credit of NHS Highland midwives, that despite their added challenges of working in

geographic and digital isolation, outcomes for women diagnosed with pre-eclampsia have been good.

One midwife was keen to point this out as:

They've all been managed and outcomes have been good.

(Midwife 2, Focus group I)

That sense of professional pride in practice was consistent across the two sub-themes of recognising pre-eclampsia and assessing and dealing with pre-eclampsia.

5.2.1 Recognising pre-eclampsia

Despite the midwives' excellent track record in achieving good outcomes for women diagnosed with pre-eclampsia, there have been challenges in recognising pre-eclampsia. One midwife recalled how in the case of a routine ante-natal check, she suspected that a woman might be pre-eclamptic:

She was, 30, 35, 34 or 35 weeks I think, first pregnancy and that was the one where she just came for a routine ante-natal check... and she just presented with three pluses of protein and raised blood pressure and so we just take the bloods here... and just took her straight through (to a General Hospital) and they kept her in and I think they were just, she just stayed on bed rest for a while, but again, she was a lady who didn't, didn't feel unwell, she had no headache, no sort of problems at all... so it was just fortunate that it was picked up with, you know, the blood pressure and the protein really when she presented for a routine appointment so, yeah, but she's home, baby's doing fine, she's doing fine so that was all good.

(Midwife 1, Focus group S)

This good outcome was as a result of the midwife's experience and professional competence. Another midwife at the same location recalled that there have still been some fearful moments in her practice. Her recollection led to the following dialogue:

We've had one very recently that was quite a severe case of pre-eclampsia, about a month ago, a lady with her second pregnancy, so it was an atypical cause it's more common with your first pregnancy... and she had 2+ protein and mildly raised blood pressure, but her blood pressure wasn't that high and I took bloods and her bloods were altered as well and she really wasn't believing she had pre-eclampsia and she went up to "R" (General Hospital) but there was a bit of confusion whether it was pre-eclampsia or not, probably because it was her second pregnancy and her blood pressure wasn't that raised so she ended up coming home again, she sort of self-discharged... and she came home again so we were really quite concerned about her and we kind of got all ready with our pre-eclampsia, our eclampsia kit and everything, and pregnancy mum guidelines just in case she presented fitting and she actually came in for a scheduled check two days later and still had lots of protein and her blood pressure was more raised and she wanted to go to Glasgow so I arranged for her to go to Glasgow, 'cause that's where she had family, and she was actually delivered the next day and she was only 32 weeks, or something like that, so it was really quite a severe case but really quite a scary one cause she wasn't, she really wasn't taking on board how ill she was...

(Midwife 7, Focus group S)

Researcher: *And the outcome was ultimately?*

...and, yeah, she's, the baby's discharged already so she's doing really well but it was quite scary for a few days here for us.

(Midwife 7, Focus group S)

This too was a successful outcome for the woman and baby. These narratives illustrate the competence of rural midwives who are constantly challenged by factors that arise from working in remote locations.

5.2.2 Assessing and dealing with pre-eclampsia

Successful outcomes depend on how well pre-eclampsia is managed as well as how it is initially diagnosed. One midwife expressed the view that good management derives from how well midwives working in remote areas are able to keep up to date with best practice:

I think sometimes, you know, because we're not sort of located, you know, within a hospital environment or whatever, we sometimes worry that we're not always hearing the updated information, you know, if policies and procedures change or management of things, like pre-eclampsia, change, things like that, I think there's a concern sometimes that we're not always getting that information filtered through... if changes are, are made to policies and guidelines and procedures in the future that, you know, it could be automatically like updated or something so we would always have the up to date information and knowledge, you know, at our finger tips and again, cause we're out and about and, you know, we're going paper light, so you're not carrying round, you know, lots of folders and all sorts of stuff with you, you know, you, if, if, you're dealing with something, obviously pre-eclampsia we are fairly used to dealing with but, you know, even more unusual things, you know, you maybe haven't dealt with them for some time and then you've got to get back to base to log onto the computer to look up, you know, what the guidelines are and everything around it so, as I say, some kind of preloaded device with current guidelines, you know, would potentially be very helpful when we're out and about in community.

(Midwife 8, Focus group S)

That view correlates with previous findings about how a preloaded mobile device could help overcome some of the negative effects of digital isolation whilst midwives are on the move. A colleague at the same location was enthusiastic about this possibility which led in turn to a dialogue between her and the previous midwife:

Oh, absolutely, well I think that's what we should have rather than, I'm well up for that... I think it's a terrific, I think there's huge potential here.

(Midwife 4, Focus group S)

Another midwife in the same focus group discussion added,

Things sort of come in and out of fashion and it takes us a while to catch up with that, you know. With regards to pre-eclampsia it was, for a while there, it was like they didn't want to know about anybody's blood pressure over 90 and until it was over 100 but now they seem to have gone back again to being more conservative about it and it's, sometimes difficult for us to keep up with what's going on I think.

(Midwife 8, Focus group S)

That exchange highlights why these rural midwives considered that there might be value in having an informative digital tool with them at all times that could be regularly updated (when connected to the internet) to keep them abreast of the latest guidelines, procedures and advice on best practice.

Another challenge to managing pre-eclampsia reported by the participants was the unpredictability around who they might find themselves supporting. With the Highlands becoming an increasingly popular tourist destination, it

was not uncommon for women in the last two months of their pregnancies to be on holiday in the area:

I think the good thing in Scotland is that we're used, we're used to the, the women's handheld record, we know where to find things. The scariest cases I've had have been with holiday makers, they just pitch up and they're usually the ones that have got fulminating preeclampsia, you've never met them before, try to find things in their notes, they maybe don't have their notes with them, so I think that's certainly highlights it's good to have a national set of guidelines.

(Midwife 5, Focus group O)

That story led to an exchange between participants at the focus group around patient (women's) records:

Again, a triage form would be probably something more in the woman's, that when we've got an electronic record you can actually have that rather than it being a separate piece of paper, you know, because obviously it would go with their record cause it's a, something that is actually part of her record rather than something you'd hold separately cause you want it to be retained in their notes so.

(Midwife 1.O)

A colleague summed this up as:

That would be good actually if folk had electronic records.

(Midwife 3.O)

This dialogue in the group also serves to illustrate another challenge that is currently being faced and widely discussed across all NHS Boards in Scotland. At present patients undergoing treatment and intending to travel are expected to carry their paper patient records with them and to present them if they require treatment elsewhere. It relies upon the patient remembering to carry their records and also not to lose them. In this case, a digital record

could have sped up the process and shortened the period of time that the woman was in danger.

The theme of encountering women with pre-eclampsia reveals some instances of how midwives recognise, assess and manage pre-eclampsia in remote and rural settings. It may be possible that this assessment and management practice might be enhanced using a mLearning/mHealth toolkit such as has been discussed during the focus groups.

5.3 Learning on the move

It is a requirement of the UK Nursing and Midwifery Council (NMC) that midwives undertake regular Continuous Professional Development (CPD). Highland midwives currently have to work on this by logging on to LearnPro on NHS computers either at their bases or at home. The mLearning/mHealth toolkit described to the midwives during the focus groups could enable them to work on their CPD away from any connection to the internet.

This theme is divided into two sub-themes: the "Facility to study on the move" and "Staying updated" explore whether a digital device that is preloaded with learning materials might offer any advantage over the way that the midwives currently work on their CPD.

5.3.1 Facility to Study on the Move

Most of the participants did not view working on their CPD at either their bases or at home as being at all convenient:

For example, a lot of things are on Learnpro, and with the best will in the world it's very time consuming, the amount of time you have to spend doing that. Now, if you had some of that actually available on your phone so that, actually, when you were sitting on a train, sitting on a ferry, you could do that and have it then signed off and it linked

into Learnpro then actually it would probably take the pressure off folk for their PDP (CPD).

(Midwife 1, Focus group O)

This suggests that the “anywhere and at any time” flexibility of having learning materials preloaded on a mobile device might enable midwives to make more productive use of time when they are on duty but not actually attending to the women in their care. This could be particularly useful for some midwives who can spend up to four hours in a single working day (though not every working day) travelling on ferries to visit women living in island communities.

There's 23 inhabited islands off the coast of Argyll but the ones with, that are the main isles... you get transfers from Bute over the mainland, Mull, Coll, Tiree, Islay, Jura...

(Midwife 1, Focus Group O)

The increased mobility and flexibility of offline CPD learning access using a mobile device also raised some concerns that “anywhere and at any time” might add to midwives’ workloads:

I like my free time to be my free time. I don't really want to do Learnpro on my days off to be honest.

(Midwife 3, Focus group I)

That view, whilst not widely held among all the midwives who participated in the study, does nevertheless highlight the need for sensitivity around the introduction of new technologies that might result in an expectation by NHS strategists and management that such technologies could lead to midwives being tasked with taking on more work.

Most participants in the focus groups welcomed the idea of preloading CPD materials on to a tablet (meaning no requirement for internet connectivity).

The particular appeal was that it might enable them to work on their CPD anywhere and at any time and subsequently upload their submissions to either LearnPro or the new Turas system whenever they were able to connect to the internet. This was particularly appealing to the participants who spent some of their working days travelling on ferries:

So, yeah, ferry journeys etc, you could actually be doing something, yeah, and that, but as long as it was either linked into Learnpro or linked in to so that you could link it into your portfolio so you can evidence.

(Midwife 1, Focus group O)

It was this flexibility that most appealed to the midwives irrespective of their locations and could also apply to time spent travelling on planes to visit island communities or on trains to attend face to face meetings and trainings in Inverness.

5.3.2 Staying updated

Linked to an ability to undertake CPD on the move, several participants saw additional possibilities and value in a mobile support tool if it could also provide them with regular updates on new policies and procedures. In particular several midwives saw value in having a digital pre-eclampsia triage checklist as part of a digital toolkit:

I think the whole triage issue is quite a big thing as well so that's maybe something that could be on the, the app, or put out, or on a tablet just like having a, a triage sheet on, on the tablet so that you're aware that a midwife is going to do all the questions and everything just to exclude conditions that it's, that it's been done, it's been, if you've not got a triage form with you when you're seeing somebody.

(Midwife 5, Focus group O)

If adopted, this digital triage checklist could potentially move away from the current paper checklist and take another step on the journey towards paperless practice.

Another participant in the same focus group, linked this suggestion to the introduction of electronic records:

Again, a triage form would be probably something more in the woman's, that when we've got an electronic record you can actually have that rather than it being a separate piece of paper, you know, because obviously it would go with their record cause it's a, something that is actually part of her record rather than something you'd hold separately cause you want it to be retained in their notes so...

(Midwife 1, Focus group O)

Such paperless practice could minimise the complications and dangers that midwives have described as arising when women travelling in the Highlands from other locations in the UK and abroad present with complications in their pregnancies but with no personal paper records.

A facility that enables midwives to learn on the move with a combination of preloaded CPD modules and an up to date pre-eclampsia triage checklist would be welcomed and seen to have the potential to enhance current rural midwifery practice.

The theme "Learning on the move" has revealed that most of the participants welcomed the potential to use a mobile device that required no internet connectivity to work on their CPD. The inclusion of audio-visual multimedia (including text, video, animation and voice recordings) resources in the learning materials also appeared to be acceptable and could be further

tailored to use as an interface between midwives and women who had been diagnosed with pre-eclampsia.

5.4 Using audio-visual resources

The term *audio-visual resources* refers to resources that promote the acquisition of knowledge by text and other media: this could include using pictures (still or moving images), voice and music (song) or in some cultures drama, dance and puppetry. These are all resources that do not necessarily have to rely on sophisticated technologies to communicate with learners. All of these methods can be applied using mobile devices.

Two sub-themes emerged, “Making pre-eclampsia less scary” and “Stimulating the senses”

5.4.1 Making pre-eclampsia less scary

All the participants were shown a video module from *Well@Work* – an award-winning programme that I have helped to develop in association with NHS Health Scotland

Figure 2. Screen shot from IHL’s *Well@Work* programme



Most participants in the study saw value in having a module in a similar style that they could use as something that they could use to facilitate conversations with women who had been diagnosed with pre-eclampsia and who required reassurance about how they would be managed and supported

through the remaining weeks of their pregnancies. One participant summed this up as:

I suppose, you know, pre-eclampsia can be quite a scary sort of subject when you're sort of talking to women about it so you using a kind of cartoon format like that (example shown from Well@Work) while you're still giving information maybe makes it a little bit less scary, you know, it's, you can, you can obviously expand on it through your discussion but, it's, it's not quite so sort of intimidating maybe when you're talking about something that's potentially quite serious, you know, condition, you know, it may be kind of, you know, doesn't scare them too much if you've got a format like that.

(Midwife 8, Focus group S)

This midwife's view is based on the format being simple and conveyed in easily understood everyday language. Such a format could provide an anywhere, anytime (for example enroute to hospital via ambulance or on a plane) empathetic interface between the midwife and woman who may be very fearful for her life and that of her unborn baby. Such fears can potentially be aggravated when far from hospital services in rural locations.

Another midwife felt that this facility could be an antidote to the popularity of "Dr Google":

...you mention pre-eclampsia they go and google ... so it might be quite useful to have something that you can sit and watch with them... rather than them going away and googling it and getting the fright of their lives.

(Midwife 7, Focus group S)

This refers to the growing tendency of people to seek medical advice from the wide range of information on the internet. A Google search for any

condition – in this case pre-eclampsia – will list information which is not necessarily evidence-based, and will lack provenance.

5.4.2 Stimulating the senses

Effective learning is better supported when it is multisensory. Even on a mini-tablet, or large smartphone, the screen is large enough for a midwife to use as an interface to help demystify the condition for a woman who has been diagnosed with pre-eclampsia. A midwife described how she saw herself using a preloaded mobile device:

I think it's good. It's good to have something if you've got it with you on hand for every consultation when you need it and I think that's the issue you have with lots of information for women.

(Midwife 5, Focus group S)

This reinforces the view that the presentation of audio-visual material from a mobile device that is immediately to hand, could have advantages over a midwife carrying paper based information sheets or leaflets in her practice bag.

Another midwife in the same focus group concurs:

I think it's quite nice 'cause it's kind of basic and kind of visual rather than loads of like data.

(Midwife 4, Focus group S)

This theme “Using audio-visual resources”, demonstrates that in general the midwives in the focus groups were positive about a multimedia module on a mobile device that could take account of all learning styles and provide a useful interface between midwives and the women in their care. Some midwives however were not always comfortable with technological innovation.

5.5 Feeling uneasy with advances in technology

This theme is further divided into two sub-themes: 5.5.1, "Feeling professionally compromised" and 5.5.2, "Fear of change". Although the participants discussed the advantages of having a multimedia module, the following sub-theme reveals apprehension among some participants with the addition of new technology into their professional practice:

5.5.1 Feeling professionally compromised

This sub-theme reflects the participants' unease with the possibility of the introduction of new technology into their professional practice:

As long as it's (the mLearning tool) reliable and it's actually, 'erm, supporting practice, or beneficial to practice rather than just another thing you have to do then, then yes, there's lots of opportunity, but it has to be reliable and it has to be of benefit.

(Midwife 4, Focus group S)

To an extent, that midwife was supportive of the introduction of new technology with the proviso that it had to be of benefit and did not add to the workload that she was already expected to fulfil.

Another midwife stressed the reason why she and her colleagues wanted to be involved in the focus group discussions:

I think that's why we were keen to be part of the focus group because I definitely wanted to get the point across that we shouldn't be looking at midwives needing help with diagnosis.

(Midwife 1, Focus group O)

This account suggests the midwives were apprehensive about the possibility of the introduction of new technology into their professional practice. There was a sense that they might forfeit their autonomy in decision-making.

The participants in this study exhibited a range of emotional responses to the possible introduction of an mLearning tool into their practice. This included a view held by several participants (in one of the focus groups) that I had by recruiting midwives, recruited the wrong group of participants to this study:

And actually, you know, I'm sure you would understand that, that, you know, we pride ourselves on actually making sure that we are competent and able to practise and we put a lot of effort into that, that's a completely different demographic that having worked in a lot of countries, the level of training and learning for a lot of midwives, never mind when you go out to community health workers, you know, so you've got to look at the demographics.

(Midwife 1, Focus group O)

This reflected this midwife's pride in her professional practice. She also appeared to see herself as speaking on behalf of the midwifery profession in Highland Scotland and did not acknowledge that a tool developed with content based on the practice and experience of Highland midwives might help to develop an appropriate tool for CHWs in LMICs.

A colleague did however acknowledge that some value might come from the findings of this study:

...we want to be part of something that's going to make a difference, we don't want to be in it just because it's a study and we've been coerced into it... We're too long in the tooth, we've been around a long time. We're not submissive... I definitely wanted to get the point across that we shouldn't be looking at midwives needing help with diagnosis.

(Midwife 3, Focus group O)

All of the participants in the study felt competent in their professional practice in respect of diagnosing and managing pre-eclampsia. Indeed several participants at one focus group felt that the suggestion to include this

proposed module in the mLearning/mHealth toolkit was a slight on their professional practice:

It's always within our professional capability, you know, to manage pre-eclampsia and to inform women about it. I can't quite grasp what it is we're looking at because I think it sounds like what we do on a day-to-day basis already. I can't see what the advantageous of having an app would be.

(Midwife 3, Focus group I)

It was clear that the midwives felt proficient in their professional practice and had a strong emotional attachment to their role as highly competent practitioners working at remote locations. What became evident in analysis was a degree of fear of change in their practice.

5.5.2 Feeling uneasy with change

Given the mixed emotional response as to whether participants might feel professionally compromised by the introduction of a new mLearning/mHealth toolkit, it was not surprising that some participants also felt uneasy with the changes that might come about as a result:

So I do think from that point of view, we're pretty switched onto it. But, I mean, I guess it's not to replace what we do. What, I, I still have trouble with an app, but of course I'm old fashioned and I don't use my mobile phone much, I don't use many apps, I don't, you know, it's not within my, too old I think, but, so I can't quite see how, how it works, you know, how it'll enhance anything, I can't see it.

(Midwife 3, Focus group I)

This suggests that for some midwives, age may be a barrier. That demographic is however changing and within the next decade it is likely that, subject to connectivity, the majority of adults in the UK population will be

using mobile devices to access the internet (according to Ofcom [2017] 66% already do so: www.ofcom.org.uk)

However, other participants felt less unease with change providing that along with change, came benefits:

...there's lots of opportunity, but it has to be reliable and it has to be of benefit.

(Midwife 4, Focus group 5)

That was indicative of an openness to experimenting with new ideas.

One midwife who had been most vocal in her view that I had recruited the wrong participants to my study, expressed that in her opinion the toolkit being suggested is better suited to CHWs in a LMIC setting than as a support for Highland midwives. This may have been as a result of feeling professionally challenged about her own competency. Nonetheless she did agree that the introduction of a tool such as described at the focus groups might bring some benefits to a Highland setting:

I certainly don't think that it would change the way that we make decisions but I do think that the information will enhance how we can deliver that information to people who might not ordinarily grasp what we're trying to tell them, erm, and I also think it will, it'll ease some of the fears... We're something, we're trying to move into the twenty first century, dragging wi'r [our] heals but wi'r [we are] getting there.

(Midwife1, Focus group I)

This "Fear of change" appears to be embedded in the fierce sense of the midwives' pride in their practice that runs through both sub-themes. It may well be that this combination of pride in practice and an apparent unease

with advances in technology may be the greatest barrier to the adoption of a mLearning/mHealth toolkit.

5.6 Chapter summary

The themes and sub-themes, drawn from the data have revealed that geographic and digital isolation are significant challenges and that a mLearning/mHealth toolkit could be part of a solution to these challenges. Most participants would be willing to try out a mLearning/mHealth toolkit, providing they are consulted from the outset as to what their needs are and that they are involved in the development of the toolkit. Most of all the data suggests that a new approach to enable "Learning on the move" would be very much welcomed by the midwives who participated in the focus groups.

Based on the above qualitative analysis of the findings, the following points are summarised as worthy of further discussion:

- Both geographic and digital isolation are real challenges
- Most participants saw advantages in a mLearning/mHealth toolkit that requires no internet connectivity
- The potential to work on CPD whilst on the move was welcomed
- The possibility of using multimedia as an explanatory interface between midwives and women who have been diagnosed with pre-eclampsia was welcomed
- Most participants were pleased to have been consulted on their opinions about the introduction of a mobile digital toolkit
- Some midwives felt that their professional integrity and autonomy might be compromised by the introduction of a mLearning/mHealth toolkit
- Some midwives felt that they might not be the most appropriate audience for a mLearning/mHealth toolkit

In the next chapter these findings are used as a framework for further discussion.

CHAPTER 6– Discussion

6.1 Introduction

The aim of this research has been to build on previous work in the area of mHealth as applied to Reproductive, Maternal and Child Health (RMCH). My study questioned whether a mLearning/mHealth toolkit (for example an intervention based on a digital tablet that is preloaded with advisory, triage and CPD modules) might help midwives to mitigate the complications that can arise from pre-eclampsia when working in rural and remote locations. The aim at the outset of this study was to discover whether a new mLearning/mHealth toolkit that is designed to support midwifery practice in remote and rural locations in Highland Scotland could:

- Be acceptable and useful to rural midwives in detecting, managing and making timely referrals in respect of women presenting with possible pre-eclampsia?
- and
- Offer any advantage and/or improvement over current practice?

6.2 Interpreting the findings

The following framework provides the basis upon which to discuss the findings:

Table 8: Summary of Findings

Question	Answer
Are geographic and digital isolation real challenges for midwives working in Highland Scotland?	Geographic and digital isolation are the major challenges faced by midwives working at remote and rural locations in Highland Scotland.

Are there advantages in using an mHealth/mLearning toolkit that requires no internet connectivity?	The participants welcomed the idea of a tool based on a mobile device that required no internet connectivity
Would using multimedia as an explanatory interface between midwives and the women in their care?	The possibility of using multimedia as an explanatory interface between midwives and women who have been diagnosed with pre-eclampsia was welcomed
Did the midwives want to be consulted/involved in the development of new mHealth interventions?	The participants particularly welcomed being consulted before development of a prototype of the tool commenced
How do midwives view the introduction of new mHealth interventions?	Some midwives felt that their professional integrity and autonomy might be compromised by the introduction of a mLearning/mHealth toolkit
Are Highland midwives the most appropriate users of a mHealth/mLearning toolkit?	Not necessarily. Therefore the question arises as to which categories of healthcare practitioners could benefit from a tool such as described in this study? That the development of a tool such as described, needs to be informed by further research leading to a better understanding of clinical needs in different contexts – one size does not fit all.
How do the findings relate to the literature review?	The findings correlate in respect of the need for end users to be involved in the design of new mHealth interventions (UCD) as well as the value of having mLearning CPD included as part of mHealth interventions.

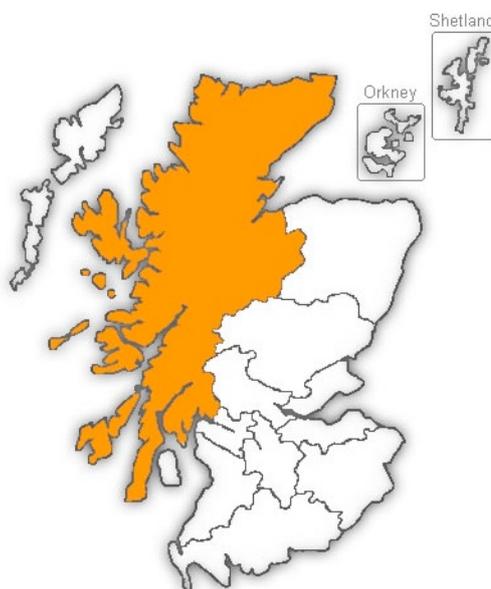
The above answers in Table 8, are not intended or presented as generalisable to all regions and contexts but are the answers of this particular study with this cadre of rural midwives. The findings in respect of the challenges faced by midwives working in geographic and digital isolation are fundamental to the exploration about how a mLearning/mHealth toolkit might support midwives in the management and referral of women with pre-eclampsia in rural and remote areas of Highland Scotland.

6.3 Facing the challenges of working in geographic and digital isolation

An Australian definition by Bourke et al. (2012) describes working in isolation within the context of locations that have challenges around both the provision of healthcare services and the recruitment and retention of the staff required to provide such services.

Highland Scotland has many such locations and NHS Highland is the largest NHS Board area (by land area) in the whole of the UK.

Figure 9: NHS Highland Board area



Whilst the NHS Highland Board area encompasses a landmass that is larger than Belgium, it has a population of only 333,000 (smaller than that of most UK cities) of whom some 70% (233,100 people) live in small isolated communities including on 93 inhabited islands. A further 350,000 tourists are estimated to be drawn to the area each year, mainly to remote locations and mainly during June, July, August and September (Visit Scotland, 2017). The demographics of the region are unique and challenging for any providers of healthcare.

In Chapter Five (p. 46) I noted two unintended consequences of this boom in tourism. One midwife (Midwife 3, Focus group O p. 46) recounted an occasion when, during the tourist season there had been a traffic accident resulting in a lengthy diversion along narrow roads that were clogged with traffic. In that instance, the journey time from the location where a woman was diagnosed as possibly suffering from pre-eclampsia to her arriving in Glasgow increased from approximately 2 hours under normal traffic conditions to approximately 4 hours. Those extra two hours could have proved to be fatal. Another unintended consequence of the popularity of Highland Scotland with tourists is that pregnant women taking holidays in the region may become unwell. They may present to local midwives with complications such as pre-eclampsia. It is very seldom that such women have their medical records to hand. These acute situations add to the complexities facing rural midwives in their practice.

All healthcare practitioners working at remote and rural locations in the NHS Highland Board area are, to some extent, affected by the challenges of geographic and digital isolation. The geographic isolation is both topographical and historical. The topographical isolation includes a long coastline punctuated and indented by numerous long sea lochs, mountainous terrain, very few main roads, numerous ferry crossings and three railway lines that terminate in ferry ports.

Figure 4: The Islands of Jura and Islay (© A. White)



This dramatic and rugged landscape is set within a historic socio-political context of centuries of economic decline and of long folk memories that have their roots in the failed Jacobite rebellion of 1745-46 and more especially in the 19th century Highland Clearances. Since the 1980s that decline has been significantly reversed with investment first by the Highlands and Islands Development Board (HIDB) and now with continuing investment from Highlands and Islands Enterprise (HIE).

HIE and the Scottish Government have also promised to transform the fortunes of the Highlands by connecting even the most isolated crofts on the most remote inhabited islands to the rest of the world via an infrastructure consisting of a network of virtual super-highways trunking super-fast broadband (defined as 300 Mbits per second by Ofcom, 2017) into every hospital, GP surgery, school, workplace and home. The failure of HIE and the Scottish governments to deliver fully on this promise has led to widespread disaffection and frustration from among all sectors of the population throughout Highland Scotland. Indeed this frustration has been exacerbated in so much as the promise of universal super-fast broadband by 2020, applies only to fibre optic and existing copper cable connections to existing landlines and hence to Wi-Fi routers at individual locations. It does not address the issue of 3G and 4G connectivity to mobile devices whilst on the

move. These IT infrastructure weaknesses were reported by the midwives in this study as creating frustration and a sense of digital isolation.

The mountainous terrain of Highland Scotland will for the foreseeable future make the quality and signal strength of line of sight connectivity via mobile phone masts inconsistent. Until the advent of affordable new communication technologies (such as satellites, kites and balloons) in Highland Scotland, the challenges for midwives of working on the move in both geographic and mobile digital isolation remains irrevocably linked. The challenges the midwives narrated to inform this study were:

- Difficulties when trying to communicate with colleagues
- The increased time taken to transport women to a centre that provides specialist care (e.g. to a Central Maternity Unit [CMU] or to a General Hospital)
- The increased time taken to turn around lab tests (not all CMUs have labs) compared to urban colleagues
- Accessing up to date knowledge and advice can be difficult

This is not new but it is an up-to-date reaffirmation and acknowledgement of the challenges that are still faced by midwives who are working in remote locations in Highland Scotland. These challenges are described by the term geographic-digital isolation.

The findings of this study would seem to support the presupposition that a mobile device, preloaded with a mLearning/mHealth toolkit (no internet connection required) could mitigate at least some of the negative effects experienced by midwives working in both geographic-digital isolation.

Throughout this study I have sought to remove any bias from my presupposition that a mobile device that is preloaded with a mLearning/mHealth toolkit (no internet connection required) might mitigate at least some of the negative effects experienced by midwives working in both geographic-digital- isolation.

The following section compares the findings of this study with the literature review (Chapter 3).

6.4 Comparing findings with the published literature

The literature review justified the aim of this study to investigate whether there is a need for a new mLearning/mHealth intervention. The evidence synthesis of the literature generated two research questions that informed this study:

- Might a solution such as an mLearning/mHealth tool be acceptable and useful to rural midwives in detecting, managing and making timely referrals in respect of women presenting with possible pre-eclampsia?

And

- To ascertain whether a solution such as an mLearning/mHealth tool offer any advantage and/or improvement over current practice?

Based on the literature review four sub-topics emerged: the ubiquity of mobile devices, the need for evidence based mHealth interventions, a need to involve end-users (midwives) in the development of such interventions and the potential to develop predictive mHealth interventions. Each of these themes will be explored in relation to the findings of this study.

6.4.1 The ubiquity of mobile devices

Boulos et al. (2014) described smartphones as the most common personal computer and how, since the launch of the Apple iPhone in 2007, they have revolutionised the way that we communicate and access information. Mobile devices (smartphones and tablets) provide an anytime, anywhere, portal into the entire world- wide web of knowledge. Boulos et al. (2014) suggest that mobile devices have much to offer users in the areas of education, healthcare and medicine.

The literature review was set within the context of a world where developments in mobile technologies and multifunctional mobile devices with ever more powerful smart phones with larger screens. Engmann et al. (2016) confidently predicted that over the next 20 years, continuing technological innovation in the area of mHealth such as telemonitoring of pregnant women and foetuses using smartphones, may have the potential to result in transformational changes around how healthcare practitioners respond to challenges in the area of Reproductive Maternal and Child Health (RMCH). I would contend that for these transformational changes to be universally accessible, the challenges posed by geographic-digital isolation must first be addressed before healthcare practitioners and the people they serve in rural and remote areas can fully benefit. The midwives in this study have mobile devices. However the infrastructure to support their use is not robust.

6.4.2 The need for evidence-based mHealth interventions

There are some perceived barriers such as the cost of funding evidence-based research but there are also facilitators (not least the ubiquity of smartphones) to the adoption of mHealth interventions.

Boulos et al. (2017) argue that the very ubiquity of mobile devices and of health apps, mitigates against research into their efficacy. Hogan and Kern (2012) raise concerns some that apps may not be based on any evidence and may even have the potential to lead to harm if users follow their advice. I share their view that there could and should be more evidence-based research into the safety and efficacy of mHealth interventions (see Chapter Three [pp. 42-46]).

6.4.3 Involving end-users (midwives)

The need to involve end-users was a recurring theme in the literature review. It supports Speciale and Freytis (2013)'s acknowledgement of the ubiquity of smartphones and how women and midwives increasingly use mobile phones. Whilst this, at the time of their study, was still largely to access personal

information via SMS, email and social media apps, Speciale and Freytis (2013) point out how, as a result of this development and smartphones becoming an essential part of everyday life, there are unprecedented opportunities for mobile devices to improve the outcomes for women and newborns. Most of the midwives in the focus groups shared a similar view. This was summed up by one participant as:

I think it's good, it's good to have something if you've got it with you on hand for every consultation when you need it and I think that's the issue you have with lots of information for women.

(Midwife 5, Focus group S)

Since 2013 there has been an exponential increase in people using smartphones as their primary way of accessing the internet (Ofcom, 2017) report that 66% of people in the UK use their smartphones to access the internet. This suggests that Speciale and Freytis (2013)'s argument is more valid in 2018. It is therefore important that mHealth interventions in the area of maternal health are introduced in a way that is relevant and acceptable both to women and midwives. This recurring theme of the need to involve healthcare professionals and the users of healthcare, in the development of mHealth tools is supported by Derbyshire and Dancey (2013) who whilst exploring the role of mHealth across a number of conditions as these pertain to women, cite the input from midwives and women as being the key to ensuring the quality, efficacy and credibility of apps / mHealth interventions that focus on maternal health.

The participants in this study particularly welcomed the opportunity to say what they wanted from a new mLearning/mHealth toolkit. Their feedback about what they wanted from such a non-diagnostic mHealth tool was:

- The facility to work on CPD on the move

- Updates on the latest advice, guidance and procedures in respect of pre-eclampsia
- A simple pre-eclampsia triage check list
- A module that could be used to help explain pre-eclampsia to women who have just been diagnosed as having the condition
- Advice on other complications that can arise during pregnancy

What some of the midwives did not want from a new mLearning/mHealth toolkit was step by step guidance about the diagnosis and treatment of pre-eclampsia.

...you know, I'm sure you would understand that, that, you know, we pride ourselves on actually making sure that we are competent and able to practice and we put a lot of effort into that,

(Midwife 1, Focus group O)

This midwife's pride in her professional practice is supported by a recent article in the Lancet (Shennan et al,2017) which cites the latest UK wide research (Office for National Statistics. Death registrations summary tables—England and Wales. 2014) as identifying only two women having died as a result of eclampsia between 2012 and 2014. Shennan et al 2017 also describe this statistic as a significant improvement on 10 deaths from eclampsia between 2009 and 2011. They attribute this improvement to perhaps being due to the NICE 2011 updated guidelines on pre-eclampsia.

6.5 Describing what is novel?

The integrative review found one mLearning/mHealth intervention that is similar to the tool described to the participants in the study focus groups. It is *PotM*, a stand-alone smartphone app that has been developed in Canada and South Africa and deployed in several sub-Saharan countries to support CHWs in detecting and managing pre-eclampsia. I have found no

documentation of *PotM* or any other mLearning/mHealth tool offering users the possibility of learning on the move with no internet connection. Yet it is what much of the literature reported as being potentially the most valuable component of a mHealth intervention. It is also the feature that many of the midwives described as the most useful in the mLearning/mHealth toolkit that I described at the focus groups (Chapter Four p.56)

The tool described in this study is novel in so much as it is envisaged as a mLearning/mHealth toolkit for midwives that would require no internet connectivity and is composed of several multimedia modules preloaded on to a tablet. The larger screen size of a tablet and an intuitive user interface ought to make it easy for users to navigate. Moreover it would have quality assured provenance in so much as each module would be comprised of evidence-based content provided by NHS subject matter experts that is peer reviewed. Importantly midwives and other healthcare practitioners could suggest additions to the toolkit to meet needs that have been identified in practice at a local level.

The participants in the study focus groups found the idea of including CPD modules as part of the toolkit to be particularly novel. This view was echoed at a subsequent workshop at Napier University in Edinburgh where I demonstrated the concept behind the toolkit to members of a study group from the Association of Malawian midwives.

Participants in the study focus groups also found the possibility of having a multimedia program to help explain pre-eclampsia in a reassuring way to women who had just been diagnosed as pre-eclamptic as useful and novel. It was felt that this could be especially helpful during transfers by ambulance to a general hospital, when women and paramedics could watch a short programme together about what a woman diagnosed with pre-eclampsia can expect whilst she is in hospital following triage by a midwife.

I think it's good, it's good to have something if you've got it

with you on hand for every consultation when you need it and I think that's the issue you have with lots of information for women...

(Midwife 5. Focus group S)

and

I think it's quite nice cause it's kind of basic and kind of visual rather than loads of like data.

(Midwife 4, Focus group S)

6.6 Examining the potential for further research

Additional potential advantages of including short multimedia modules that were not discussed during the focus groups, could be instances where users have the option to listen only to the audio track. The content would be accessible to women who have visual impairments or have literacy issues. It would also enable users to listen and learn whilst undertaking other activities such as driving, cycling, running or walking. It would be simple to produce foreign language versions that could help midwives and other healthcare practitioners to communicate with the increasing number of pregnant migrant women in Highland Scotland who present with complications in their pregnancies and who may not be able to speak or understand English. These latter advantages which were not explored in the focus groups, could taken forward in future studies.

The findings have already informed the development of a minimum viable prototype (MVP) of the toolkit, now entitled *mApt*[™]. This was part funded by NHS Highland Research and Development. Working with a Lead Midwife from NHS Highland, I was able to develop and write the script of the content for an advisory mLearning module (Appendix O). This included preparation for a short course CPD module about how midwives could interact with and support women who have been diagnosed with pre-eclampsia (Appendix O)

preloaded on to the tablets in such a way that participants could also upload a secure *Certificate of Achievement* to Learnpro and/or the new NES Turas platform. In developing the CPD module for *mApt*TM, advice from both RRHEAL and NES was sought.

This MVP of *mApt*TM has been designed as an interactive eBook and has many of the characteristics of an app. It incorporates material that users can select to read, watch and listen to.

Figure 5: Screen shot from prototype of *mApt*TM

4. ASSESSMENT

The previous module covered some of the symptoms of pre-eclampsia. To recap, physical symptoms include:

- Oedema in the face, hands and or feet
- Headache
- Visual disturbance
- Upper abdominal pain
- Nausea & vomiting



Women must be made aware of symptoms of pre-eclampsia and that if they have any of them they should immediately contact their midwife or their GP surgery.

6.6.1 The potential to develop predictive mHealth interventions

Klasnja and Pratt (2011) predicted the development of mHealth ecosystems where accurate outcome prediction models will become the norm as a powerful way to identify individuals who are at incrementally increased (and decreased) risks associated with conditions such as pre-eclampsia.

The technology now exists to integrate such predictive models with decision enabling machine learning and artificial intelligence (AI) algorithms into mHealth applications. Such applications could equip healthcare practitioners, other than midwives, to identify those women, fetuses, and ultimately newborns most at need of specialist (obstetric and midwifery) hospital-based care. This could further enable triage of women who are at risk and enable

midwives and other healthcare practitioners to initiate lifesaving interventions in the community prior to transportation to hospital.

However participants in the focus group viewed this as both devaluing their professional standing as qualified midwives and potentially allowing non-midwifery healthcare practitioners including GPs to possibly misdiagnose complications in pregnancies:

Being reassured because somebody's blood pressure's fine or, is not good enough because actually, the risk of the predictive analytics is that you've got the risk that it's actually going to reassure you that's the person's fine but actually there's something, that's woman's not telling you she's fine, and what you're seeing isn't fine so actually, that's got the risk then of reassuring, falsely reassuring and supporting the consultant at the other end saying the person's fine.

(Midwife 1, Focus group O)

Conversely, the introduction of machine learning that is capable of diagnosis, as part of a mLearning/mHealth toolkit such as described in this study, could fortify the ability of midwives to adapt and work in the challenging contexts of remote and rural locations. It could potentially lighten their workload, freeing them to deal with the women who are presenting with complications in their pregnancies and who have already been competently triaged by healthcare practitioners using the enhanced tool but who are not midwives. It could also trigger SMS reminders to the women in their care within a home setting.

Such a machine learning enabled mLearning/mHealth toolkit would be considered as a medical device. Its development would require to be subjected to a rigorous ethics approval process followed by clinical trials before it could be approved for use in the UK. If such a tool were to be approved and importantly accepted by midwives, then it potentially could lead to the future that was predicted by Klasnja and Pratt (2011) becoming a reality.

There could however be risks. Thomas and Lupton (2015) note that digital technologies including apps are playing an increasingly important role as novel healthcare interventions. Yet they are quick to point out, that despite the considerable number of pregnancy apps that are available, there has been little research into the efficacy or provenance of their content. This, Thomas and Lupton (2015) argue, could result in pregnant women making risky decisions based on dubious information from apps that could supplant the professional advice from midwives and other healthcare professionals.

6.7 Implications for practice

A WHO report (2010) identified the challenges associated with recruiting and retaining healthcare staff in remote and rural areas and recent news reports have focussed on these challenges as they apply to midwives.

The BBC (www.bbc.co.uk recently (21st November 2017) reported that,

Birth services at a hospital on Skye have been temporarily suspended because of a shortage of available midwives.

NHS Highland said the staffing situation affecting Broadford's Dr MacKinnon Memorial Hospital was temporary, but "significant".

The challenge of geographic-digital isolation is a key factor influencing NHS Highland's ability to recruit and retain midwives at remote locations. Evidence from a recent Canadian study (Fahlman, 2017) suggests that the ubiquity and familiarity with using mobile devices has enabled nurses at remote locations to embrace mHealth and mLearning resources to enhance their practice and to strengthen their communities of practice.

I would suggest that this same familiarity among Highland midwives using mobile devices might transform the way in which they and other healthcare practitioners work at remote locations and could be supported by policymakers in the area of RMCH.

The adoption of a mLearning/mHealth toolkit such as I have described in this study has the potential to have positive implications for midwifery practice. That might in turn help to build new knowledge and influence the design of digital tools within the context of the social systems where they might be deployed, such as within rural and remote communities of practice among midwives in Highland Scotland and beyond. That would, as the findings and other authors suggest, require the involvement of midwives and other end-users from the outset of such an initiative.

6.8 Reacting to change

The introduction of a new mLearning/mHealth tool into the practice of midwives at remote locations in Highland Scotland is likely to be viewed by midwives as a significant change, not least because it may conflict with the pride that the focus group participants have in their current practice.

And actually, you know, I'm sure you would understand that, that, you know, we pride ourselves on actually making sure that we are competent and able to practice and we put a lot of effort into that.

(Midwife 1, Focus group 0)

Beer and Nohria (2000) contend that a high proportion of change initiatives are unsuccessful and that this is due to employee resistance to change. Wittig (2012) describes employees' reactions to change as being influenced by several factors including: employees' emotions and perceptions; their personal defence mechanism; the attitudes of employers and line-managers; the attitudes of employees; how the change process is communicated and whether employees are able to participate in the decision making that is involved in implementing change.

Based on the feedback from the focus group participants, their pride in their current practice may be important barrier to change to be overcome or

indeed enlisted in the support of an introduction of a mLearning/mHealth toolkit. The single most important facilitator of change is likely to be the involvement from the outset of midwives in the development of a mLearning/mHealth toolkit. This study clearly identified the significance of this involvement.

MacVicar and Nicol (2013) in their Board Paper for NHS Education for Scotland (NES) place an emphasis on the role of NES and RRHEAL in so much as it identifies them as holding a unique position within what the NES paper describes as drivers of a “*dynamic process of change.*” This is twofold in that:

It enables NES /RRHEAL to respond to identified common core needs across Boards in an efficient and a coordinated manner and

It enables NES /RRHEAL to provide our education and research partners with a clear set of collated priority workforce needs and to use collected intelligence and alignment with workforce planning to assist with horizon scanning and programme planning.

(p.7)

NES, (2013) concludes that:

The remote, rural and Island Boards are clear that high-level education support is integral to robust workforce planning and redesign. They need assurance that affordable, accessible education will be in place before investing in new roles, new ways of delivering service. (p.7)

With further research, and in particular the opportunity to trial *mApt™* as part of the NPP, there is the potential for this study to perhaps further catalyse and be part of this dynamic process of change.

6.9 Answering my research questions

Analysis of these topics has helped, at least in part, to answer my two initial research questions:

Might a solution such as that proposed be acceptable and useful to rural midwives in detecting, managing and making timely referrals for pre-eclampsia?

Here the answer is inconclusive. It is both yes and no. No in so much as all of the participants considered themselves to be highly competent in the diagnosing and treatment of pre-eclampsia and felt that a purely advisory component patronised their professionalism. However, had the mLearning/mHealth toolkit that I described been categorised as a NICE approved medical device that incorporated some diagnostic functionality and addressed other complications in pregnancy such as gestational diabetes, then the answer might have been yes. Further research on this is required.

In respect of managing pre-eclampsia, the answer is yes:

...you know, you maybe haven't dealt with them for some time and then you've got to get back to base to log onto the computer to look up, you know, what the guidelines are and everything around it so, as I say, some kind of preloaded device with current guidelines, you know, would potentially be very helpful when we're out and about in community.

(Midwife 8, Focus group S, p.30)

It was that aspect of being able to access up to date information whilst on the move, that particularly appealed to most of the participants in the focus groups.

And in regard to the second research question:

Does a solution such as that proposed offer any advantage and/or improvement over current practice?

Here the answer is less equivocal and in the instance of CPD, it is "yes". A typical response from participants in the focus groups was,

So, yeah, ferry journeys etc, you could actually be doing something...

(Midwife1, Focus group O, p.36)

It is evident that there are opportunities for further research that could result in novel, innovative outcomes that might turn out to be transformational for rural and remote maternity care providers.

6.10 Continuing Professional Development (CPD)

The inclusion of CPD modules could be the most useful element of the mLearning/mHealth toolkit described to the participants at the focus groups. It would enable midwives to utilise downtime rather than have to wait until they were either online at their base or at home.

NES (2013) (p.7) noted that:

Each of the remote, rural and Island areas has different education and training support needs. However these areas share an urgent and ongoing need to redesign the community and hospital workforce to ensure delivery of improved and sustainable services.

NES (2013) extrapolates that continuing and inclusive education has a role to play in supporting service improvement across the health sector. This NES paper was written in 2013. Since then there have been considerable changes in the ways that NHS employees are expected to work and how continuing education and CPD are delivered.

I would suggest that mLearning might be perceived as having unshackled learners from being bound to *first generation* eLearning programmes on desktop computers or on personal laptop computers. Learners can now tap into learning on the move anywhere and at any time. Such learning materials, if they are experienced by users on smartphones or mini tablets can, quite literally put a world of learning resources into the pockets of learners.

6.11 Taking the toolkit to scale

Van Dijk and Hacker (2000) suggest that to take ICT applications to scale, they should be made more attractive to older people, women and ethnic minorities. This, Van Dijk and Hacker (2000) contend is a matter of design, culture, context and tone and of addressing these factors in the development of new applications. Producers, designers and representatives of healthcare practitioners and consumers of healthcare all have roles to play in bridging the divide created by geographic-digital isolation.

Within the socio-cultural context of the geographic-digital isolation of Highland Scotland, NES (2013) advised that:

There is a crucial role for NES and RRHEAL in working with education providers, professional bodies, Boards, and local authorities to ensure that well co-ordinated and efficient education solutions are designed, delivered and shared across Scotland. These solutions need to be of high standard, affordable, accessible and transferable to be of best value across the health and social care workforce. (p.7)

If the proposed trials of a prototype of *mApt*[™] in Highland Scotland prove *mApt*[™] to be useful, there may be opportunities to take *mApt*[™] to scale across the participating Northern Peripheries Project (NPP) partner states in Europe and Canada as well as in Malawi and potentially to take *mApt*[™] to scale globally.

Moreover, if the core costs of writing content, filming and animation, computer coding and user experience/interface design are covered as part of further research in Highland Scotland (and that research confirms both the need and usefulness of the tool), then the costs of taking the tool to scale may be affordable. Additional costs would arise mainly from the cost of mobile devices, downloading data, contextualising and translating content to take account of local languages and cultural norms. As such they would fall well within the budgetary parameters of £1M-£3M that DfID, USAID and EU (H2020) typically allow to take such projects to scale. At the time of this submission, discussions are at an early stage with TNO (Netherlands) and AMREF (Kenya & Malawi) in regard to developing partnerships that could take the tool to scale.

6.12 Chapter Summary

I have discussed how my findings may have the potential to form a basis for further research. and how through my exploration of the midwives' perspectives, my findings have since led to the development of a mLearning/mHealth toolkit.

I have also given some thought as to whether if such a new toolkit was to incorporate algorithms linked to safe and reliable predictive analytics, then it could bring about changes in RMCH practice that might be transformational.

In the next and concluding chapter, I discuss the findings in relation to the original aims and questions of this study, revisit the relevant literature to compare, contrast and draw out new insights and implications for practice.

CHAPTER 7– Conclusions

7.1 Introduction

The aim of this research has been to discover whether a mLearning/mHealth intervention (in this instance a digital tablet preloaded with a toolkit of advisory, triage and CPD modules) might help to mitigate the complications that can arise from pre-eclampsia. The goal was to find out whether a new mLearning/mHealth toolkit might support midwifery practice in remote and rural locations in Highland Scotland by answering two research questions:

- Might a solution such as a mLearning/mHealth toolkit be acceptable and useful to rural midwives in detecting, managing and making timely referrals in respect of women presenting with possible pre-eclampsia?
- To ascertain whether a solution such as an mLearning/mHealth toolkit offers any advantage and/or improvement over current practice?

This study answered these questions in that it has confirmed that both geographic and digital isolation are real challenges for midwives practicing in remote parts of Highland Scotland. Most of the midwives who participated in the study saw advantages in a mLearning/mHealth toolkit that requires no internet connectivity. They especially welcomed the potential to work on CPD whilst on the move and the possibility of using multimedia as an explanatory interface between midwives and women who have been diagnosed with pre-eclampsia was also welcomed.

However some midwives felt, as competent practitioners, that their professional integrity and autonomy might be compromised by the introduction of a mLearning/mHealth toolkit, whilst others sensed that they might not be the most appropriate audience for a mLearning/mHealth toolkit.

I believe that an underpinning strength of the study was that most participants were pleased to have been consulted on their opinions about the introduction of a mobile mLearning/mHealth toolkit.

7.2 Limitations and strengths of the study

This study is a qualitative descriptive exploration of how midwives working at rural and remote locations in Highland Scotland perceived the possible introduction of new mLearning/mHealth toolkit into their practice and whether it offered any advantages over their current practice in respect how they respond to safely managing women presenting with pre-eclampsia.

Berger and Luckmann (1966) describe qualitative description as a methodology that draws from experience as described by the focus group participants) the resources of that experience (the context of their practice). The strength of this study is that as a lay person, I had few fixed ideas of what the conversations at the focus groups might reveal the midwives' experiences to be. On the other hand I did start out with an idea of what a mLearning/mHealth toolkit might look like and contain. I believe that my preconceptions were both a strength and a limitation in how I conducted the study. It was a strength in so much as I could adequately describe the concept and potential usefulness of the mLearning/mHealth toolkit. At the same time this also placed a limitation on the study in that I had not, at that stage, developed a prototype of the toolkit, only a concept based on my thinking. That puts me at odds with Dewey (1916), *Democracy and Education*, who advised researchers that:

Thoughts are incomplete. They are suggestions and standpoints for dealing with the situations of experience. Till they are applied and tested in these situations, they lack full point and reality... only testing confers full point and reality. (p.189)

Nonetheless my analysis of the data has led to the development of the prototype of a novel mLearning/mHealth toolkit that will be tested and reported on through either commercial and/or academic research.

Two other limitations were, I recruited my participants from only one health board and that the study focuses only on pre-eclampsia. I discussed these limitations with my supervisors and they advised that to widen the scope of the study would be difficult to achieve within the time allowed to complete a Master of Research study. This small study was focussed on being an exploration of a potential need for a mLearning/mHealth toolkit ahead of possible further larger studies.

7.3 Implications for practice:

Evidence-based research is a rigorous process. Therefore, as a consequence it is not a fast process. There may therefore not always be time for new mHealth interventions to be rigorously evaluated, peer reviewed or published in any peer-reviewed professional journals. Some of these mHealth interventions might also, for commercial reasons, be deemed to be confidential and as such are not yet in the public domain.

The literature review in Chapter 3 and my attendance at conferences (Appendix P) indicate that whilst health apps are almost as ubiquitous as smartphones, very little appears to have been done to test and evaluate their efficacy.

Throughout this study, I have cited the work of other authors including Boulos et al (2017); Engmann et al (2016); Fahlman (2017) and Speciale and Freytus (2013) as indicators of how the ubiquity of mobile devices (in the hands of healthcare practitioners) has the potential to transform RMCH.

Frotell (2015) contends that in the fast moving ecosystems where the enthusiasm for mHealth thrives, the need to submit new and innovative mHealth interventions to the regulatory, and often time consuming processes of obtaining ethics approval, can render such innovations redundant, overtaken by less ethical competitors before they have even reached the stage of a feasibility study.

That represents something of a dilemma for researchers like myself who are supported by organisations that have a commercial interest in developing mLearning/mHealth tools. One solution may be to develop prototype tools that simply provide evidence-based advice but have no diagnostic functionality such as, for example, measuring blood pressure. These are therefore not considered as medical devices. However to follow that approach would be to ultimately deny (or significantly delay) midwives, working at remote and rural locations, access to the transformational benefits predicted by Engmann et al. (2016).

My findings are based on analysis of the data that I collected from midwives working at rural and remote locations in Highland Scotland. My aspiration is that these findings may help to inform other mHealth initiatives by providing findings that could be potentially transferable to other regions and cultures.

The study has resulted in the subsequent development of a prototype toolkit that requires no internet connectivity and is preloaded with interactive modules. This is about to be tested as part of a feasibility study, within the NPP, with multidisciplinary teams that include lay volunteers in especially remote parts of Highland Scotland. If these trials are successful then there is the potential for a mLearning/mHealth tool kit such as is described in this study to support midwives and other healthcare workers in rural and remote areas of Scotland as well as at other locations.

7.4 Opportunities for further research

My findings have led me to identify 4 short-term opportunities for further research:

7.4.1 Trialing *mApt*[™] with non-midwifery healthcare practitioners

In my introduction to this chapter, I described how most of the midwives who participated in this study considered that they were competent in their ability to manage and support women who presented with pre-eclampsia.

Several midwives in the study suggested that if I did go on to develop a prototype mLearning/mHealth toolkit, then conducting a trial of a prototype with other groups of healthcare practitioners other than midwives could be more helpful.

The view of these midwives was that it might be more appropriate to test such a toolkit within contexts such remote locations where women with complications in their pregnancies might first present to non-specialist healthcare practitioners or indeed within urban settings where women (particularly younger women from socially deprived backgrounds) may be visited by other healthcare practitioners including health visitors, family nurse practitioners as well as by social care professionals.

The view of some midwives in the study was that a mLearning/mHealth toolkit could be of real value in supporting non-midwives to be able to properly triage women presenting with symptoms of pre-eclampsia and to know and understand when it was appropriate and timely to refer them to midwives or specialist obstetric care. Obviously this raises the question over concerns around public safety and having the appropriately skilled practitioners available to all demographic groups. This is an area of inquiry that extends beyond the remit of this current study.

Personal discussions with The Heads of Midwifery in NHS Highland and NHS Highland Research, Development & Innovation, indicate that they would both support this opportunity for further research.

Subject to obtaining additional funding, I propose to trial the mLearning/mHealth toolkit (*mApt™*) with non-midwifery healthcare practitioners. I anticipate that the participants from my focus groups in this study will also be invited to join in this trial as well as helping to recruit non-midwifery healthcare practitioners including GPs, Family Nurse Practitioners and ambulance paramedics to participate in the trial. It will be vital that legislation and professional registration, roles and skill sets are explored in detail to ensure that public safety is assured in future studies of this nature.

7.4.2 Trialing *mApt™* as part of The Northern Peripheries Project (NPP)

NES (2013) recognises that requiring healthcare practitioners to work in isolation, brings with it evident challenges in recruiting staff to and more especially retaining them in the remote parts of the Highlands. This is also a challenge across a number of other countries that have populations scattered across remote and rural geographies. Following on from a (WHO, 2010), report:

...there has been a need to build a robust evidence base identifying the social and professional factors that influence recruitment and retention of staff in remote and rural areas.

(NES 2013 p.12)

The WHO report led to initiating the Northern Peripheries Project (NPP) that received European funding to investigate these issues. The NPP involves collaboration between eight partner countries including Scotland. In Scotland the Remote and Rural Healthcare Educational Alliance (RRHEAL) is the lead for the project. To date this has resulted in a survey of some 5000 participants. This, together with feedback from NPP focus groups and

interviews, provides a basis upon which professional and educational support packages (*such as mApt™*) could be developed to enhance the recruitment and retention of a multi-disciplinary remote and rural health and social care workforce across the NPP partner countries.

RRHEAL has supported aspects of the development of the *mApt™* prototype and it is hoped that this opportunity for further research may provide additional knowledge that can in turn contribute to the success of the NPP within Scotland and other member countries.

7.4.3 Trialing *mApt™* with midwives and CHWs in Malawi

RGU has collaborated with Aberdeen University, Napier University, the Scottish Government and Association of Malawian Midwives (AMAMI) on two maternal health projects in Malawi since 2012.

There are now opportunities for me to collaborate on extensions to these projects whereby *mApt™* could be piloted and evaluated in a LMIC setting. These opportunities include using mLearning to build capacity among teaching staff in the area of clinical skills. The outcomes from such capacity building could be further cascaded to support the training of CHWs to work in the community at district health service level and support midwives through initial triage and management of women presenting with complications in their pregnancies.

7.4.4 Developing a version of *mApt™* that has machine learning built into it

In section 6.3.4 I discussed the potential to introduce predictive analytics and machine learning into a tool such as *mApt™* and how this raised concerns around the safety of using predictive analytics.

The Centre for Maternal and Child Enquiries (CMACE, 2011) report describes how outcomes vary throughout the UK with women from disadvantaged

backgrounds or those with more complex social needs general experiencing poorer pregnancy outcomes. The CMACE (2011) report postulated that some doctors and midwives had inadequate knowledge and skills relating to recognising and responding appropriately to potentially life threatening conditions and communicating well within and between teams. Another report (King's Fund, 2008) argues that whilst some problems may be detected and managed throughout pregnancy, others such as pre-eclampsia may arise suddenly and unexpectedly. Managing such deviations from the norm may include interventions which in themselves increase the risk.

Mol et al. (2016) note that whilst:

...perfect prediction of pre-eclampsia has been a noble but hitherto elusive goal, distinction between women who are at low risk and high risk is possible. (p.2)

Mol et al. (2016) hypothesise that the development of a predictive model requires to be based on the various risk factors for PET. However Mol et al. (2016) caution that in real clinical practice, these factors (e.g. chronic kidney disease and previous PET) predict only 30% of women who develop pre-eclampsia.

Conversely, the benefits of including machine learning in a tool such as *mApt™* could help outweigh these risks. Knoble et al.(2015) whose article *Electronic diagnostic algorithms to assist mid-level health care workers in Nepal* which I chose to remove from my Literature Review (because of the low MMAT/SIGN score and relevance to this study) concludes that the *e-algo* app functions well both as a learning aid and as a diagnostic tool.

I would suggest that it might be worth exploring the potential power of machine learning in the area of maternal healthcare. The development of a prototype will however be expensive and my employer (Interactive Health Ltd) is currently assessing how that could be funded.

7.5 Planning for dissemination

I have identified several opportunities to submit abstracts to conferences:

- SHINE (EU Partnership) conference – Inverness, 16th March 2018
This will build on my attendance in September 2017 at a similar conference in the Hague (Netherlands) that opened up the potential to collaborate with TNO on further research and development on how *mApt*[™] might be enhanced and taken to scale. By presenting my findings at this conference, I hope to cement a collaborative partnership with TNO that will support the bids that I intend to make for H2020 funding (SME Instrument and Eurostars programmes).
- Rethinking Remote, Inverness, 24th – 25th May 2018
This annual conference attracts senior decision-making international delegates. Presenting at this conference may provide me with networking opportunities that facilitate taking *mApt*[™] to scale.
- HMISS, eHealth Europe – Sitges, Spain, 27th-29th May 2018
The DHI is a member of HMISS and I am a student member. The previous eHealth Europe conferences that I have attended have had “Speaker’s Corner” opportunities for researchers and organisations to make short presentations on the findings of their research. eHealth Europe conferences attract ministerial level delegations and as such offer networking opportunities that could offer further research opportunities that could help to take *mApt*[™] to scale.
- Royal College of Midwives Annual Conference – Manchester, UK, 4th - 5th October 2018

7.5 Personal reflections

I came to this study as a lay-person and a novice academic researcher. These were both factors that presented me with challenges. My Research Degree Registration (Appendix A) proposed:

An investigation and analysis of whether mobile devices can support the practice of midwives and health professionals in the rural and remote areas of Highland Scotland?

I related that to the scoping review of literature that I undertook as part of my initial PG Cert 1 assignment (Appendix B). I went on to describe how I proposed to work with focus groups of healthcare practitioners and based on their feedback go on to develop a prototype of a mLearning/mHealth toolkit, test that prototype with participants from the focus groups and then revisit the focus groups for feedback on how useful they found the prototype.

At that stage I viewed the development of a mLearning/mHealth toolkit as my objective in undertaking this study. I have subsequently come to understand that the purpose of studying for a Master of Research degree is to build and demonstrate my competence as an academic researcher and that this study may lead to opportunities for further research (Chapter 7.3.1 – 7.3.4). Such opportunities might then lead onto the development of a mLearning/mHealth toolkit that could be taken to scale.

Subsequent discussions with my supervisors enabled me to formulate my research questions and to recruit only midwives to participate in the focus groups. Further consultation with my supervisors led me to agree that my proposed development and testing of a mLearning/mHealth toolkit could not be completed within the timeframe allowed for the completion of a Master of Research study. As a result the proposed testing of a prototype was removed from this study and is now viewed as an opportunity for further research.

My initial approaches to this study were academically naïve, commercially biased and overly influenced by my experiences in sub-Saharan Africa. I now understand that whilst my study may ultimately help inform the development of a mLearning/mHealth toolkit for healthcare practitioners in LMICs, these are two very different contexts. One size does not fit all.

If I were to start again I would be better informed from the outset of my study, to focus on literature that describes the challenges faced by midwives working in rural and remote areas of Highland Scotland before turning my lens on what has been done to address similar challenges elsewhere in the world.

1.7 Conclusions

The discussion of my findings in Chapter Six leads me to conclude that the study does build on current research. This supports the evidence from my PG Cert scoping review of the literature (Appendix B) that provided the rationale for my research that indicated a need for innovations in the provision of rural and remote maternity care.

Key findings from my study are that geographic and digital isolation in rural and remote areas of Highland Scotland (where digital isolation means no connection to the internet via mobile devices whilst on the move) are real challenges for midwives working in such areas. Most of the midwives who participated in the study saw advantages in using a mLearning/mHealth toolkit that requires no internet connectivity to help overcome these challenges. The participants particularly welcomed the idea that a mLearning/mHealth toolkit such as was described to them at the focus groups could enable them to work on their CPD whilst on the move. The participants also welcomed the inclusion of an audio-visual module that could be used to simply explain pre-eclampsia to women.

There was less congruence around the value of a mLearning/mHealth toolkit having a module that provided advice to qualified midwives on how to

diagnose pre-eclampsia. Most participants felt competent in their ability to diagnose and manage women with pre-eclampsia, but agreed that a mLearning/mHealth toolkit could be of value to other healthcare practitioners with less experience of seeing and then triaging women who present to them with symptoms of what might be pre-eclampsia.

My aspiration is that this study can catalyse and inform outcomes through further research to fit the context Barkman and Weinehall (2017) p.1, describe as a prerequisite for a mHealth ecosystem to take seed, flourish and be sustainable;

mHealth initiatives need to be integrated into national health systems and priorities and fit into the system that a country has already invested in. Strategic and integrative policy decisions on the national/regional level are required in the concrete steps of action plans. Partnership between government, health care providers, Community Health Workers, the private sector and universities is considered a precondition for success.

This holds a promise of a future where advances in mLearning could be ever more closely aligned with transformational advances in the use of mobile devices in the area of RMCH – a new era when midwives and other healthcare practitioners at rural and remote locations could be supported to work ever more effectively whilst on the move.

7.8 Conflict of interest

Both Interactive Health Limited, of which I am a director and NHS Highland Research, Development and Innovation, have a joint commercial interest in developing a commercial version of *mApt*[™] (Appendix N). I have

endeavoured at all times to be objective and to avoid any commercial bias
how this study reports my findings.

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APPENDIX

Appendix A - Research Degree Registration (RDR)

Could a mobile health (mHealth) intervention support midwives in the management of women with hypertension in rural and remote areas of Highland Scotland?

The safety, quality of care and experience of women, infants and health care professionals is the focus of this research, especially as it relates to the diagnosis and treatment of pre-eclampsia.

A literature review and my attendance at conferences indicate that whilst health apps are ubiquitous, very little has been done to test and evaluate their efficacy in supporting midwives and other healthcare professionals in improving maternal and newborn health. "This presents the opportunity to leverage mHealth for maternal and newborn care, particularly in under-resourced health ecosystems." (Tamrat and Kachnowski, 2012)

Derbyshire and Dancy (2015) advise that "Patient groups should also ideally be involved in the development and testing of mobile medical apps."

I will take account of this advice and propose to adopt a qualitative methodology based on:

- Obtaining approval from NHS & RGU ethics
- Recruiting focus groups of midwives to establish the acceptability of using mobile devices as an interface and diagnostic tool

(Selection/development of apps, Selecting a cohort of trial users

Developing a minimum viable prototype (MVP),

Revisiting the Focus Groups for feedback on the prototype (subsequently removed after consultation with my supervisors)

Based on the outcomes of the initial focus groups, I will work with the RGU School of Nursing and Midwifery and NHS Highland to investigate the efficacy

of a mobile device that is preloaded with 3 suites of apps:

1. "Advisory", providing off-line information on ante/post natal maternal health.
2. "Diagnostic", using an off-line Blood Pressure App (*subsequently removed after consultation with my supervisors*)
4. "CPD", enabling remote learning/revalidaton for practitioners.

The target population is midwives based at rural and remote locations in the Scottish Highlands and Islands.

Appendix B Initial Scoping Review (PG Cert 1)

This systematic scoping review examines the main issues and trends associated with the fast moving and constantly evolving landscape of mHealth and in particular how these trends pertain to supporting the practice of rural midwives in their management of women with pre-eclampsia. Six research questions are addressed in this review:

- Is there a need for end-users to be involved in developing new mHealth interventions?
- What mHealth apps aimed at supporting healthcare professionals in the management of pre-eclampsia have been described in the literature?
- What methodologies have been used to study or evaluate these apps and what processes or outcomes have been examined?
- What evidence of effectiveness exists?
- What barriers and facilitators to adoption have been reported, including usability and accessibility?

The researcher used four online databases (CINHAL, Medline, Pubmed and Google Scholar) to search for published studies. The search terms included "eHealth", "mHealth", "mobile health", "telehealth", "remote and rural healthcare", "remote and rural maternal healthcare", "rural midwives", "midwives' CPD", "the use of smartphones by rural midwives", "pregnancy", "pre-eclampsia", "eclampsia" and "pregnancy induced hypertension". This initial search resulted in 392 "hits". Eleven articles and papers met the following selection criteria:

- Articles and papers in English
- Articles and papers on mHealth
- Articles on interventions using mobile devices and apps
- Articles and papers on midwifery and mHealth,
- Articles and papers on eclampsia and pre-eclampsia,
- Articles and papers on eclampsia and pre-eclampsia and mHealth,
- Articles and papers on maternal healthcare in remote and rural locations

And by excluding any articles and papers that:

- Had not been peer reviewed – an exception was made in the case of an article (The Emperor’s New Phones) by Frotell (2015) in the British Medical Journal. This is justified on the grounds that this paper was presented by Frotell at the UCL 2015 mHealth conference which I attended and because of its particular relevance to this study.
- That duplicated others
- Had been first published prior to the launch of the iPhone in 2007.

Eleven articles and papers were finally selected for review.

mHealth thrives in an ecosystem that is constantly evolving. There may not always be time for new mHealth interventions to be evaluated, peer reviewed or published in any professional journals. Some of these mHealth interventions might for commercial reasons be deemed to be confidential and as such are not yet in the public domain. For these aforementioned reasons, it was prudent to extend this review to a search of the world-wide-web (Google and Google Scholar) and of the various “app stores” (Apple’s App Store, Google Play and Microsoft Store). This search, though not exhaustive used the same criteria as was applied to the search for articles and papers. The researcher discovered numerous apps in the area of pregnancy were found and are summarised in figure 2. These were mostly aimed at pregnant women and ante and post-natal parents. The majority are categorised as entertainment and very few maternal health apps are targeted at healthcare professionals. Five examples that are aimed at supporting midwives include:

Findings:

Boulos et al (2014) set the scene for this proposed study. They describe smartphones as the most common personal computer and how, since the launch of the Apple iPhone in 2007, they have revolutionised the way that we communicate and access information. Mobile devices provide an anytime, anywhere portal into the entire world- wide-web of knowledge and have

much to offer users in the areas of education, healthcare and medicine. Smartphones in particular are pocket sized, hand-held and easy to use on the move. As such mobile devices can be particularly useful to healthcare professionals such as midwives who serve remote and rural locations.

Lee et al (2016) undertook a systematic review of the literature on the impact of mHealth interventions on maternal and newborn health in low and middle-income countries (LMICs). Lee et al's review covered the full range of mHealth technologies that are being applied in the area of maternal and infant health. Their analysis of primary-source research papers confirmed that mHealth technologies are increasingly being introduced to enhance health care to improve the quality of pre- and post-pregnancy care, and are more and more being used as a means of collecting pregnancy and child health data. Frotell (2015) makes a very similar argument but contends that there is a very low evidence base to support the efficacy of mHealth. Lee et al (2016) echo Frotell (2015) and conclude that whilst the anecdotal evidence of the benefits of mHealth is compelling, evidence-based recommendations are essential for policymakers and planners who wish to make informed choices about investing in mHealth interventions based on rigorous research, monitoring and evaluation to establish their safety, efficacy and socio-cultural impacts.

The ubiquity of smartphones was acknowledged by Speciale and Freytis (2013) who focused on how mobile phones are increasingly used by women and midwives. Speciale and Freytis (2013) point out how as a result of this development there are unprecedented opportunities for mobile devices to improve the outcomes for women and newborns. At the same time, Speciale and Freytis (2013) highlight how very few midwives are ever consulted in shaping how these technologies can be applied in the area of maternal healthcare. They argue that the relationship between mHealth interventions and midwives could be more mutually beneficial if midwives were able to contribute to how mHealth interventions in the area of maternal health are

developed. Speciale and Freytis (2013) also argue that whilst technology can have an important role to play, any technological innovation needs to be firmly based on the needs of the women and the midwives who provide their care. It is therefore vital that mHealth interventions in the area of maternal health are introduced in a way that is relevant and acceptable both to women and midwives. This recurring theme of the need to involve healthcare professionals and indeed the users of healthcare in the development of mHealth apps is supported by Derbyshire and Dancy (2013) who cite the input from midwives and women as being the key to ensuring the quality, efficacy and credibility of apps that focus on maternal health.

The researcher's review of the literature selected from data bases using Refworks confirmed that there is a consensus around a need for more healthcare professionals to be involved in the development of new mHealth interventions but found no references to any mHealth interventions such as is envisaged in maApt™. However, the researcher's subsequent search (Fig. 2) using Google Scholar found one mHealth intervention, a smartphone app called *Piers on the Move (POTM)* that has some of the same functionality that is envisaged in the development of maApt™. Lim et al (2015) describe *POTM* as a low-cost, easy-to-use, mHealth application that has been designed to be used by Community Health Workers (CHWs) in South Africa to accurately predict the risk of the adverse outcomes associated with pre-eclampsia in pregnant women. However, Lim et al (2015) make no reference to midwives being consulted at the outset of the development of the app as regards the functionality that they (the midwives) wanted from the app and how it might support their professional practice. The *POTM* app is downloadable on to the CHW users' personal smartphones. However, the variety in the makes and operating systems (Apple, Android and Windows) of these smartphones may lead to inconsistencies in the functionality and reliability of the *POTM* app. Lim et al (2015) also report users (the CHWs) having difficulties in navigating *POTM* due to the small size of the touch-screen "buttons" on a smartphone. Nonetheless the development of the *POTM* app does serve to illustrate how

fast mHealth is evolving and the paper that describes the *POTM* app (Lim et al, 2015) provides valuable insights for this proposed study. In particular it supports the rationale for adopting an NHS owned tablet as the host device for maApt™ as this will both eliminate any inconsistencies in its functionality and because of its larger screen size, any difficulties in navigation.

Summary:

This initial scoping review of the literature found no evidence of similar mHealth interventions in the area of maternal health where midwives are evidenced as being members of any development teams. However, based on this initial scoping review two consistent themes do emerge:

- A need to base new mHealth interventions on well-researched evidence that has been monitored and evaluated and secondly
- A need to involve end-users (midwives and women) in the development of such interventions.

Appendix C – Ethics application

Appendix C – Ethics application

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RESEARCH ETHICS: RESEARCH STUDENT AND SUPERVISOR ASSESSMENT (RESSA)

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The aim of the University's *Research Ethics Policy* is to establish and promote good ethical practice in the conduct of academic research. This *self-assessment* is intended to enable researchers to undertake an initial self-assessment of ethical issues in their research.

Ethical conduct is not primarily a matter of following fixed rules; it depends on researchers developing a considered, flexible and thoughtful practice.

This *self-assessment* aims to engage researchers discursively with the ethical dimensions of their work and potential ethical issues, and the main focus of any subsequent review is not to 'approve' or 'disapprove' of a project but to make sure that this process has taken place.

KEY SUMMARY

The *Research Ethics Policy* is available at www.rgu.ac.uk/research-ethics-policy
Please describe the project in plain English (i.e. non-scientific terms)

↑

Research Student Name	Alan White
Principal Supervisor	Professor Susan Crowther
Graduate School	Nursing & Midwifery
Research Project Title	Exploration of how a mobile health (mHealth) intervention may support midwives in the management and referral of

↑

↑

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The focus of this research is the safety and quality of care for women and newborns through pregnancy and childbirth and how geographic and digital remoteness can impact on maternal health.

My aim is to examine whether digital devices (e.g. iPads) that are preloaded with advisory, diagnostic and Online Continuous Professional Development (OCPD) apps can support midwives and healthcare professionals, who work in remote and rural areas, in their care and management of women who exhibit early symptoms of pre-eclampsia during pregnancy.

My objective is, following on from a literature review, to develop, pilot and evaluate the efficacy of a prototype device.

The focus for the research will be to work with midwives to inform the development of a device that is in-

PART 1: DESCRIPTIVE QUESTIONS			
1.	Does the research involve, or does information in the research relate to:	Yes	No
	[see Guidance Note 1]		
	(a) individual human subjects	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	(b) groups (e.g. families, communities, crowds)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	(c) organisations	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	(d) animals?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	(e) genetically modified organisms www.rgu.ac.uk/hr/healthsafety/page.cfm?page=26027#122628	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Please provide further details:			
<p>The research has the support of the Head of Midwifery and senior Research and Development managers in NHS Highland. It will be based on 3-4 focus groups at different locations (Inverness/Cromarty, Skye and Fort William) in the NHS Highland area. Midwives will be invited to join the focus groups. It is anticipated that each focus group will be formed from a maximum of 5 midwives. No mothers or any other non-NHS staff will participate in the focus groups.</p>			

(b) or elsewhere? [\[see Guidance Note 4\]](#) ✕



Please state what you believe are the consequences of the research: ✕

✕

<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>

¶

PART 3: ETHICAL PROCEDURES ✕

5. ✕	Does the research require informed consent or approval from: [see Guidance Note 5(i)] ✕	Yes ✕
✕	(a) research participants ? ✕	✓ ✕
	(b) research subjects ? [see Guidance Note 5(ii)] ✕	✓ ✕
	(c) external bodies ? [see Guidance Note 5(iii)] ✕	✓ ✕

.....Section Break (Odd Page).....

In the first instance I am seeking ethical approval from the School of Nursing and Midwifery Research Ethics Panel (SERP) at Robert Gordon University. Following receipt of this consent this I will seek approval via IRAS and the Ethics Committee for Research & Development in NHS Highland.

I will also require to have the informed and freely given consent of all participants in the project based

6.	Are there reasons why research subjects may need safeguards or protection? [see Guidance Note 6]	Yes
		<input type="checkbox"/>

If you answered yes to the above, please state the reasons and indicate the measures to be taken to address them:

7.	Does the research involve any "regulated work with children" and/or "regulated work with protected adults", therefore requiring membership of the <i>Protecting Vulnerable Groups (PVG) Scheme</i> ? [see Guidance Note 7]	Yes
		<input type="checkbox"/>

[Please note: if the research potentially involves "regulated work", this MUST be raised with HR Business Partner immediately. In this instance, the Human Resources Department will conduct a detailed assessment and will confirm whether or not PVG Membership is required.]

(a)	PVG membership is not required.	<input type="checkbox"/>
(b)	PVG membership may be required for working with children.	<input type="checkbox"/>
(c)	PVG membership may be required for working with protected adults.	<input type="checkbox"/>
	PVG membership may be required for working with both children and protected adults.	<input type="checkbox"/>

If you answered yes to (b), (c) or (d) above, please give further information about the work to be required to undertake and the nature of the contact with these groups. Please provide as much detail as possible:

If you answered yes to (b), (c) or (d) above, please give further information about the work you will be required to undertake and the nature of the contact with these groups. Please provide as much detail as possible:

<input type="checkbox"/>	
<input type="checkbox"/>	Yes
Are you already a PVG member?	
<input type="checkbox"/>	
If yes, please provide your PVG Scheme number:	
<input type="checkbox"/>	Yes
Are specified procedures or safeguards required for recording, management, or storage of data? [see Guidance Note 8]	
<input checked="" type="checkbox"/>	
<input type="checkbox"/>	
If you answered yes to the above, please give details:	
I will require specific consent from participants to make audio recordings at the focus groups. This will be based on identities being <u>anonymised</u> in the transcribing of these recordings.	
The information in the recordings and subsequent transcriptions will be deemed to be confidential. The recordings will be deleted and the transcribed information will be stored on a computer at RGU and will be password protected. Only I and my academic supervisors will be able to access to this data. It will be deleted five years after the completion.	

.....Section Break (Odd Page)

PART 4: THE RESEARCH RELATIONSHIP

9. Does the research require the researcher to give or make undertakings to research participants or subjects about the use of data? [\[see Guidance Note 9\]](#)

If you answered yes to the above, please outline the likely undertakings:

I will only use the data collected for my dissertation, to inform development of a ~~potentially~~ for publication in journals and presentation at conferences.

10. Is the research likely to be affected by the relationship with a sponsor, funder or employer? [\[see Guidance Note 10\]](#)

If you answered yes to the above, please identify how the research may be affected:

My research is funded by the Digital Health and Care Institute (DHI) as a "Developing a Highly Skilled Workforce Scholarship".

It should be noted that there is a joint commercial interest based on Heads of Terms between RGU and the researcher's employer Skills at Work Ltd trading as Apt™.

PART 5: OTHER ISSUES

11. Are there any other ethical issues not covered by this form which you believe you should raise?

If you answered yes to the above, please give details:

STATEMENT BY RESEARCH STUDENT

I believe that the information I have given in this form is correct, and that I have addressed the ethical issues as fully as possible at this stage.

My research is funded by the Digital Health and Care Institute (DHI) as a "Developing a Highly-Skilled-Workforce-Scholarship".

It should be noted that there is a joint commercial interest based on Heads of Term between RGU and the researcher's employer Skills at Work Ltd trading as Apt™. The

PART 5: OTHER ISSUES

11. Are there any other ethical issues not covered by this form which you believe you should raise? **Yes**

If you answered yes to the above, please give details:

STATEMENT BY RESEARCH STUDENT
I believe that the information I have given in this form is correct, and that I have addressed the ethical issues as fully as possible at this stage.

Signed: Alan White Date: 11.01.2017

If any ethical issues arise during the course of the research, students should complete a further RESSA form. The Research Ethics Policy is available at www.rgu.ac.uk/research-ethics-policy

PART 6: TO BE COMPLETED BY THE PRINCIPAL SUPERVISOR

↑	12. Does the research have potentially negative implications for the University? [see Guidance Note 11]	Yes <input type="checkbox"/>
---	--	---------------------------------

↻	If you answered yes to the above, please explain your answer:	<input type="checkbox"/>
---	---	--------------------------

↑	13. Are any potential conflicts of interest likely to arise in the course of the research? [see Guidance Note 12]	Yes <input type="checkbox"/>
---	--	---------------------------------

↻	If you answered yes to the above, please identify the potential conflicts:	<input type="checkbox"/>
---	--	--------------------------

↑	14. Are you satisfied that the student has engaged adequately with the ethical implications of the work? [see Guidance Note 13]	Yes <input checked="" type="checkbox"/>
---	--	--

↻	If you answered no to the above, please identify the potential issues:	
---	--	--

↑	15. Has the RESSA been considered and/or approved by an internal forum, e.g. a School Ethics Review Panel (SERP) or equivalent? If yes, please provide details.	Yes <input type="checkbox"/>
---	---	---------------------------------

↻	it is being submitted in August 2016 before data collection begins once ethical approval, as set out in this form, has been approved.	
---	---	--

16. Please select one of the following:		<input type="checkbox"/>	<input type="checkbox"/>
The research project should proceed in its present form – no further action is required		<input type="checkbox"/>	<input type="checkbox"/>
The research project requires ethical review by the University's Research Ethics Sub-Committee (RESC)			<input checked="" type="checkbox"/>
The research project requires ethical review by an external body (N.B. Question 5 above). If this applies, please give these details:			<input checked="" type="checkbox"/>
Title of external body providing ethical review	NHS Highland R and D		
Address of external body			
Anticipated date when external body may consider project	Unknown		

↑
↑

AFFIRMATION BY PRINCIPAL SUPERVISOR			
I have read the research student's responses and have discussed ethical issues arising from the research student. I can confirm that, to the best of my understanding, the information presented by the research student is correct and appropriate to allow an informed judgement on whether further ethical approval is required.			
Signed:	Susan Crowther	Date:	10th August 2016

- If any ethical issues arise during the course of the research, a further RESSA should be completed. ¶

Appendix D – Ethics approval from NHS Highland

1. Study Information

Full title of study:	Exploration of how a mobile health (mHealth) intervention may support midwives in the management and referral of women with pre-eclampsia in rural and remote areas of Highland Scotland
IRAS Project ID:	224895
Sponsor Amendment Notification number:	AM01
Sponsor Amendment Notification date:	01/04/2018
Details of Chief Investigator:	
Name [first name and surname]	Alan White
Address:	Solutions Architect at Interactive Health Ltd, Aurora House, Inverness Campus, Inverness
Postcode:	IV2 5NA
Contact telephone number:	07710370528
Email address:	alan@ihmobilehealth.com

Details of Lead Sponsor:	
Name:	Alan White
Contact email address:	alan@ihmobilehealth.com
Details of Lead Nation:	
Name of lead nation <i>delete as appropriate</i>	Scotland
If England led is the study going through CSP? <i>delete as appropriate</i>	NA
Name of lead R&D office:	NSH Highland

Appendix E - Literature Review Protocol

The initial scoping review (Appendix B) that justified the need for this study addressed six research questions:

- Is there a need for end-users (midwives) to be involved in developing new mHealth interventions?
- What mHealth apps aimed at supporting healthcare professionals in the management of pre-eclampsia have been described in the literature?
- What methodologies have been used to study or evaluate these apps and what processes or outcomes have been examined?
- What evidence of effectiveness exists?
- What barriers and facilitators to adoption have been reported, including usability and accessibility?

My findings from the initial scoping review confirmed that there is a consensus around a need for more healthcare professionals to be involved in the development of new mHealth interventions. Based on these findings, I concluded that two questions require to be answered:

1. Might a solution such as an mLearning/mHealth toolkit be acceptable and useful to rural midwives in detecting, managing and making timely referrals in respect of women presenting with possible pre-eclampsia?
and
2. To ascertain whether a solution such as an mLearning/mHealth toolkit offers any advantage and/or improvement over current practice?

Methods:

The protocol sets out in advance the methods to be used in the review with the aim of minimising bias.

Four online databases (CINHAL, Medline, Pubmed and Google Scholar) will be used to search for primary source published studies. The search terms included "eHealth", "mHealth", "mobile health", "telehealth", "remote and rural healthcare", "remote and rural maternal healthcare", "rural midwives", "midwives' CPD", "the use of smartphones by rural midwives", " mHealth

interventions in pregnancy”, “mHealth interventions in pre-eclampsia”, “mHealth interventions in eclampsia” and “mHealth interventions in pregnancy induced hypertension” and each of the above in association with rural and remote midwives in Highland Scotland.

Appendix F

Relevance of peer reviewed papers and articles

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end- users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
1. Chipps et al. (2015) South Africa	Quantitative: - survey (structured questionnaire)	Rural midwives (n=56)	Mobiles phones, text messaging and mobile apps	Survey about how midwives used mobile phones/lap- tops Midwives were not involved in the development of	23 (41%) midwives found technology easy to use. 43 (76.8%) respondents reported laptop was effective for learning, followed by 41 (73.2%) for LMS. Only 22(39.3%)	Facilitators: 45 (80.4%) midwives perceived facilitators used technology effectively, 43 (76.8%) used frequently. Barriers:	41 (73.2%) of respondents felt that the technology was essential for learning More investment required in the	++1

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end- users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
				mobile applications.	respondents reported phones were effective for learning. East access to information. 41(73.2%) respondents said technology is essential for learning.	32 (73.2%) and 34 (60.7%) midwives reported mobile phones or social networking sites were not supported for educational and work-related purposes respectively. 28 (50%) midwives perceived facilitators did not know how to use technology	technology	

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end-users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
						effectively.		
2. Coetzee et al. (2017) South Africa	Mixed methods: Focus groups	Community health workers (CHWs) & para professionals (n=24)	Videos content on tablets - health promotion messages used by CHWs	CHWs were trained to use the tablets. CHWs were asked about what helped or hinder their	CHWs experienced tablets to be effective educational and administrative tools and time-efficient compared to usual methods.	Facilitators: The tablet conveyed a sense of importance of their work to their clients. CHWs reported increased	mHealth interventions can provide considerable support to CHWs	++1

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end-users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
(2014) Australia	Focus Groups Short surveys	range of 23-60 yrs (n=21) Interviews (n=8) 2 focus groups (n=4 and n=9)	unspecified	the design of the intervention but their responses will inform the ongoing upgrades	professional use ICTs and accessing information from the internet,	level education	by participants to use social media to interact with clients	
4. Kapble et al. (2015) India	Quantitative: Field testing of intervention (Commcare app) Observation	Rural CHWs (n=15)	Smartphones	No evidence is presented of participants being involved in the design or	mHealth interventions can be effective and acceptable	Facilitators Perceived usefulness of technology	mHealth technology can positively impact the quality of	2

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end-users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
7. Lund et al (2016) Ethiopia	RCT at 73 health centres in 5 rural districts Analyses performed based on the intention-to-treat principle	Women (n=3601) Health careworkers (n=1765)	Smartphones loaded with the SDA training tool app	No evidence is presented of participants being involved in the design or development of the app. However observation of their use of the app may inform future any future enhancements	Significant reduction in perinatal mortality Attributed to enhanced training and use of smartphones	Facilitators Barriers Lack of CDD for CHWs	Significantly improved skill scores among the CHWs using the SDA intervention	+1

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end-users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
8. Medhanyie (2015) Ethiopia 2 articles, 1 study	Quantitative: Field testing of the intervention by the healthcare workers Mixed methods Questionnaire	Healthcare workers (n=25) Women (n=1,122)	Smartphones Loaded with electronic health record forms	No evidence is presented of participants being involved in the design or development of the app. However observation of their use of the app may inform	Acceptability of the intervention was high	Facilitators Improved mobile telecoms network coverage and securing mobile network airtime are required to take intervention to	Both midwives and CHWs found the intervention useful	1

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end-users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
				future any future enhancements		scale Barriers Potentially cost which was not addressed		
9. Modi et al (2015) India	Qualitative: Field testing of the <u>ImTeCHO</u> intervention and interviews	<u>CHWs</u> (n=45)	Smartphones Loaded with <u>ImTeCHO</u>	Input from <u>CHWs</u> , based on grassroots experience was used from the outset in	Intervention found to be highly acceptable	Facilitators Improved training of the <u>CHWs</u> in the use of the intervention	The intervention was found to be useful and acceptable within the	+1

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end-users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
				developing the intervention and the results from this study will inform further improvements to the tool		Barriers Poor skills among the <u>CHWs</u> ; Poor motivation due to lack of incentives for <u>CHWs</u> , to engage; Smartphones require to be provided to <u>CHWs</u>	primary care system; An improved version of is now being tested through a series of new <u>RCTs</u>	
10. Rothstein et al	Qualitative: Field testing of the Client	Community Health Nurses	Low-cost Nokia feature phones loaded	No evidence is presented of participants	Found to support existing	Facilitators Easily integrated	Mobile phones hold great promise for	++1

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end-users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
(2016) Ghana	Data App Interviews and focus groups	(CHNs) (n=200)	with the Client Data app	being involved in the design or development of the app. However observation of their use of the app may inform future any future enhancements of the intervention	Current practice and reduce workloads	with current practice Quite literally lightened the CHWs' load Saves time Cuts though bureaucratic paperwork Barriers Under reporting of	overcoming health disparities among rural populations by bridging the gap between access to client health information and access to care	

Author/year Country/No.	Study design & method of data collection	Participant characteristics	Mobile devices/ applications	Findings			Key messages	Level of evidence (SIGN)
				Is there a need for end-users to be involved in developing new mHealth interventions?	What evidence is there of the acceptability and effectiveness of mHealth interventions?	What are the barriers and facilitators to the adoption of mHealth interventions?		
Brazil	Genhealth app Interviews			in the design or development of the app. However this study will be used to inform improvements to the Genhealth app	Perceived as useful by CHWs	Poor quality hardware	order to maximise the utility and minimise any barriers to use	
12. Velez et al (2014) Ghana	Mixed methods: Field testing by participants of the mClinic app	Midwives (n=7)	Smartphones Loades with a prototype of the mClinic app	No evidence is presented of participants being involved in the design or development of	Perceived as useful by the participants	Neutral as to ease of use but... Facilitators Benefits from user familiarity with	Importance of the need to involve users (midwives) in the design of mHealth	++1

Appendix G: Quality assurance checklist summaries

CASP questions:

- Q1 Was there a clear statement of the aims of the research?
- Q2 Is a qualitative methodology appropriate?
- Q3 Was the research design appropriate to address the aims of the research?
- Q4 Was the recruitment strategy appropriate to address the aims of the research?
- Q5 Was the data collected in a way that addressed the research issue?
- Q6 Has the relationship between researcher and participants been adequately considered?
- Q7 Have ethical issues been taken into consideration?
- Q8 Was the data analysis sufficiently rigorous?
- Q9 Is there a clear statement of findings?
- Q10 How valuable is the research?

CASP checklist summary

CASP Question (Q) Yes = Y No= N Can't tell = CT

Design	Author	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SIGN
RCT	Lund et al	2016	Y	Y	Y	N	Y	Y	Study included 3601 women	CT	Y	Y	+1
Qualitative	Medhanyie et al	2015	Y	Y	Y	Y	Y	CT	Y	N	Y	Y	1
Qualitative	Modi et al	2015	Y	Y	Y	Y	Y	CT	N	Y	Y	Y	+1
Qualitative	Rothstein et al	2016	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	+++
Qualitative	Schoen et al	2017	Y	Y	Y	Y	Y	CT	N	Y	Y	Y	+1

MMAT questions:

All studies

Q1 Are there clear qualitative and quantitative research questions or a clear mixed methods question or objective?

Q2 Do the collected data address the research question?

Quantitative studies

Q3 Is the sampling strategy relevant to the research question?

Q4 Is the sample representative of the population that is being studied?

Q5 Are the measurements appropriate

Q6 Is there an acceptable response rate (60% or above)

Mixed methods studies

Q6 Is the mixed methods research design relevant to the qualitative and quantitative research questions?

Q7 Is the integration of qualitative and quantitative relevant to the research question?

Q8 Is appropriate consideration given to the limitations associated with the integration of methods?

MMAT quantitative study checklist summary

MMAT Question (Q)

Yes = Y No= N Can't tell = CT

Design	Author	Year	Q1	Q2	Q3	Q4	Q5	Q6	SIGN
Quantitative	Chipps et al	2015	Y	Y	Y	Y	Y	N	++1
Quantitative	Kaphle et al	2015	Y	Y	Y	N	Y	N	2

MMAT mixed methods study checklist summary

MMAT Question (Q)

Yes = Y No= N Can't tell = CT

Design	Author	Year	Q1	Q2	Q6	Q7	Q8	SIGN
Mixed	Coetzee	2017	Y	Y	-	Y	Y	++1

methods	et al							
Mixed methods	Dalton et al	2014	Y	Y	Y	Y	Y	+++
Mixed Methods	Knoble et al	2015	Y	Y	-	N	Y	1
Mixed methods	Lim et al	2015	Y	Y	-	Y	Y	+++
Mixed Methods	Velez et al	2014	Y	Y	-	Y	Y	+++

Appendix H Maternal health apps and eLearning programmes

App/technology	Functionality	Evidence
<p>oMama</p> <p>Developed by by the Better Outcomes Registry and Network (BORN), a programme of the Children's Hospital of Eastern Ontario (CHEO)</p>	<p>This is a new app that connects women and families to trusted, evidence-informed healthy pregnancy, birth and early parenting information</p>	<p>It is a pilot project launched in November 2015 for families in Ontario, Canada. This review found no published articles on <i>OMama</i>.</p>
<p>Baby Buddy</p> <p>Developed in the UK by the Best Beginnings team:</p>	<p>This is new app aimed at providing information to Midwives and women</p>	<p>It has been the subject of an internal evaluation (Cooper 2015). This has not been peer reviewed, nor has it been published</p>

		independently
<p><i>POTM</i></p> <p>Developed by PIERS study Group – Canada & South Africa</p>	<p>A new app</p> <p>Community Health Workers (CHWs) in South Africa.</p> <p>Its focus is on pre-eclampsia, but it does not provide a holistic support too</p>	<p>It is the subject of 3 papers that duplicate each paper (Dunsmuir et al. 2014) and Lim et al, 2015) and Dadelszen et al (2015)</p>
<p>LEAP</p> <p>Developed by AMREF in Kenya</p>	<p>This is a new app that has evolved from SMS (Text Messaging)</p> <p>It is aimed at front line health workers in Kenya and elsewhere in Sub Saharan Africa</p> <p>AMREF claim that its use has resulted in a significant decrease in the levels of maternal and newborn mortality and morbidity in rural Kenya.</p>	<p>AMREF have conducted an internal review, using Kirkpatrick’s methodology but nothing has been published and at the time of the AHAIC conference, the app had been temporarily withdrawn</p>
App/technology	Functionality	Evidence
<p>“Pre-eclampsia: Diagnosis and Management”</p> <p>Developed by Action on Pre-eclampsia (APEC)</p>	<p>A non-interactive pdf aimed at midwives and healthcare professionals.</p> <p>It looks very dated and unengaging</p>	<p>None</p>

<i>Mbindyo and Mutuku (2017)</i>	Described as an app to support CHWs in Uganda and Kenya	None, but reported on at AHAIC 2017

Appendix I Information for participants in the focus groups
Preliminary information for potential participants



Exploration of how a mobile health (mHealth) intervention may support midwives in the management and referral of women with pre-eclampsia in rural and remote areas of Highland Scotland

Information Sheet for Participants March 2017

As a midwife working in NHS Highland, you are invited to participate in a research project conducted by a post-graduate researcher, Alan White, from the Robert Gordon University (RGU). Before you decide whether or not to participate, it is important to understand why the research is being done and what involvement will mean for you. Please take time to read the following information carefully. Talk to others about the study if you wish. Feel free to ask the researcher if there is anything that is not clear or if you would like more information (contact details at the end of this information sheet). Take time to decide whether or not you wish to take part.

Part 1 of this information sheet tells you the purpose of this study and what will happen if you take part. Part 2 gives you more detailed information about the conduct of the study.

Part 1

What is the purpose of the study?

The project aims to assess and evaluate whether a mobile health (mHealth) intervention can support midwives in the management of pregnant women with hypertension in rural and remote areas of Highland Scotland? The Midwifery and Research and Development Functions in NHS Highland and the Digital Health and Care Institute support the project. The intervention in this instance is called *maApt*[™]. It is a new holistic mHealth tool, a tablet (e.g. an iPad) that is preloaded (no internet connectivity is required) with advisory, diagnostic and Online Continuous Professional Development (OCPD) apps. For the period of the study *maApt*[™] is only intended to supplement, not replace your current practice.

Why have I been invited?

When you took part, either in person or via video conferencing in the stakeholder meeting in Inverness on the 31st May, you kindly indicated that you would be interested in being a member of one of the 2-4 cohorts of Highland midwives that would take part in a pilot of *maApt*TM.

Do I have to take part?

No, it is up to you to decide. If you are interested, please let the researcher know by filling in the attached reply form and emailing that, along with any queries that you may have to him at: a.h.white@rgu.ac.uk . You will then be asked to sign a consent form to show you have agreed to take part. If you do decide to take part, you are still free to withdraw at any time without giving a reason.

What will happen if I decide to take part?

The study will require you to attend two focus groups, each lasting for approximately two hours. The first focus group is intended to elicit your views on content that could support your practice in respect of:

- Advisory apps to support midwives' knowledge and facilitate discussions between them and expectant parents
- Diagnostic apps to assist in the early diagnosis and management of pre-eclampsia
- A virtual learning environment to support the Online Continuous Professional Development (OCPD) of midwives – this will be based on a series of short courses being developed by RGU that meet the criteria of the Nursing and

Midwifery Council (NMC) for midwives' CPD. This aligns with the re-validation criteria of the Nursing and Midwifery Council (NMC) for midwives, it includes:

Your input at the Focus Group will be recorded and subsequently transcribed and analysed by the researcher. The recorded data will be used solely for the use of this study and although confidentiality cannot be assured, all identities will be anonymised in the transcribing, such as change of place names and use of pseudonyms or numerical codes. The recordings will be deleted and the transcribed information will be stored on a computer at RGU and will be password protected until it is deleted. Only the researcher and the supervisors at RGU will be able to access to this data. It will be deleted within five years completion of the researcher's dissertation. You will be required to sign the attached Consent Form prior to participating in the first focus group.

The next step will be to develop a prototype of *maApt*[™]. You will then asked to attend a half day training session when you will be issued with an iPad-mini that remains the property of NHS Highland, is encrypted to comply with NHS Highland's IT policy and is preloaded with the *maApt*[™] apps. You are then expected to use *maApt*[™] over the next two months to supplement your current practice. Following on from that, you will be asked to attend the second focus group. This will be conducted in the same way as the first.

Travelling expenses incurred by taking part in an interview or group discussion will be reimbursed.

The research will take 10 months to complete (from April 2017).

Will my taking part in the study be kept confidential?

Yes, all information that is collected during the course of the research will be kept strictly confidential according to the Data Protection Act 1998. Names and contact details will be stored separately from other data collected. Data will be reported anonymously in all reports, papers and presentations arising from the research. Data will be stored for 5 years and will be destroyed when it is no longer needed for the project. Anonymous data may be shared with other researchers.

This completes Part 1. If the information in Part 1 has interested you and you are considering taking part, please read the additional information in Part 2 before making any decision.

Part 2

What if there is a problem?

Any complaint about the way you have been dealt with during the study or any possible harm you might suffer will be addressed. If you have a concern about any aspect of this study, you should ask to speak to the researcher who will do her best to answer your questions. If you remain unhappy and wish to complain formally, you can do this through the researcher's Principle Supervisor, Professor Susan Crowther at The Robert Gordon University. Her email address is s.a.crowther@rgu.ac.uk

What will happen to the results of the research study?

The research aims to contribute to the growing body of knowledge around the need for and efficacy of mHealth interventions in maternal and child health. It is hoped that this study can help inform initiatives by providing findings that are applicable around the world.

A report of the study will be written; results may be published in peer review journals and reported at one or more conferences. Participants will be given the results of the study in the form of a summarised report. You will not be identified in any report or publication without your permission.

Who is organising and funding the research?

The research is being undertaken by Alan White, Programme Development Director at Apt (www.aptlearning.co.uk) and a MRes student at The Faculty of Health and Social Care at The Robert Gordon University, Aberdeen. The Scottish Digital Health and Care Institute (DHI) is funding the research.

Who has reviewed the study?

This study has been reviewed and approved by RGU (RESSA), North of Scotland Research Ethics Service (NOSRES), National Research Ethics Service (NRES), School of Nursing and Midwifery Review Panel (SERP).

What happens next?

Please get in touch if you have any questions about the research or about this invitation to participate. If you do decide that you would like to take part in the research, please complete and return the attached consent form to a.h.white@rgu.ac.uk

Contact for further information:

If you have any questions or would like any more information about this study, please contact:

Alan White, MRes student at The Robert Gordon University

Telephone: 07710 370528 or e-mail a.h.white@rgu.ac.uk

We look forward to you agreeing to participate in the study.

Appendix J - Poster aimed at recruiting participants



Calling Highland Midwives

You are invited to participate in focus groups and to help explore how a mobile health (mHealth) intervention may support midwives in the management and referral of women with pre-eclampsia in rural and remote areas of Highland Scotland. The first focus groups will be held close to where you work in mid June or early July.

The project aims to assess and evaluate whether a mobile health (mHealth) intervention can support midwives in the management of pregnant women with hypertension. The intervention in this instance is called *maApt*[™]. It is a new holistic mHealth tool, a tablet (e.g. an iPad) that is preloaded (no internet connectivity is required) with advisory, diagnostic and Online Continuous Professional Development (OCPD) apps.

For further information please contact Claire Darling:

claire.darling1@nhs.net

or Alan White:

a.h.white@rgu.ac.uk

Appendix K Flyer sent to participants



Exploration of how a mobile health (mHealth) intervention may support midwives in the management and referral of women with pre-eclampsia in rural and remote areas of Highland Scotland

Information Sheet for Participants, May 2017

As a midwife working in NHS Highland, you are invited to participate in a research project conducted by a post-graduate researcher, Alan White, from the Robert Gordon University (RGU). Before you decide whether or not to participate, it is important to understand why the research is being done and what involvement will mean for you. Please take time to read the following information carefully. Talk to others about the study if you wish. Feel free to ask the researcher if there is anything that is not clear or if you would like more information (contact details at the end of this information sheet). Take time to decide whether or not you wish to take part.

Part 1 of this information sheet tells you the purpose of this study and what will happen if you take part. Part 2 gives you more detailed information about the conduct of the study.

Part 1

What is the purpose of the study?

The project aims to assess and evaluate whether a mobile health (mHealth) intervention can support midwives in the management of pregnant women with hypertension in rural and remote areas of Highland Scotland? The Midwifery and Research and Development Functions in NHS Highland and the Digital Health and Care Institute support the project. The intervention in this instance is called *maApt*[™]. It is a new holistic mHealth tool, a tablet (e.g. an iPad) that is preloaded (no internet connectivity is required) with advisory, diagnostic and Online Continuous Professional Development (OCPD) apps. For the period of the study *maApt*[™] is only intended to supplement, not replace your current practice.

Why have I been invited?

When you took part, either in person or via video conferencing in the stakeholder meeting in Inverness on the 31st May, you kindly indicated that you would be interested in being a member of one of the 2-4 cohorts of Highland midwives that would take part in a pilot of *maApt*[™].

Do I have to take part?

No, it is up to you to decide. If you are interested, please let the researcher know by filling in the attached reply form and emailing that, along with any queries that you may have to him at: a.h.white@rgu.ac.uk . You will then be asked to sign a consent form to show you have agreed to take part. If you do decide to take part, you are still free to withdraw at any time without giving a reason.

What will happen if I decide to take part?

The study will require you to attend two focus groups, each lasting for approximately two hours. The first focus group is intended to elicit your views on content that could support your practice in respect of:

- Advisory apps to support midwives' knowledge and facilitate discussions between them and expectant parents
- Diagnostic apps to assist in the early diagnosis and management of pre-eclampsia
- A virtual learning environment to support the Online Continuous Professional Development (OCPD) of midwives – this will be based on a series of short courses being developed by RGU that meet the criteria of the Nursing and

Midwifery Council (NMC) for midwives' CPD. This aligns with the re-validation criteria of the Nursing and Midwifery Council (NMC) for midwives, it includes:

Your input at the Focus Group will be recorded and subsequently transcribed and analysed by the researcher. The recorded data will be used solely for the use of this study and although confidentiality cannot be assured, all identities will be anonymised in the transcribing, such as change of place names and use of pseudonyms or numerical codes. The recordings will be deleted and the transcribed information will be stored on a computer at RGU and will be password protected until it is deleted. Only the researcher and the supervisors at RGU will be able to access to this data. It will be deleted within five years completion of the researcher's dissertation. You will be required to sign the attached Consent Form prior to participating in the first focus group.

The next step will be to develop a prototype of *maApt*[™]. You will then asked to attend a half day training session when you will be issued with an iPad-mini that remains the property of NHS Highland, is encrypted to comply with NHS Highland's IT policy and is preloaded with the *maApt*[™] apps. You are then expected to use *maApt*[™] over the next two months to supplement your current practice. Following on from that, you will be asked to attend the second focus group. This will be conducted in the same way as the first.

Travelling expenses incurred by taking part in an interview or group discussion will be reimbursed.

The research will take two years to complete (from June 2017).

Will my taking part in the study be kept confidential?

Yes, all information that is collected during the course of the research will be kept strictly confidential according to the Data Protection Act 1998. Names and contact details will be stored separately from other data collected. Data will be reported anonymously in all reports, papers and presentations arising from the research. Data will be stored for 5 years and will be destroyed when it is no longer needed for the project. Anonymous data may be shared with other researchers.

This completes Part 1. If the information in Part 1 has interested you and you are considering taking part, please read the additional information in Part 2 before making any decision.

Part 2

What if there is a problem?

Any complaint about the way you have been dealt with during the study or any possible harm you might suffer will be addressed. If you have a concern about any aspect of this study, you should ask to speak to the researcher who will do her best to answer your questions. If you remain unhappy and wish to complain formally, you can do this through the researcher's supervisor, Professor Susan Crowther at The Robert Gordon University. Her email address is s.a.crowther@rgu.ac.uk

What will happen to the results of the research study?

The research aims to contribute to the growing body of knowledge around the need for and efficacy of mHealth interventions in maternal and child health. It is hoped that this study can help inform initiatives by providing findings that are applicable around the world.

A report of the study will be written; results may be published in peer review journals and reported at one or more conferences. Participants will be given the results of the study in the form of a summarised report. You will not be identified in any report or publication without your permission.

Who is organising and funding the research?

The research is being undertaken by Alan White, Programme Development Director at Apt (www.aplearning.co.uk) and a MRes student at The Faculty of Health and Social Care at The Robert Gordon University, Aberdeen. The Scottish Digital Health and Care Institute (DHI) is funding the research.

Who has reviewed the study?

This study has been reviewed and approved by RGU (RESSA), North of Scotland Research Ethics Service (NOSRES), National Research Ethics Service (NRES), School of Nursing and Midwifery Review Panel (SERP). The Caldicott Guardian for Grampian was consulted regarding data protection issues.

What happens next?

Please get in touch if you have any questions about the research or about this invitation to participate. If you do decide that you would like to take part in the research, please complete and return the attached reply slip to **a.h.white@rgu.ac.uk**

Contact for further information:

If you have any questions or would like any more information about this study, please contact:

Alan White, MRes student at The Robert Gordon University

Telephone: 07710 370528 or e-mail a.h.white@rgu.ac.uk

We look forward to you agreeing to participate in the study.

Appendix L - Consent Form



School of Nursing and Midwifery

The Robert Gordon University

Garthdee Road

Garthdee

CONSENT FORM

Could a mobile health (mHealth) intervention support midwives in the management of women with hypertension in rural and remote areas of Highland Scotland?

Participant identification Number:

187

Name of Researcher: Alan White

Please Initial the boxes

1. I confirm that I have read and understand the information sheet dated August 2016 (version 1) for the above study and have had the opportunity to ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, and without my legal rights being affected.
3. I understand that data collected during the study, may be looked at by individuals from the research team, regulatory authorities, or the funding body for the study, where it is relevant to my taking part in this research. I give permission for these individuals to access my data.
4. I agree for my input at focus groups to be recorded and understand that these recordings will be deleted after they have been typed up.
5. I agree that anything I may say during the course of the interview may be used as anonymous quotes in any presentation of the research (written or oral).
5. I agree to take part in the study.

Name of participant

Date

Signature

Researcher

Date

Signature

Appendix M Examples of coding for thematic analysis

Thematic codes:

- 1 Working in Isolation
- 2 Recognising and dealing with women with pre-eclampsia in rural and remote settings
- 3 Learning on the move
- 4 Using audio visual resources
- 5 Feeling uneasy with advances in technology

Transcribed from Argyll & Bute - Focus Group "O" (Held in Admin VC room in Maternity wing at Oban Hospital) attended by 3 midwives physically present and 3 midwives participating via video conferencing:

440	looking at something, either it's because you're	4
441	passively watching something and, you know,	
442	it's either that or a 10 year old magazine or,	
443	you know, just because something exists	
444	doesn't mean you're going to search it out and	
445	look for it.	
446	I - I mean that, that, what you've just described is	
447	actually one of the uses that's, that's meant to	
448	be, one of the ways it meant to be used	
449	actually.	
450	P3 - The dentist, I'm fed up seeing how you can get	4
451	your teeth all, the same videos over and over	
452	again.	
453	P1 - It's like all these things, they're just tools so	
454	there has to be a really good, there has to be a	4
455	motivation behind it, it's just in itself it isn't	
456	going to make you go near it.	
465	I - I'll quickly catch up.	
467	P4 - How many women do you think really read,	
468	you know, the leaflets on alcohol, you know,	
469	especially if they drink, I don't think they read	
470	them.	
471	P1 - I think any of the leaflets, we know from	
472	ancient research don't we, that leaflets are only	4
473	good if it's facilitated and gone through with	
474	the person, if you just give folk a pile of leaflets	

475	they're not going to read them.	
476	I - No. I mean, could you see yourself in a	
477	situation where if you had something like that	
478	on your phone you would sit and maybe run	
479	through it with a woman? Using it an interface,	
480	is that something you might think about using	
481	in that way?	
482	P3 - Well, I suppose there's so many different	
483	elements to health education and pregnancy,	4
484	do you know, and it may, it may enhance some	
485	of that education that you're already delivering	
486	in a face to face but, I just think there's so	
487	many elements...	
488	P1 - To promote a discussion as much as anything	
489	and we have like a health promotion sort of,	4
490	err , appointment, you know, in early	
491	pregnancy to, you know, but again that	
492	discussion's already going on between the	
493	midwife and every woman about, so, among	
494	many other things...	
495	I - Sure.	
496	P1 - ... you know so it's, you know, whether that's	
497	in their home or in here, I don't know if that's	4
498	going to interrupt your discussion and part of,	
499	because that part of your discussion is you're	
500	building a relationship with that person and I	

501	don't know if stopping and watching that is	
502	going to add to that to be honest.	
503	P3 - The only thing I'm thinking is sometimes when	
504	you're hearing it and visually seeing you will	
505	then...	4
506	P1 - Makes more of a...	
507	P3 - ...it'll be absorbed better, I don't know, just	
508	thinking through training and stuff it tends to	
509	work better if you're seeing something and	4
510	hearing it as well, it kind of reinforces it more	
511	doesn't it.	
512	P1 - I can see having it in a waiting area would be	
513	something that would be useful because people	
514	are passively taking that in then rather than it	4
515	kind of being...	
516	P4 - There's so many things to be discussed during	
517	pregnancy different, you know, parts of their	4
518	care, alcohol's only one thing...	
519	I - Oh no, I wasn't...	
520	P4 - ...to do that for every single condition or	4
530	problem that might arise.	
531	I - Yes. No, I mean, the alcohol was only really an	
532	example, it was more around the style. I mean,	
533	that bit of the program is, is actually designed	
534	to used in the waiting areas or a work force	
535	canteen sort of situation.	

536	P1 - It also helps a bit but if you're doing parent	
537	education we know people are only taking	
538	things in for like, sort of, 12 minute bunches of	4
539	time so actually having something that breaks	
540	it up and changes, you know, it's not going to	
541	do any harm.	
542	P3 - I suppose the other thing I'm thinking where it	
543	could potentially be used is your, the Facebook	
544	stuff...	4
545	P1 - Aye.	
546	P3 - ...rather than just us reading...	
547	P1 - Aye, put a link on Facebook so we can put our	
548	Facebook or something and people might look	
549	at it.	4
550	P3 - ...we've not got a Facebook page where we	
551	get...	
552	I - Okay, is that Highland wide or is that	
553	specifically something you're doing...	
554	P1 - We've got one for Argyll & Bute, Perth and	
555	Argyll & Bute.	
556		
557	I - Okay.	
558	P3 - And that's where we have, each team had	
559	administration rights to that and we, so that	
560	might be another...	4
561	P1 - So, we would, something like that on that	
562	would be...	

715	I - Is that Highland, is that Highland-wide or is	
716	that because...	
717	P4 - No, it isn't.	
718	P1 - It's Highland-wide but they're also bringing it in	
719	in Glasgow as well so we would have the	2
720	Glasgow version of that.	
721	I - Yes, okay, but it is going to be throughout the	
722	Highlands. When's the actually happening?	
723	P3 - I think they're starting working groups just now	
724	looking at it and H-'s been very much part of	2
725	that.	
726	I - Okay.	
727	P1 - So of like ideas about being up by August so	
728	probably next year.	
729	I - Okay, yeah, so I'll...	
730	P3 - Yeah, it's all kind of focus groups...	
731	I - So H-', H-'s involved?	
732	P1 - Aye, absolutely.	
733	I - Yeah, no, I'll speak to H- about that.	
734	P1 - But that also gives us the potential then of	
735	being able to have all our leaflets on electronic	2/4
736	format so you can facilitate a discussion with a	
737	woman without having to bring in 10 tonnes of,	
738	you know, when we've developed a leaflet on,	
739	for example, relative risks of giving birth in	
740	different areas the evidence-base, to be able to	

1951	I - And I'm, I'm wanting to end up with something	2/5
1952	that will inform practice.	
1953	P3 - Aye, yes.	
1954	P1 - Well, that's great cause that's exactly why...	
1955	P3 - And that's what we want as well, we want to be	
1956	part of something that's going to make a	
1957	difference, we don't want to be just because	
1958	it's a study and we've been coerced...into, do	
1959	you know, do you know...	
1960	I - Oh I know, but, no, I know and that's and	
1961	you've absolutely...	
1962	P3 - ...we've been too long in the tooth Alan, we're	
1961	been around a long time. We're not	
1962	submissive.	
1963	P1 - Good luck with transcribing this lot, that's all I	
1964	can say.	
1965	I - Yeah, yeah, no, it is, everything's anonymised.	
1966	P1 - That, you'll also find people won't be happy to	
1967	talk about individual cases.	
1968	I - No, I know, I realise that, yeah.	
1969	P1 - Far too small a population and, you know, off,	
1970	if, is that still recording or is it?	
1971	I - I can switch off if you like?	
1972	P1 - Yeah, well I think it's important, well, it's just	
1973	purely there are....	

Appendix N Field notes from focus groups

1st June 2017 – Recruitment Meeting in Inverness Centre for Life Sciences

1. Two meetings - in person and via video conferencing were held with participants who, after receiving flyers had expressed an interest in participating in the study.
2. I presented an overview of the proposed study
3. The response from participants was generally supportive and it was agreed that 3 cohorts, each of up to 6 midwives from Skye, Argyll & Bute and Dingwall would participate in the Phase 1 Focus Groups
4. Focus Groups were scheduled to take place in Broadford (Skye) on 13th June; Oban (Argyll & Bute) 22nd June and in Inverness (Dingwall) on 23rd June.

13th June 2017 – Broadford Hospital

1. I had initial difficulty finding the hospital – no roadside signage, but got directions from a Pharmacy on the main road.
2. Met and given a tour of the maternity facilities including the delivery room with a VC facility to enable contact with the obstetrics team at Raigmore (mainly post natal)
3. The focus group was held in the VC room of the nearby admin bungalow with three midwives participating in person and a further three via VC
4. Initial problems setting up the VC, but resolved with the help of the admin staff
5. One midwife left for a possible emergency, but returned before the end of the focus group
6. All participants thought that the study was relevant to their practice and wanted to continue to be involved in the study. They particularly welcomed the idea that the intervention would include preloaded CPD materials.

7. They shared stories around instances of pre-eclampsia.
8. All participants completed and signed consent forms

22nd June 2017 – Oban Hospital

1. This time I had no difficulty finding the Hospital, though for people not familiar with Oban, signage could be misleading since it indicates a Caravan site
2. The focus group was held in a VC room
3. Two midwives attended in person with 3 participating via VC, which initially didn't work due to an "outage" in the NHS VC system
4. All participants thought that the study was relevant to their practice and wanted to continue to be involved in the study. Again they particularly welcomed the idea that the intervention would include preloaded CPD materials
5. Again they shared stories around instances of pre-eclampsia, some after the recorder had been switched off
6. All participants completed and signed consent forms.

23rd June 2017 – Inverness Raigmore Hospital (Parent Craft Room)

1. Internal signage and lack of an in-patient reception desk at Raigmore caused me some difficulty in finding the Parent Craft Room, indeed a shop assistant in the reception area directed me to Outpatients, on the way there it was possible to decipher the pictograms on external signage and to return to the main building and subsequently, with directions from a nurse, to find the parent craft room. There appeared to be no internal security and I was able to wander around the maternity area un-badged and unchallenged whilst searching for the room
2. Having found the room, two participants were already there and 5 more participated via VC from Dingwall

3. The VC participants had not received flyers or consent forms – and it seemed that they had just been asked to attend a VC session without really knowing why
4. It was agreed that they would show their consent via a show of hands, witnessed by the participants who were physically present – all agreed to participate on this basis and to subsequently submit consent forms if they wished to take part in the study
5. All of the VC participants thought that the study was irrelevant to their practice since they did not consider themselves to be remote
6. Two VC participants in particular thought that the study was a slur on their professional practice and one, (the youngest) resented the idea that she might be expected to undertake CPD in her own time at home
7. It was suggested that Gestational Diabetes might be a more appropriate topic than pre-eclampsia
8. Throughout the focus group, the two midwives who were physically present were generally more supportive and wished to continue to participate in the study
9. Once the recorder had been switched off, the midwives who were physically present both suggested that it might be appropriate and valuable to include the new cohort of Family Nurse Practitioners in Dingwall/Alness/Invergordon as they are typically dealing with high levels of social deprivation and more instances of pre-eclampsia among girls and young women
10. The two midwives present completed and signed consent forms

Appendix O Scripts for *mApt*[™]

mApt MLearning Script

INTRODUCTION

Fiona:	Visuals.
<p>Welcome to this prototype of a suite of interactive iBooks covering the topic of Pre eclampsia and eclampsia. You can access it on desk top and lap top computers, smartphones and tablets and you don't have to be connected to the internet.</p>	<p><i>Ident with Fiona's name and role</i></p>
<p>It has been designed to support Midwives and other Health Care Professionals who have a responsibility for providing support to women during pregnancy</p>	<p><i>Fiona ptc</i></p>
<p>AND</p> <p>To help midwives to explain pre-eclampsia to women who may want to explore the condition a bit more with their midwife in order to gain a deeper understanding.</p>	<p><i>Fiona ptc</i></p>

Firstly, it might be helpful to know a little bit about the history of this condition which is exclusively confined to pregnancy –

Early references to eclampsia date back to Ancient Greece between 4th & 5th Century when the followers of Hippocrates subscribed to the theory of the four humors to describe the cause of illness and disease.

They believed that the body was made up of four humors (fluids) that included blood, phlegm, yellow bile, and black bile. Health depended on a balance of the humors and any imbalance in the humors resulted in illness – a very loose theory of course and not one that we subscribe to today.

They also believed that various natural phenomena 'lightning' could cause illnesses and the word eclampsia stems from the Greek word for lightning.

That might seem a little dramatic but it is used the context of a seizure which is what can happen if the condition of pre eclampsia is not controlled which is essentially what modern day midwives and obstetricians strive to achieve. It is therefore vital that we do have the knowledge and skills

Fiona ptc

*Stock
footage
of
Ancient
Greek*

<p>to identify and manage this condition.</p> <p>We have of course progressed significantly since Hippocratic times with various discoveries being made through the Middle Ages, 17th, 18th & 19th Centuries with deeper understanding of the condition and necessary treatment being gained.</p>	<p><i>buildings and art</i></p>
<p>As we moved into the 20th and 21st Centuries we now have extensive knowledge around how to identify the risks to women and their babies and ensure that appropriate pathways of care are in place to minimise harm to both Mum and baby. This is a vital component to high quality maternity care.</p>	<p><i>Stock footage of old manuscript illustrations of the</i></p>
<p>Although the focus of this module is on practice the UK, we are always mindful of the wider context around ensuring that women and babies throughout the world particularly in developing countries are also kept as safe as possible.</p> <p>We will now begin to explore the definitions of this condition, how it manifests itself and how we identify risks</p>	<p><i>4 humors</i></p>

and ensure that timely treatment is commenced to support the best possible outcomes.

*Stock
footage*

*Time
lapse
storm
clouds
and
lightning
storm*

Fiona ptc

	<p><i>NHS video footage</i></p>
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	<i>Fiona ptc</i>
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	<i>Fiona ptc</i>
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What is Pre-eclampsia?

Text (and Voice Over)	Visuals
<p>The incidence of pre-eclampsia among pregnant women is around 5% in UK and up to 8% globally.</p> <p>Of those diagnosed, less than one dies each year in the UK. This is in stark contrast to 40,000 deaths globally in 2014</p>	
<p>The risk factors include:</p>	

<p>Women aged over 40</p> <ul style="list-style-type: none"> • Primigravida • Previous pre-eclampsia • Family history on the maternal side • Multiple pregnancy • Central obesity (BMI) • Molar pregnancy (quite difficult to describe esp to woman herself) • Previous severe fetal growth restriction • Migraine • Renal disease • Connective tissue disease (similar to molar pregnancy re describing etc.) • Chronic hypertension • Diabetes 	<p><i>Insert BMI module from Well@Work</i></p> <p><i>Need something to illustrate molar pregnancy</i></p> <p><i>Illustration – perhaps animation?</i></p> <p><i>Illustration</i></p> <p><i>Animation/illustration</i></p>
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<ul style="list-style-type: none"> • Thrombophilia • Developing HELLP Syndrome • Time between pregnancies (<i>6 months and 5 years</i>) 	<p><i>of readings</i></p> <p><i>Animation to spell out HELLP</i></p>
<p>Some of these risk factors can lead to catastrophic events such as:</p>	<p><i>Seizure</i></p> <p><i>Placental abruption</i></p> <p><i>Intra uterine death</i></p>

ASSESSMENT

Text (and /or voice over)	Visuals
<p>Physical Symptoms</p> <p>Women must be made aware of symptoms the symptoms of pre-eclampsia:</p>	<p><i>Simple animations to illustrate the symptoms...</i></p>

<p>Oedema, face, hands and or feet Headache Visual disturbance Upper abdominal pain Nausea & vomiting</p> <p>Text (and Voice Over)</p>	<p>Visuals</p>
<p>If a woman who is 20 weeks pregnant and is displaying any of these symptoms, then there are tests that should be carried out...</p>	
<p>Urine testing</p> <p>The criteria that define pre-eclampsia have not changed over the past decade. That is to say...</p> <p>20 weeks' gestational age of 24-hour proteinuria - 30 mg/day</p> <p>or</p> <p>A protein concentration of 30 mg (1+ on dipstick) in a minimum of two random urine samples collected at least 4-6 hours apart but no more than 7 days apart.</p>	<p><i>Pictures of urine testing kit and animated text</i></p>
<p>Blood testing:</p>	<p><i>Ptc explaining why the tests are being</i></p>

<p>Blood samples need to be taken and sent for lab analysis in respect of:</p> <p>Urea & electrolytes</p> <p>Full blood count</p> <p>Clotting screen</p> <p>Renal & liver function</p>	<p><i>done</i></p>

MANAGEMENT OF PRE-ECLAMPSIA

Text (and Voice Over)	Visuals
<p>When a woman is diagnosed with pre-eclampsia, the decision as to how to manage her condition and whether it will be best to admit her to hospital must be made in association with senior clinicians and paediatric colleagues.</p>	<p><i>Video clip of VC session</i></p>
<p>Sometimes a woman may be diagnosed with</p>	<p><i>ptc...</i></p>

<p>pre-eclampsia and yet feel perfectly well and wonder what all the fuss is about, particularly if a decision has been made to admit her to hospital.</p> <p>She may have other children to look after so It's very important explain to her and her partner why it's important to manage the condition and why, particularly in a remote and rural setting, hospital is the best and safest place to do this.</p>	<p><i>video clip or animation of typical neonatal/baby unit)</i></p>
<p>The main aim is to reduce blood pressure as quickly as possible, keep the expectant mother safe and ensure that her baby has the best chance. The aim is to stabilise systolic blood pressure at 150 and diastolic blood pressure between 80 & 100 (NICE 2017)</p> <p>The woman's blood pressure can be controlled by administering anti-hypertensives...</p> <p>Oral Labetalol 200mg tid, Nifedipine 10mg Also: Labetalol, IV Hydralazine, prophylactic</p>	<p><i>Mild BP 140/90 – 149/99</i></p> <p><i>Mod – 150/100 – 159/109</i></p> <p><i>Severe – 160/110 or higher</i></p> <p><i>Animated text</i></p> <p><i>Oral Labetalol 200mg</i></p>

<p>Magnesium sulphate might be considered</p> <p>A decision may be taken to induce an early birth in which case it is important to get maternal steroids on board conversely if safe to keep the pregnancy going with the baby happier still on board!</p> <p>Ultimately the decision will be very dependent on where the pregnant woman is. If she is in a rural area she may require to be admitted to hospital. If she's in an urban area then the probability is that she can be managed as a day case unless her condition is severe.</p>	<p><i>tid,</i></p> <p><i>Nifedipine 10mg</i></p> <p><i>Also:</i></p> <p><i>Labetalol, IV</i></p> <p><i>Hydralazine,</i></p> <p><i>prophylactic</i></p> <p><i>Magnesium sulphate</i></p> <p><i>might be considered</i></p> <p><i>General footage /pics</i></p> <p><i>of rural and urban</i></p> <p><i>settings</i></p>
<p>Nonetheless, some presentations of pregnancy-related hypertension combined with clinical or laboratory abnormalities or intrauterine growth restriction should also be considered as potential pre-eclampsia.</p>	<p><i>Footage or pics of lab</i></p>
<p>Documenting this whole process is an essential</p>	<p><i>Footage or pics of</i></p>

<p>component of good practice.</p>	<p><i>midwife writing up notes – pos handover of these to ambulance crew – attached to her bed in hospital</i></p>
<p>Monitoring</p>	
<p>Both the woman and her baby need to be monitored. If good care is not provided to the mum to be, then the baby will be compromised and it is vital to emphasise this to the woman and her family.</p>	<p><i>Animated text</i></p> <p><i>Routine monitoring at home includes:</i></p> <p><i>BP</i></p> <p><i>Urinalysis</i></p> <p><i>Bloods</i></p> <p><i>Baby:</i></p> <p><i>Size</i></p> <p><i>Movement</i></p> <p><i>Liquor volumes</i></p> <p><i>Umbilical Doppler (scan)</i></p>
<p>If the woman is considered to be at severe risk and is in hospital then monitoring is more</p>	<p><i>Oxygen Saturation</i></p> <p><i>BP</i></p>

intense:	<p><i>ECG</i></p> <p><i>Blood Glucose</i></p> <p><i>CTG (baby)</i></p> <p><i>Renal function (catheter)</i></p> <p><i>Mg Toxicity if the woman is on Magnesium take bloods for this</i></p>
Intra partum (birth) care:	
<p>Women need to be very closely monitored during labour – may well be induced or possible caesarean section. There is a need to liaise with paediatrics as the baby is likely to require care.</p>	<p><i>Animated text...</i></p> <p><i>BP monitored continually if severe hypertension but can be hourly if mild or moderate</i></p> <p><i>Baby should be continuously monitored (CTG)</i></p> <p><i>IV access essential</i></p> <p><i>Bloods</i></p>

	<i>haematological & biochemical – vital to have clotting screen especially if going to have epidural</i>
Vital to liaise with anaesthetic colleagues particular around pain relief, must restrict fluids, care around administration of epidural – normally done	
There may be a need for operative delivery once in 2 nd stage especially with severe hypertension.	<i>Talking head re actual birth bit – who will be in room etc. (mainly for Mum’s benefit)</i>
It is ABSOLUTELY ESSENTIAL THAT SYNTOMETRINE IS NOT GIVEN AS A 3RD STAGE DRUG – this drug contains Ergometrine known to raise BP (cases where women have died as a result of being given this drug)	<i>Re third stage drug (birth of placenta – talking head would be ideal)</i> Actions: <i>Call for Help 2222</i>

	<p><i>ABCDEF (this needs to be explained ?talking head)</i></p> <p><i>Correct positioning</i></p> <p><i>Airway Management</i></p> <p><i>Delivery of Oxygen</i></p> <p><i>Intravenous access</i></p>
<p>Eclamptic fit:</p> <p>An eclamptic fit can happen both prior to birth and post-natally. It is an obstetric emergency and must be recognised and dealt with immediately.</p> <p>Team work is vital and this includes non clinical staff – runners, someone to write things on a white board to record such things as when people arrived and what they did, when drugs given (this needs to be someone clinical).</p> <p>The fit will self terminate within 90 seconds but will recur unless treatment commences i.e.</p>	<p><i>Animated text...</i></p> <p><i>Pharmalogical intervention (Magnesium)</i></p> <p><i>Loading Dose: Give 4g MgSO₄ over 5-15 mins, Maintenance Dose Give 1g/hr</i></p>

commencing Magnesium Sulphate (MgSO ₄). Failure to treat will result in the death of the mother and possibly also the baby.	<i>MgSO₄ for 24hrs</i> <i>Further Fit give bolus</i> <i>2g MgSO₄</i>
After these kind of events needs to be a supportive debrief for all involved including woman and her family – may need to Significant Event Review	<i>"team" pic</i>

CONTINUING PROFESSIONAL DEVELOPMENT (CPD)

Case Study	Q&A
This will hopefully follow the RRHEAL video clip – participants will be asked to watch carefully and answer questions (voice over). Need to format questions using combination of true/false, choose correct option, fill in blanks (haven't got round to doing this!)	Do you think Sandra is at risk Yes

<p>CPD would also reflect on the Do you think Sandra is at risk</p> <p>Yes</p> <p>contents of App.</p> <p>Midwives or which health care professional completing CPD would get a certificate</p> <p>pass rate 80%.</p>	
	<p>What are her risk factors?</p> <p>) Gestation, (b) parity, (c) recent visit to ED & findings, (d) all of the above</p> <p>) <u>Correct choice (d)</u></p>
	<p>What are you going to do?</p> <p>) Arrange to see Sandra later in day & check her BP, (b) review her tomorrow, (c) contact Consultant obstetrician using SBAR & ABCDE tools to highlight your concerns,</p>

	<p>establish management plan etc. <u>Correct choice (c)</u></p>
	<p>How should this lady be transferred to hospital?</p> <p>) In her own car, (b) public transport, (c) by ambulance/air <u>Correct choice (c)</u></p>
	<p>Is the baby at risk if so why? List options including all</p> <p>Yes baby is at risk because – if learner answers yes then go on to why? (a) possible premature birth, (b) risk of placental abruption, (c) risk of growth restriction, (d) all of the above <u>Correct choice (d)</u></p>
	<p>Should Sandra receive medication to bring her blood pressure down if so which drug should be used?</p> <p>Yes Sandra should receive medication – again if learner answers yes then go to next part (a) IV/oral Labetalol, (b) oral</p>

	<p>Nifedipine, (c) IV hydralazine, (d) IV Magnesium Sulphate, (e) this will depend on advice and guidance from Consultant Obstetrician and local protocols <u>Correct choice (e)</u></p>
	<p>Should corticosteroids be considered regarding the wellbeing of the baby and why? Yes they should – if you answered yes then why? (a) to help baby’s brain develop, (b) to help baby’s lungs to mature, (c) to reduced the incidence of Respiratory Distress Syndrome, (d) both (b) & (c) <u>correct answer (d)</u></p>
	<p>Who should accompany this lady to hospital) Paramedic, (b) Midwife, (c) both Paramedic & Midwife <u>Correct answer (c)</u></p>
	<p>Should Sandra suffer an eclamptic fit how would you manage?) Call for help, (b) ABCDE approach, (c) ensure Sandra is safe, (d) use Magnesium Sulphate protocol, (e) all of the above <u>Correct answer (e)</u></p>

	<p>D. Should this case be classed a 'near miss' and be the subject of a 'Significant Event Review'? Yes this case should be classed as a 'near miss' and should be the subject of 'Significant Event Review (SER)'</p> <p>if you answered Yes, who should be involved including the patient?</p> <p>A SER should primarily highlight (learning) for Emergency Department colleagues and should be conducted in a (supportive) way. It will support and the need for (collaborative) working between ED and Maternity Staff. (Findings & recommendations) should be shared widely.</p>

SUMMARY

Fiona	Visuals
We have explored pre eclampsia and eclampsia pretty thoroughly. I hope you	<i>Ptc</i>

<p>found it useful to your practice.</p> <p>I will now just give a quick summary of main points:</p> <p>Preclampsia can be life threatening to Mum & baby, it is a killer of women although improved in UK – where, thanks to good practice, it is now the least likely cause of maternal death.</p>	
<p>We must not however become complacent - pre-eclampsia can still kill. It needs to be spotted and diagnosed early to allow treatment to begin and a management plan drawn up. The management plan needs to be appropriate in context of where woman lives, women must be sign posted to self help groups, websites etc.</p> <p>It is our responsibility to provide the best possible care we can to keep Mums & Babies safe'</p>	

Appendix P Notes from conferences

P.1

MHealth Conference: How can mobile technology improve health in low and middle income countries 27-28 Jan 2015 - University College London

Notes from attendees Dr Lucia D'Ambruoso (Aberdeen University) & Alan White (Skills@Work):

- The event provided access to a broad group of academics, health professionals, development practitioners, postgraduate students, the media and the public interested and working in global mHealth. The presentations, keynote addresses and panel discussions provided information on the application of cutting edge mHealth interventions from many countries and world regions. The organisers encouraged audience participation and input by way of 'live-tweeting' as well as engaging plenaries and panel discussions.
- The University College London Institute for Global Health and Umeå Centre for Global Health Research, Sweden hosted the conference *mHealth: Evidence from low- and middle-income countries*, in London January 27th and 28th 2015. The first of its kind in the UK, the event assessed the evidence base for mHealth in the world's poorest settings, and considered the evaluation and sustainability dimensions of mobile and digital technologies for health in low and middle income countries (LMICs).
- The rationale for the event relates to the explosive growth of mobile technology over the past decade that has generated new thinking around the potential of "mhealth" to improve health. Responding to a relatively weak evidence base from LMICs, the two-day symposium examined current

debates around evidence within the fields of health systems and health education, and with a focus on tangible health outcomes. Academics, health professionals, development practitioners, postgraduate students, the media and the public were in attendance. BBC Media Action (<http://www.bbc.co.uk/mediaaction>) was also part of the conference organisation team.

- A systematic review on the evidence base for mHealth interventions in LMICS authored by the organisers was distributed with the conference papers. The review highlighted that despite the large number of pilot studies on mHealth interventions, a general lack of attention to demonstration of health impact exists. On this basis, the discussions over two days focused on embedding research and development of mHealth interventions within health systems and health ministries, with a view to enhancing country ownership, and on developing robust evaluation frameworks that employ mixed methods to capture the contexts and mechanisms as well as impacts of implementation.
- Keynote addresses from His Excellency Dr Keseterbirhan the Minister of Health of the Federal Democratic Republic of Ethiopia and Professor Alain Labrique from the Global mHealth Initiative, Johns Hopkins University (<http://www.jhumhealth.org>) were accompanied by plenaries and panel discussions through which a range of mHealth interventions were presented (including the use of mobile phones for the registration of vital events in Bangladesh; mobile-base reporting of child birth event sin India; mobile training for community health workers in Kenya; mHealth for antiretroviral therapy adherence in India; mobile phone based interventions for post-abortion family planning in Cambodia; and the ethics and equity of mHealth).
- On the final day, the ethics of information/data sharing through mHealth interventions, and implications for equity were discussed, as were facilitating

the scalability and sustainability of mHealth approaches, and the critical importance of leadership through ministries of health. The meeting concluded with consideration of how to bring promising approaches to scale. Through the conference evaluation survey, the organisers also invited opinion on developing a regular event through which practices and evaluation methodologies etc. could be shared on a continuous basis.

3.

Relevant outcomes in respect of onehealthmobile

- General consensus (following some debate on day 1) that smartphones, providing they are either free or affordable are the way to move forward – extra time to train CHWs in their use (estimated at max 4 days) was considered to be outweighed by their capacity and interaction with the content.
- Audio described content considered essential – in European and local languages.
- Up front buy-in from MoHs essential
- Up front user involvement /consultation essential
- Need for both advisory and diagnostic apps on the same device
- Smartphones not tablets

- Use apps in tandem with SMS
- Data Protection needs to be assured in line with local legislation

P.2 Notes on eHealth week 2016 in Amsterdam; 8-10 June

Overview

The key themes were:

- Empowering People
- Trust and Standards
- Social Innovation and Transition

With one exception, I chose to focus on the two latter topics, where the emphasis was around interventions to improve self-management, end-of-life-care and good governance based on new guidelines on EU legislation and voluntary codes of practice.

Sessions Attended and relevance to study

“Healthy minds for everyone in the 20th century – emotional and mental health through digital programmes”

This was a very informative session largely highlighting the work of the Dutch Trimbos Institute in the area of e-mental health programmes.

There was nothing of direct relevance to my study, though the Trimbos Institute could be a potential collaborator if maApt™ was eventually to extend to include topics such as post-natal depression.

“What’s next?”

A whacky 50 minute presentation by Nick Adkins of

<https://reeldx.com/about/>

Via an entertaining, at times inspirational, if somewhat circuitous route that took in the feel-good virtues of gifting pink socks and the Burning Man Festival, Nick shared the company's vision to provide an easy to use, secure, HIPAA-compliant platform for creating, storing, and sharing medical video.

Real patient videos have many applications — accurate and infinitely replayable patient discharge instructions, allowing video recorded by parents of their child's symptoms to be included in the EHR, enabling EMS personnel to efficiently record the accident scene for the benefit of the ER doctors, **and curating libraries of real cases for medical education**. These are just some of the many applications for secure medical storage.

ReelDx is enabling all of these and more by solving the core problems of video in the clinical environment: security and HIPAA compliance, storage and efficient sharing, and reliable and easy playback on any device.

This session was not relevant, at least in the short term, to my study but it did highlight the potential that real video stories can play in enhancing the CPD of healthcare professionals and that is relevant to the approach that Nicola Brownie's group on Online Continuous Professional Development (OCPD) is looking at and therefore could inform the CPD function of maApt™.

"Good implementation practices – readiness for scaling up"

Key points raised in this session, which included a presentation on "Living it Up" from Donna Henderson from the Scottish Centre for Telehealth and Telecare were around motivation:

- Make it fun
- Consider gamification - doesn't have to mean dumbing down
- Need to "evangelise" if apps are to get to scale

- Must meet a need
- Consider links to Fitbit – not only steps, think about sleep patterns
- Must make the job easier if aimed at health care professionals
- Is it something that consumers or health boards/ministries will pay for, otherwise developers get no reward and therefore no incentive to invest in development
- Consider virtuous funding circles similar to Tom’s Shoes - <http://www.toms.co.uk/>

This is relevant to the study given discussions around the need for maApt™ to offer midwives something new that is of use, e.g. the dynamic visualisation of data.

“Towards a common approach in assessing validity and reliability of mHealth apps”

This is now summarised by the European Commission at...

<http://ec.europa.stfi.re/digital-single-market/en/news/code-conduct-privacy-mhealth-apps-has-been-finalised?sf=bbbeyry#ab>

“The Code of Conduct on privacy for mobile health apps has now been formally submitted for comments to the Art 29 Data Protection Working Party. Once approved by this independent EU advisory group, the Code will be applied in practice: App developers will be able to voluntarily commit to follow its rules, which are based on EU data protection legislation.

The Code has been drafted with the vision to be easily understandable, also for SMEs and individual developers who may not have access to legal expertise.

It is expected to raise awareness of the data protection rules in relation to mHealth apps, facilitate and increase compliance at the EU level for app developers.

These are the issues covered by the Code:

- User's consent,
- Purpose limitation and data minimisation,
- Privacy by design and by default,
- Data subjects rights and information requirements,
- Data retention,
- Security measures,
- Principles on advertising in mHealth apps,
- Use of personal data for secondary purposes,
- Disclosing data to third parties for processing operations,
- Data transfers,
- Personal data breach, and
- Data gathered from children.

On 7 June 2016, the Code of Conduct was formally submitted for comments to the Article 29 Data Protection Working Party. Once approved by the Working Party, the Code will be applied in practice: App developers can sign it on a voluntary basis, thereby committing to following its rules.

Trust in mHealth apps

As revealed by the European Commission's 2014 mHealth Green Paper consultation, people often do not trust mHealth apps, such as those monitoring your health or giving health advice. Respondents to the mentioned consultation considered that having users' consent as well as strong privacy and security tools in place is a crucial issue in relation to mobile health apps.

This becomes even more important as these apps process health data which is amongst the most sensitive personal data. Therefore, the scope of this Code are mobile apps which process data concerning health.

Appropriate action

It was concluded that an appropriate action to help increase and promote trust, would be the industry themselves setting up a code of conduct on mobile health apps. This code would cover privacy and security principles and be signed by app developers. The aim should be to provide easily accessible guidance on how European data protection legislation should be applied in relation to mHealth apps.

This idea was very much welcomed by app developers. A drafting team of industry members was set up whose task it was to develop the text of the code. The European Commission's role in this process has been to act as a facilitator.

The possibility of drawing up codes of conduct is foreseen in Article 27 of the Data Protection Directive (Directive 95/46/EC) and this possibility continues to exist under the General Data Protection Regulation.

Next steps

While waiting for the Opinion of the Article 29 Working Party, discussions are already taking place on the practicalities of the governance and on how to ensure a proper communication of the Code to app developers and the general public.”

This is all relevant to my study and I will incorporate a synopsis into the ethics section of my Research Proposal.

“Are apps and wearables redefining healthcare delivery?”

This session looked at improving the “Care Continuum” by empowering healthcare consumers with apps and wearables and questioning whether the “hospital can ever be brought home?”

Key points (mainly based around the soon to be launched Philips Health watch... <http://www.wearable.com/health-and-wellbeing/philips-announces-health-watch-and-other-wellness-gadgets-1624>)

raised were:

- Potential to change health habits for life
- A predictive and preventative self management resource
- A lifetime wellness resource that is with the consumer almost all the time
- Can be motivational and lead to behavioural change
- Supports self management of hypertension
- Links to Philips health suite <https://itunes.apple.com/gb/app/philips-healthsuite-health/id1018192035?mt=8>
- “Keeps the hospital in the home”

This could be relevant to my study and it may be worth considering providing several mothers with the watch. It is not however clear at this stage if the Philips devices are classed as medical devices and CE approved. I will investigate this as part of my study.

N.B. Philips were a “premier” sponsor of the conference and DHI have a good working relationship with Philips, so this investigation could be pursued via DHI. Philips Africa have previously expressed an interest in supporting a trial of maApt™ in E Africa.

“Safe mHealth products: Buckle up, it’s the law”

Further information and discussion around the new EU codes including as they pertain to what constitutes a medical device.

My understanding is that maApt™ will be considered to be a medical device and that these guidelines will need to be taken account of in the study as it relates to the piloting of maApt™ and in applications for ethics approval.

Trust in health apps is likely to be increased if an app has incorporated an academic evaluation.

mHealth app developers are being encouraged to sign up to the voluntary codes of conduct that will be announced shortly.

Summary

The key take away is around the fact that there are now over 160,000 health apps available via the app stores or downloadable from healthcare providers' websites. This number is growing and...

- Most are aimed at healthcare consumers
- Most come without any professional/academic provenance
- Trust in apps needs to be underpinned by a "quality mark" geared to adhering to guidelines and (EU) legislation
- Apps can support existing resources
- There is an important role for apps, providing that they are underpinned by academic research and evaluation

O.3 - African Health Agenda International Conference (AHAIC)

My participation at the African Health Agenda International Conference (AHAIC) in Nairobi during March 2017 highlighted:

- The pan- African need and appetite for mHealth interventions in a number of clinical areas

- A focus on the need for mlearning (that has real provenance) for nurses and Community Health Workers
- A high level of local ITC skills (programming) especially in Kenya, Ghana, Ethiopia and South Africa
- A parallel lack of experience in subject market expertise, content creation, and digital design expertise (other than in South Africa) – but lots of talent waiting for direction or collaboration
- The agility of local mHealth developers to keep/set the pace with the fast moving mHealth ecosystem

P.4 - Summary Report on Participation at MIT Learning Journey & ILP R&D Conference 13-17 November

13th November

Met with Dr Richard Fletcher from MIT's "D-Lab". Dr Fletcher has a particular interest in the social impacts of technology around healthcare and education. Common areas where there is potential for collaboration (either directly with IHL or other Highland based SMEs include:

- Wearable sensors linked to diagnostic phone apps particularly in the areas of cardiovascular conditions and diabetes
- Diagnosis through thermal imaging - also linked to phone apps
- Relationship between health and resilience and how well people can "bounce back"

He would be particularly open to discussing collaborations around developing machine learning in managing stress and other aspects of mental wellbeing including anxiety, depression and substance abuse which are the largest areas of concern in the USA.

He's also working on some clever stuff around using doppler radar to replace ultrasound.

Have not as yet followed up on any specifics.

14th November

Met first with HIE's MIT contact Marie-Teresa Vander Sande – essentially a welcome lunch and overview of the ILP programme.

Then met with Professor Brian Anthony from the Department of Mechanical Engineering.

Areas of common interest include:

- Orthotics and Prosthetics, he's involved in some interesting 3D modelling based on sensor feedback in respect of measurement, surprisingly there is no gait lab at MIT, so potential for collaboration with RGU on one of our currently non priority projects. Also Links to Stryker in this area and to Iceland based OSSUR - <https://www.ossur.com/about-ossur/company-background>
- Prof Anthony is also involved in looking at applications using advanced ultrasound in the area of emergency medicine, so there may be some areas of common interest with MIME

We also covered off the potential to hire MIT post-grads on placement for specific projects at \$25k per head. Marie Teresa would be able to advise further on that.

The Conference, 15th – 16th November

The keynote sessions were all highly informative and broadly confirmed that IHL was in the right place on the curve as regards incorporating machine learning into our programmes – always providing that we can find a source of funding.

The break-out sessions were also very interesting and particularly relevant were:

- Data Ownership Impact on Privacy and Security
- Internet Governance and Culture
- Blind Machine Learning
- Cybersecurity Impacts on International Trade
- Build AI Products Faster, Cheaper – especially relevant as this presentation described exactly the brief that Interactive Health needs to issue in order to recruit a coder.

Finally...

Marie-Teresa's networking dinner was generous and enjoyable, but actually not great for meaningful networking as we were all seated at one long table, so very limiting in who I actually managed to speak to.

Best for networking was the SME exhibitors lunch where I did meet companies who whilst not directly relevant to IHL are relevant to pharma colleagues in particular <https://www.celect.com/> - smart retail inventory.

**Appendix Q Agreement between NHS Highland Research and
Development and Interactive Health Limited**

AGREEMENT FOR PARTNERSHIP PROJECT

This Agreement dated 20 of September 2017 is between

INTERACTIVE HEALTH (Referred to as “the Company”)

NHS Highland Health Board, constituted pursuant to the National Health Service (Scotland) Act
1978 (as amended) and having its headquarters at NHS Highland Assynt House, Beechwood Park,
Old Perth Road, Inverness IV2 3BW

(referred to as “the NHS Organisation”)

TERMS AND CONDITIONS OF PARTNERSHIP PROJECT: “maApt™”

1 DEFINITIONS

The following expressions shall have the following meanings:

- 1.1 **"Company"** means Lead Contractor - - **Interactive Health Limited**, Aurora House, Inverness Campus, Inverness IV2 5NB
- 1.2 **"NHS Organisation"** means **NHS Highland Research Development & Innovation Division**, Centre for Health Science, Old Perth Road, Inverness IV2 3JH (a Division of “the NHS Organisation”)
- 1.3 **"Proposal"** means a quotation or other similar document describing the Services submitted by the Company;
- 1.4 **"Collaboration"** means the services as described in the Proposal;
- 1.5 **"Terms and Conditions"** means the terms and conditions of Collaboration as set out in this document and any subsequent terms and conditions agreed in writing by the Company;

- 1.6 **"Agreement"** means the Partnership Agreement between the Company and the NHS Organisation for the provision of the Services incorporating these Terms and Conditions;
- 1.7 **"Intellectual Property Rights"** means any patent, trademark, service mark, registered design, copyright, design right, right to extract or exploit information from a database, database rights, know-how, confidential information or process, any application for any of the above, and any other Intellectual Property Right recognised in any part of the world whether or not presently existing or applied for;
- 1.8 **"Arbitrator"** is the party nominated to resolve a dispute between the Company and the NHS Organisation.
- 1.9 **"Partners"** refers only to the Agreement between NHS Highland Research Development and Innovation Division and Interactive Health Limited.
- 1.10 **"Contributor"** refers to Ms Sarah McLeod as the subject matter expert and co-writer of materials on pre-eclampsia

2 GENERAL

- 2.1 These Terms and Conditions shall apply to the Agreement for the supply of Services by the Company to the NHS Organisation and shall supersede any other documentation or communication between parties.
- 2.2 Any variation to these Terms and Conditions must be agreed in writing between the Company and NHS Organisation in writing .
- 2.3 Nothing in these Terms and Conditions shall prejudice any condition or warranty, express or implied, or any legal remedy to which the Company may be entitled in relation to the Services, by virtue of any statute, law or regulation.

3 PROPOSAL

- 3.1 The Proposal for Services is attached to these Terms and Conditions.
- 3.2 The Proposal for Services shall remain valid for a period of [30 days].
- 3.3 The Agreement between the Company and the NHS Organisation, incorporating these Terms and Conditions, shall only come into force when both confirm acceptance in writing.

4 SERVICES AND DELIVERY

- 4.1 The Services are as described in the Proposal.
- 4.2 Any variation to the Services must be agreed by the Company in writing.
- 4.3 The Services shall commence on 20th September 2017 as per the proposal unless terminated according to the terms of this Agreement.

OR

- 4.4 The Services shall commence on 20thth September 2017 and continue until terminated by either party giving not less than 3 months notice in writing or unless terminated according to the terms of this Agreement.
- 4.5 The Services shall be carried out at the place of work of the Company or the NHS Organisation or any other location that the Company deems appropriate

- 4.6 Dates given for the delivery of Services are estimates only and not guaranteed. Time for delivery shall not be of the essence of the Agreement and the Company shall not be held liable for any loss, costs, damages, charges or expenses caused directly or indirectly by any delay in the delivery

5 PRICE AND PAYMENT

- 5.1 The price for Services is as specified in the Proposal and is exclusive of [VAT and] any other charges as outlined in Phase 1 of the Proposal. For the purposes of this agreement this is deemed to be limited to Seven Thousand Pounds (£7,000.00)
- 5.2 The terms for payment are £3,000.00 to be paid upon signature of this agreement and the balance of £4,000 to be paid upon receipt by the NHS Organisation of the Company's final invoice
- 5.3 The NHS Organisation must settle the first payment within 28 DAYS from the date of set up as a supplier.
- 5.4 The Company is entitled to recover all reasonable expenses incurred in obtaining payment from the NHS Organisation where any payment due to the Company is late.
- 5.5 The NHS Organisation is not entitled to withhold any monies due to the Company.
- 5.6 The Company is entitled to vary the price to take account of:
- 5.7.1 any additional Collaboration requested by the NHS Organisation which were not included in the original Proposal;
- 5.7.3 any reasonable increase in hourly rate, if applicable;
- and any variation must be agreed between the NHS Organisation and the Company in writing.
- 5.7 The Company shall be responsible where relevant for the payment of National Insurance contributions as self-employed persons and for the payment of any Income Tax, VAT or other liabilities arising out of remuneration for providing the Services.

6 NHS ORGANISATION OBLIGATIONS

- 6.1 The NHS Organisation agrees to cooperate with the Company and shall provide any support, information and facilities (e.g. by way of video conferencing with Highland midwives and meeting room facilities) to the Company as may be required within the terms of the proposal.

7 COMPANY OBLIGATIONS

- 7.1 The Company shall supply the Services as specified in the Proposal.
- 7.2 The Company shall perform the Services with reasonable skill and care and to a reasonable standard and in accordance with recognised codes of practice.
- 7.3 The Company shall have the authority to delegate any obligations to other employees, its partners in this agreement or subcontractors but undertakes to notify the NHS Organisation of any significant changes to personnel.

8 CONFIDENTIALITY, FREEDOM OF INFORMATION and DATA PROTECTION

8.1 Confidential information

- 8.1.1 Each Party agrees to ensure that information supplied to them under this Agreement and belonging to or licensed to the other Party and marked as confidential is treated as confidential.
- 8.1.2 The NHS Organisation agrees to treat the Results of the Study as confidential.
- 8.1.3 Each Party agrees:
- To ensure that any of their employees, students, consultants or sub-contractors who participate in the operation of the Study are made aware of, and abide by, the requirement of clause 8.1.
 - To use the confidential information solely in connection with the operation of the Agreement and not otherwise.
 - Not to disclose the confidential information in whole or in part to any person without the other Party's written consent.

8.1.4 The provision of clause 8.1 shall not apply to the whole or any part of the confidential information that is:

- Lawfully obtained free of any duty of confidentiality.
- Already in the possession of the Party receiving such information and which they can show from written records (other than as a result of a breach of clause 8.1.1 or 8.1.2).
- In the public domain (other than as a result of a breach of clause 8.1.1 or 8.1.2).
- Necessarily disclosed pursuant to a statutory obligation.
- Disclosed with prior written consent of the other Party.
- Necessarily disclosed by a Party by virtue of its status as a public authority in terms of the Freedom of Information Act 2000 or the Freedom of Information (Scotland) Act 2002.

8.2 The restrictions contained in clause 8.1 shall continue to apply after the termination of this Agreement for 10 years.

8.3 NHS Organisation
NHS Organisation
NHS Organisation
NHS Organisation
Freedom of Information

8.3.1 Parties to this Agreement which are subject to the Freedom of Information Act 2000 (FOIA) or the Freedom of Information (Scotland) Act 2002 (FOI(S)A) and which receive a request under FOIA or FOI(S)A to disclose any information that belongs to another Party shall notify and consult that Party as soon as reasonably practicable, and in any event, not later than five working days after receiving the request.

8.3.2 The Parties acknowledge and agree that the decision on whether any exemption applies to a request for disclosure of recorded information under FOIA or FOI(S)A is a decision solely for the Party responding to the request.

8.3.3 Where the Party responding to an FOIA or FOI(S)A request determines that it will disclose information it will notify the other Party in writing, giving at least two working days notice of its intended disclosure.

8.4 Medical Confidentiality (DFATA PROTECTION)

- 8.4.1 The Parties agree to adhere to the principles of medical confidentiality in relation to Participants (where relevant). The Parties shall comply with the requirements of the common law of confidentiality, the Data Protection Act 1998 and, as appropriate, the NHS Confidentiality Code of Practice or the Scottish Executive Health Department NHS Code of Practice on Protecting Patient Confidentiality or the Confidentiality: Code of Practice for Health and Social Care in Wales or the Code of Practice on Protecting the Confidentiality of Service Users in Northern Ireland, (when implemented).
- 8.4.2 Personal data shall not be disclosed to the Company by the NHS Organisation, save where this is required directly or indirectly to satisfy the requirements of the Protocol, or for the purpose of monitoring or reporting adverse events.
- 8.4.3 Neither the Company nor the NHS Organisation shall disclose the identity of Participants to third parties without the prior written consent of the Participant except in accordance with the Data Protection Act 1998 or, as appropriate, the NHS Confidentiality Code of Practice or the Scottish Executive Health Department NHS Code of Practice on Protecting Patient Confidentiality or the Confidentiality; Code of Practice for Health and Social Care in Wales or the Code of Practice on Protecting the Confidentiality of Service Users in Northern Ireland, (when implemented).

9 INTELLECTUAL PROPERTY RIGHTS

- 9.1 Any Intellectual Property Rights created as a result of the Services shall be shared, in Scotland, with the NHS Organisation and allow for free use of materials (created as an outcome of the project) by the NHS Organisation's own customers.
- 9.2 Materials will be acknowledged as being a co-production with all partners and contributors.
- 9.3 The Company shall take all reasonable steps to ensure that they, or others to whom work has been delegated, refrain from causing damage to the Intellectual Property Rights belonging to the NHS Organisation.

9.4 The NHS Organisation shall not distribute any Intellectual Property Rights belonging to the Company to any third party without the written consent of the Company.

9.5 The NHS Organisation and the Company shall not infringe the Intellectual Property Rights of any third party during the term of this Agreement.

10 PROFIT SHARING

10.1 This AGREEMENT is based on NHS Highland (NHS) and IHL entering into an agreement whereby NHS invest £7,000 + (an in kind contribution of £2000 for content writing by Sarah McLeod –the Contributor) in Stage 1. This to reflect their joint ownership in the Intellectual Property in maApt and in line with their respective investment in Stage 1, a sharing in any net profit based on: (IHL) 55 : 45 (NHS) subject to negotiation and net of any dividend or royalty paid to an external Stage 2 investor.

10.2 Preliminary research findings indicate both a need for a product such as maApt. Within the UK, the primary market would be NHS boards in England, NHS Wales and NHS Northern Ireland. Within these boards the potential user groups could include:

- Student midwives
- Midwives
- Family Nurse Practitioners (or equivalents)
- Health Visitors
- GPs
- Practice Nurses
- Blue Light First Responders

Excluding the police and fire brigades this indicates a potential market in England of some 300,000 users. This proposal assumes a 10% market penetration, i.e. some 30,000 potential users.

IHL's illustrative model would be to charge an annual license fee to each NHS Board or Police / Fire Brigade Authority that adopts maApt of for example £900 per year + an additional annual fee of £50 per user. Thus for example a NHS Organisation with 1500

registered users would pay an annual total of £75,950.00. On that basis, IHL would expect full cost recovery within 2 years.

These figures are purely illustrative and at this stage take no account of the Social Return on Investment in terms of any lives saved or improved quality of lives, nor do they take account of any direct financial savings that could accrue through, for example, fewer admissions to hospitals.

11 TERMINATION

- 11.1 The Agreement shall continue until the Services have been provided in terms of the Proposal or any subsequent date as mutually agreed in writing by both parties or until terminated by either party in accordance with these Terms and Conditions.
- 11.2 The NHS Organisation may terminate the Agreement if the Company fails to comply with any aspect of these Terms and Conditions and this failure continues for a period of eight weeks after notification of non-compliance is given.
- 11.3 The Company may terminate the Agreement if the NHS Organisation has failed to make over any payment due within four weeks of the sum being requested.
- 11.4 Either party may terminate the Agreement by notice in writing to the other if: the other party commits a material breach of these Terms and Conditions and, in the case of a breach capable of being remedied, fails to remedy it within a reasonable time of being given written notice from the other party to do so; or
- 11.5 The other party commits a material breach of these Terms and Conditions which cannot be remedied under any circumstances; or the other party passes a resolution for winding up (other than for the purpose of solvent amalgamation or reconstruction), or a court of competent jurisdiction makes an order to that effect; or the other party ceases to carry on its business or substantially the whole of its business; or
- 11.6 The other party is declared insolvent, or convenes a meeting of or makes or proposes to make any arrangement or composition with its creditors; or a liquidator, receiver, administrative receiver, manager, trustee or similar officer is appointed over any of its assets.
- 11.7 In the event of termination the NHS Organisation must make over to the Company any payment for work done and expenses incurred up to the date of termination.

Any rights to terminate the Agreement shall be without prejudice to any other accrued rights and liabilities of the parties arising in any way out of the Agreement as at the date of termination.

12. PUBLICATION

- 12.1 Following completion of the Project, the Company shall use all reasonable endeavours to ensure the appropriate publication or other dissemination of the conclusions of the Project.
- 12.2 The NHS Organisation shall not publish or otherwise disseminate the conclusions of the Project, including all or any part of the Results of the Project without the prior written consent of the Company, such consent not to be unreasonably withheld or delayed. Any publication or other dissemination of the conclusions of the Project by the NHS Organisation shall not occur until the Company has published the conclusions of the Project.

13. SETTLEMENT OF DISPUTES

- 13.1 The Parties shall first attempt to solve amicably any dispute, claim or difference of opinion arising out of relating to this Agreement.
- 13.2 During a period of 28 days period of arbitration both parties must continue with their obligations as stated in this Agreement.
- 13.3 Judicial authorities shall finally and conclusively settle any dispute arising out of or relating to this Agreement, or the breach or termination thereof under the laws of Scotland.
- 13.4 This Agreement shall be made and interpreted in accordance with the legislation of Scotland.

14. WARRANTY

Both parties warrant their authority to enter into this Agreement and have obtained all necessary approvals to do so.

15. LIMITATION OF LIABILITY

15.1 The Company shall not be liable under any circumstances to the NHS Organisation or any third party for any indirect or consequential loss of profit, consequential or other economic loss suffered by the NHS Organisation howsoever caused, as a result of any negligence, breach of contract, misrepresentation or otherwise. Nothing in these Terms and Conditions shall exclude or limit the liability of the Company for death or personal injury, however the Company shall not be liable for any direct loss or damage suffered by the NHS Organisation howsoever caused, as a result of any negligence, breach of contract or otherwise in excess of the sum insured under the professional indemnity insurance policy held by the Company in the insurance year in which the NHS Organisations claim is first notified.

16. INDEMNITY

16.1 The NHS Organisation shall indemnify the Company against all claims, costs and expenses which the Company may incur and which arise directly or indirectly from the NHS Organisations breach of any of its obligations under these Terms and Conditions.

17. FORCE MAJEURE

Neither party shall be liable for any delay or failure to perform any of its obligations if the delay or failure results from events or circumstances outside its reasonable control, including but not limited to acts of nature, strikes, lock outs, accidents, war, fire, breakdown of plant or machinery or shortage or unavailability of raw materials from a natural source of supply, and the party shall be entitled to a reasonable extension of its obligations.

18. ASSIGNMENT

The NHS Organisation shall not be entitled to assign its rights or obligations or delegate its duties under this Agreement without the prior written consent of the Company.

19.RELATIONSHIP OF PARTIES

The Agreement shall be construed as establishing a project- partnership or co-production between the parties

20.THIRD PARTY RIGHTS

Nothing in these Terms and Conditions intend to or confer any rights on a third party.

21.SEVERANCE

If any term or provision of these Terms and Conditions is held invalid, illegal or unenforceable for any reason by any court of competent jurisdiction such provision shall be severed and the remainder of the provisions hereof shall continue in full force and effect as if these Terms and Conditions had been agreed with the invalid, illegal or unenforceable provision eliminated.

22 WAIVER

The failure by either party to enforce at any time or for any period any one or more of the Terms and Conditions herein shall not be a waiver of them or of the right at any time subsequently to enforce all Terms and Conditions.

23 NOTICES

Any notice to be given by either party to the other may be served by email, fax, personal service or by post to the address of the other party given in the Proposal or such other

address as such party may from time to time have communicated to the other in writing, and if sent by email shall unless the contrary is proved be deemed to be received on the day it was sent, if sent by fax shall be deemed to be served on receipt of an error free transmission report, if given by letter shall be deemed to have been served at the time at which the letter was delivered personally or if sent by post shall be deemed to have been delivered in the ordinary course of post.

24. ENTIRE AGREEMENT

These Terms and Conditions supersede any previous agreements, arrangements, documents or other undertakings either written or oral.

25. GOVERNING LAW

These Terms and Conditions shall be governed by and construed in accordance with the law of Scotland and the parties hereby submit to the exclusive jurisdiction of the Scottish courts.

PROPOSAL

Attached

NAME OF COMPANY):

INTERACTIVE HEALTH LIMITED

BUSINESS ADDRESS OF COMPANY:

Aurora House, Inverness Campus, Inverness, IV2 5NB

NAME OF NHS ORGANISATION:

NHS HIGHLAND RESEARCH & DEVELOPMENT

ADDRESS OF NHS ORGANISATION:

Centre for Life Science, Old Perth Road, Inverness IV2 3JH

DESCRIPTION OF SERVICES TO BE SUPPLIED:

As specified in the Proposal.

THE PRICE:

£7,000.00 (excludes work in kind by the contributor)

PAYMENTTERMS:

As specified in Clause 5 of this Agreement

SIGNED :

Print name: Alan White, Director

For and on behalf of Interactive Health Limited

date:

SIGNED:

Print name: Frances Hines, Manager

For and on behalf of NHS Health Scotland Research and Development

date:

Appendix R

PowerPoint presentation of initial findings to supervisors



MRes Findings

Alan White

4 Themes

- Challenges to midwifery practice in remote and rural areas
- Incidence of pre-eclampsia
- Continuous Professional Development
- Perceived value of a tool such as mApt™

Challenges to practice in remote and rural areas

Two sub themes emerged at all three locations:
Digital Isolation and Geographic Isolation

Incidence of pre-eclampsia

It is very much to the credit of NHS Highland midwives that there have been no recent deaths that can be attributed to pre-eclampsia

Continuous professional development (CPD)

- Agreement that the preloading of CPD materials onto a tablet could be the most useful thing about *mApt*TM

Perceived value of a tool such as *mApt*TM

YES in respect of CPD on the move, YES to having information to hand that would help them to explain pre-eclampsia to women in their care and YES to there being no need for internet connectivity

But at the same time...

- Perceived as a slur on the participants' professional practice
- More suited (in the UK) to Family Nurse Practitioners, A&E and blue light first responders – potential for further research

