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# “The use of an electronic health record (EHR) in a maternity shared-care environment”

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 **CRE** In Primary  
Health Care  
Microsystems

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## Background

This report presents findings of a study titled “The use of an electronic health record (EHR) in a maternity shared-care environment”. The utility of the maternity EHR is compared with a paper hand-held record (PHR).

The PHR has been a successful and integral tool used in maternity shared-care for many years. Hamilton introduced the ‘Co-op (co-operation) card’ in 1956 in the United Kingdom (UK) and since this time, women and clinicians have used some version of the PHR to record maternity care provided<sup>1</sup>. The PHR continues to be widely used in the UK and also in Australia and New Zealand<sup>2</sup>. The woman carries the PHR with her and the care given is documented at each visit to either the General Practitioner (GP) or the hospital health care provider. Evidence shows that PHRs improve communication between health care providers, reduce anxiety and increase women’s involvement in their care<sup>3</sup>.

The benefits of the PHR have been demonstrated in previous, mainly descriptive studies but little formal evaluation has been done on the data collected or on the experiences of health care providers using the PHR.

Increasingly, patient EHRs have been implemented around the world<sup>4</sup>. These records are often driven by government regulations or financial institutions, predominantly in the USA, the UK and Denmark<sup>5-7</sup>. EHRs have been designed to enhance integration and provide access to information in a digital format that can be used by both patients and health care providers, from anywhere at any time<sup>8</sup>. Digital records are accessed using a variety of devices and media, including: USB (portable memory) stick and web-enabled interfaces of personal computers, smart phones or tablets.

Additionally, much work has been done on evaluating the implementation of EHRs in a variety of health care settings, such as hospitals, pharmacies, GP surgeries and allied health care providers (psychology, dietetics, social work and physiotherapy)<sup>4</sup>. Implementation issues of standardising processes, safety and security, promoting evidence based practice, ease of use, easing workload and using less paper charts have all been cited and continue to challenge using the EHRs to their full potential<sup>4,8</sup>.

The EHR was proposed in Australia in the 2010/2011 federal budget and the Australian Government Department of Health and Aging (DoHA) with the National E-Health Transitory Authority (NEHTA) announced an investment over 2 years to deliver a national Personally Controlled EHR (PCEHR)<sup>9</sup>. The implementation of the EHR proposed to greatly enhance both the quality and the timeliness of available health care information. It was suggested that the PCEHR would allow consumers to have access to information, better manage their health care online and be beneficial to health care providers through improved sharing of clinical information. In wave 2 of the national EHR roll-out, the maternity EHR was introduced at the Mater Mothers’ Hospital (MMH), Brisbane, Queensland to operate in a GP shared-care environment. The initiative was aimed at addressing the fragmentation of care previously provided in the first National PHC Strategy “Towards a 21st Century Primary Health Care System”<sup>10</sup>. The strategy identified that improvement was needed particularly in maternity care.

The maternity EHR was developed as an electronic alternative to the previously used paper based system, to be accessible to internal hospital health care providers, aligned GPs and participating women in a shared-care setting<sup>10</sup>. The maternity EHR has incorporated access to the system for providers and women via doctor and patient portals.

Shared-care is seen as a service provided between the primary and secondary care sectors, with GPs as the fundamental component to providing a continuum for women centred care throughout their pregnancy<sup>11</sup>. To improve the integration of care between these sectors, a clinical pathway was developed at the MMH, as a guide to define the roles both the GP and the hospital played in the management of the woman throughout her pregnancy<sup>12</sup>. This

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pathway was added to the PHR as the antenatal visit schedule and checklist acting as a clinical prompt, delineating the activities to be conducted<sup>12</sup>. The full pathway as seen in the PHR used at the MMH is provided in Appendix 1 and is still today widely accepted as a clear guide to 'best practice' expectations of each provider at each antenatal visit. The pathway has streamlined antenatal care and provided a direct link between GP and hospital responsibilities, with an emphasis on creating partnerships with and making the woman the centre of her antenatal care.

The EHR in a maternity shared-care setting aims to further improve shared-care integration, in order to provide safe and effective clinical care between GPs, health care providers (midwives, doctors and allied health) and the woman herself. The success of the EHR relies heavily on web technologies and the incentive and time to participate in software designed to integrate shared-care information<sup>13</sup>. There is evidence of using the PHR as an integration tool between shared-care health providers, but determining if the PHR or the EHR better facilitates this integration is not known. This study was undertaken to investigate the differences in using a PHR and an EHR in a GP maternity shared-care environment with regards to data completeness, experiences of users and integration of care between women and health care providers.

This report provides a summary of the study questions, study methods and results. It is supported by a systematic literature review published in January 2014 titled *"In a maternity shared-care environment, what do we know about the paper hand-held and electronic health record: A systematic literature review"*<sup>14</sup>. The abstract for this paper is provided in Appendix 2. Three papers have also been submitted or are under review for publication. The first paper has been submitted to BMC Health Services Research and is a comparison of the completeness of clinical data in the paper hand held record (PHR) and the electronic health record (EHR), titled *"Sharing of clinical data in a maternity setting: How do paper hand-held records and electronic health records compare?"*. The second and third papers are descriptions of the experiences of the women and health care providers, using the PHR and EHR, which are currently in review and in progress (respectively).

## IMPLICATIONS

While women and health care providers are familiar with and have traditionally used the PHR, findings of this study have demonstrated that the EHR captures a more complete set of maternity evidenced based data than the PHR. The data in the EHR is available to be viewed as it is entered and shared by women, health care providers and GPs. The EHR has been under-utilised, however women, hospital health care providers and GPs have indicated that they recognise the benefits and have shown enthusiasm in using the record. The interviews from women and health care providers have highlighted that limitations of the EHR are predominantly related to access and education. The findings of the study will enable clinicians, managers and policy makers to implement strategies that improve access to and sharing of information on the EHR. Hospital administrators can be reassured of the value of the maternity EHR in terms of data completeness and availability and will be able to reassess the EHR implementation strategies and see the value in employing continued follow up support for hospital providers at the MMH. The findings of this report will also highlight to system developers the issues with the current EHR from the GP's perspective. One of the key findings is that accessing the current system is time consuming and cumbersome for the GP user, as there is an additional login and security layer to the EHR system. Having the EHR system integrated into each practice's Information Communications and Technology system, with only one layer of access/login would ameliorate this issue. More efficient work flows which reduce data redundancy between the EHR and the practice's own systems also need to be designed and implemented in consultation with users, along with a consistent Human Machine Interface for the GP and the woman.

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## Methods

### INTRODUCTION

Our systematic literature review identified specific gaps in knowledge surrounding maternity PHRs and EHRs<sup>14</sup>. There was a surprising lack of information about data completeness of important maternity variables in both the maternity PHR and EHR. While the review established that there was some information on the experiences of women and health care providers using the PHR and EHR, it became apparent that more work could be done in comparing the two records for benefits and limitations, particularly from the GP group. The study was designed to address these gaps and aligns with the research questions, which were developed from recommendations in the National Health Care Reform Agenda<sup>10</sup>.

Subsequently a paradigm of inquiry has informed the study design and methodology and methods have been chosen on which to answer the research questions outlined below.

### RESEARCH QUESTIONS

1. Does the use of an EHR improve the completeness of recorded specific evidence based best practice variables, compared with a PHR?
2. What are the experiences of women and health providers when using an EHR and a PHR for perception, satisfaction and usability?
3. How does the integration of care differ between using an EHR and PHR for teamwork, clinical input and process deliverables?

### STUDY SETTING

The MMH is a tertiary referral maternity hospital, with an established shared-care arrangement with GPs who have completed an alignment or education program with the hospital. If aligned, the GP obtains RACGP (Royal Australian College of General Practitioners) Group 1 points. The GP must have current medical indemnity insurance and is required to complete a questionnaire each triennium. If alignment conditions are not maintained, the GP will be removed from the maternity alignment database. In a GP shared-care arrangement, low risk antenatal women visit the MMH routinely at the time of booking in and again at the 36-41 week gestation period. The aligned GP manages the care of women at visits between these time periods<sup>15</sup>.

In July 2012, the MMH introduced a maternity EHR as an alternative to the PHR. Pregnancy information is hand written on the PHR and also entered into the Mater Matrix obstetric database by midwives during antenatal visits or other encounters at the MMH. The EHR design was based on the data content into Matrix, which enables data to automatically populate the record at the point of entry. Matrix captures data such as demographics, obstetric history, family history, medical and surgical history, allergies, standard observations (e.g. blood pressure), routine laboratory and ultrasound results, as well as antenatal admissions and visit data. Once these data are entered into the Matrix system, another computer system (Verdi) is used to provide the EHR specific report view (i.e. Matrix does not provide an EHR style report or view of the data).

During the visits to the antenatal clinic the women are seen by a variety of clinicians, including: midwives, allied health and hospital doctors. The first visit a woman makes to the MMH antenatal clinic is usually in the period between twelve and sixteen weeks, known as the 'booking in visit'. At this visit the woman is initially seen by a midwife and a hospital based doctor, where physical observations, an antenatal history and an appropriate model of care are discussed. If the woman has no significant medical history or antenatal risk factors, the GP shared-care model will be the recommended model of care to utilise during the



pregnancy. At this visit the woman can choose to use either a PHR or an EHR to record antenatal information during her pregnancy. During the pregnancy the woman also has an opportunity to access allied health professionals if required. This may occur as an identified need by the woman or it may come as a referral from the midwife or doctor. Allied health professionals include physiotherapists, social workers, dieticians or psychologists.

## STUDY DESIGN

A comparative cohort, multi-method design was chosen to address the three research questions described above. The study is divided into two Phases, as shown in Figure 1.

- > Phase 1 – Users of a maternity PHR.
- > Phase 2 – Users of a maternity EHR.

In each of the Phases, two sets of data have been collected and analysed separately.

- > *Quantitative* clinical data collection – a comparison of specific evidenced based best practice variables from manual audit of the PHR and data extraction of these variables from the MMH Matrix database.
- > *Qualitative* interview data collection – information collected from face to face, small group interviews and focus groups, from antenatal women, GPs and hospital health care providers.

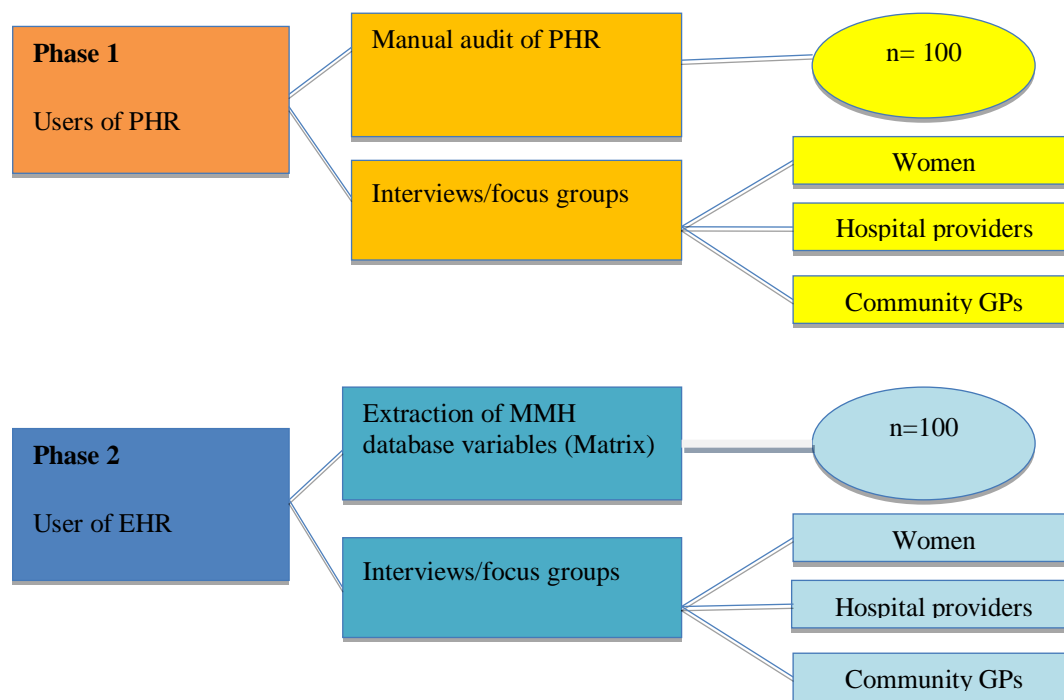


Figure 1. Study methodology demonstrating users of the PHR in Phase 1 and users of the EHR in Phase 2

The completeness of variables collected in the maternity records utilised a quantitative data extraction and analysis approach. Additionally, seeking a range of qualitative interview information from the users of the maternity records has provided a comprehensive review of the benefits and limitations of each of the maternity records.

Combining the quantitative and qualitative data in a multimethod approach, has provided dual and important perspectives about the maternity records and increased the scope of data collected<sup>16,17</sup>.

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# QUANTITATIVE APPROACH TO EXTRACT VARIABLES

## Objective

The objective of the quantitative analysis was to identify and compare the PHR (manual paper audit) and the EHR (extracted from Matrix) for completeness of specific evidenced based best practice variables (further referred to as 'best practice variables').

## Participants

The data analysed in this quantitative approach were obtained from women participating in GP shared-care with the MMH, in Phase 1 and Phase 2 between the period of 01 July 2011 and 03 June 2013. Phase 1 data was collected while the PHR was in use (before the EHR) and Phase 2 data were collected 6 to 12 months after the introduction of the EHR in 2012.

## Outcome variables

Best-practice variables were chosen after examining the National Clinical Practice Guidelines for antenatal care and guidelines used by the MMH<sup>18,19</sup>. The guidelines recommend the collection of key clinical data as determined by best practice evidence levels A or B. The guidelines were informed by systematic reviews, National Institute for Health Care and Excellence (NICE) guidelines and relevant Australian guidelines, such as the National Health and Medical Research Council (NHMRC); Australasian Diabetes in Pregnancy Society (ADIPS); MMH's Antenatal Guidelines and New South Wales (NSW) Department of Health<sup>20-23</sup>. Recommendations were based on evidence about the accuracy of assessments in predicting complications in pregnancy and the effectiveness of interventions in reducing symptoms as described in Table 1.

Table 1. Description of grades of recommendations from National Antenatal Guidelines

Description	Grade
Body of evidence can be trusted to guide practice	A
Body of evidence can be trusted to guide practice in most situations	B
Body of evidence provides some support for recommendation (s) but care should be taken in its application	C
Body of evidence is weak and recommendation must be applied with caution	D
Recommendation formulated in the absence of quality evidence (where a systematic review of the evidence was conducted as part of the search strategy)	CBR*
Area is beyond the scope of the systematic literature review and advice was developed by the EAC and/or the Working Group for Aboriginal and Torres Strait Islander Women's Antenatal Care	PP**

\*CBR - Recommendation formulated in the absence of quality evidence (where a systematic review of the evidence was conducted as part of the search strategy)

\*\*PP - Area is beyond the scope of the systematic literature review and advice was developed by the EAC and/or the Working Group for Aboriginal and Torres Strait Islander Women's Antenatal Care

The variables chosen for inclusion in this study were those: graded as evidence level A or B and those additional non-classified variables, as described in the National Clinical Practice

Guidelines<sup>19</sup>. The final set of specific evidenced based best practice variables are shown in Table 2. The primary outcome measure for the study was a composite score that consisted of all the best practice variables from the PHR and was measured out of 31 (in Phase 1) and in the EHR was out of 28 (in Phase 2). The secondary outcome measures were each of the best practice variables from the PHR (in Phase 1) and the EHR (in Phase 2).

Table 2. Specific best practice variables included in Phase 1 and Phase 2 from antenatal guidelines

Specific best practice variables	Evidence Level (Phase 1-draft guidelines)	Evidence Level (Phase 2-final guidelines)
Clinical measurements		
BMI (body mass index)	B	B
Blood pressure	B	B
Proteinuria	B	B
Screening		
Blood Group	B	B
Antibody status	B	B
Haemoglobin	B	B
Human immunodeficiency virus	B	B
Hepatitis B	A	A
Rubella	B	B
Syphilis	B	B
Urine Culture(MSU)	A	A
GCT (glucose challenge test)	ADIPS guidelines	Not included
GTT (glucose tolerance test)	ADIPS guidelines	ADIPS guidelines
Pregnancy assessments / advice		
Dating scan	B	B
Nuchal scan	B	B
Morphology	MH guidelines	MH guidelines
Folic acid supplementation advice	B	A
Iron supplement advice	B	B
Use of vitamins in diet assessment	B	B
Iodine supplement advice	NHMRC	CBR
Vitamin D deficiency assessment	B	CBR

Oral health advice	B	B
Tobacco smoking	B	A
Alcohol assessment	MH guidelines	MH guidelines
Illicit drug use assessment	MH guidelines	MH guidelines
Domestic violence assessment	B	B
Mental health assessment (EDPS)	NHMRC	B
Immunisation- pre-conception assessment - recorded		
Pertussis	NHMRC	NHMRC
Hepatitis B	NHMRC	NHMRC
Varicella	NHMRC	NHMRC
Immunisations required in pregnancy - recorded		
Fluvax	NHMRC	A
	<b>n= 31</b>	<b>n=28</b>

## Data Analysis

The sample size was calculated based on the primary outcome. The calculation was based on evidence found in the literature, reporting on completeness of health record data. Based on literature results of five non-maternity<sup>24-27</sup> and three maternity papers<sup>28-30</sup>, it was assumed that 75% of records would be complete in Phase 1 and 90% of records would be complete in Phase 2. Considering a relative change of 15% between records and using a 95% confidence interval, 97 records were needed in each Phase of the study to detect a significant difference in the primary outcome. Data were analysed using SPSS for Windows (Version 21). Descriptive data analysis was undertaken using frequencies summarised using numbers and percentages. Chi-squared analyses (or Fishers Exact tests for cell sizes less than 5) were planned to compare differences between the PHR and EHR frequencies. An alpha level of 0.05 was used to detect statistical significance. Data were recorded in an audit spreadsheet structured to capture the specific best practice variables, described in Appendix 3. Each variable was operationalised as 'present' or 'not present'.

## QUALITATIVE APPROACH TO STUDYING EXPERIENCES

This strategy comprised a study to explore the experiences of those who used the maternity PHR and EHR. In order to determine meaningful perspectives on using the EHR, Phase 2 interviews were conducted one year following the introduction of the record in June 2012.

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## Objective

The objectives of the qualitative analysis were to:

- > Explore and compare women's, hospital provider's and GP's experiences when using the PHR and EHR.
- > Determine if and how the integration of care differs between the PHR and EHR in GP shared-care environment.

## Participants

Three groups participated in the GP shared model of care at the MMH were:

4. Low risk pregnant women participating in maternity shared-care (between GP and MMH). These women have been assessed as low risk at the first MMH antenatal booking and are considered eligible to participate in the GP shared-care model.
5. Hospital health care providers (doctors, midwives, allied health, midwifery managers) who provide maternity services to women participating in GP shared-care at the MMH.
6. Community providers from aligned MMH GP practices who provide maternity care to women participating in the GP model of shared-care.

## Description of maternity records

The hospital has traditionally used a PHR that is carried by the woman during her pregnancy as she visits various health care providers within the hospital and the GP. The PHR is an A4 size booklet and can be folded to an A5 size. The booklet includes the following sections: contact information, birth planning, clinical information (medical and obstetric histories, blood and ultrasound results, clinic visits) and lifestyle issues (tobacco, alcohol, drug usage). The sections all have a similar format and an example of the PHR is provided as Annex A (Mater Mothers Hospital, Pregnancy Health Record, Version 2, 12/2012).

The EHR was designed to be a secure online tool, which enables a woman to securely view and add information to be shared between her GP and the hospital. In order for the EHR information to be transferred and viewed by all users, the GP is required to have a compliant software system linked to the hospital. The EHR is accessed by women through the hospital website patient portal using individual login information. The home page of the portal has tabs to the EHR, maternity health information (listed in alphabetical order), contact details and a message page. In the EHR tab, there are links to personal information, scheduled appointments as well as past and present pregnancy summary information. The present pregnancy link is divided into 2 sections:

7. Icons for information viewed by the woman (antenatal history, summary of visits, issues and plans, test results, health care provider details, summaries/reports such as initial interview with midwife); and
8. Icons for details that can be entered by the woman (notes and questions, birth preferences).

An example of the EHR user interface, as used at the MMH, is provided in Appendix 4. A comparison of features between the PHR and the EHR is outlined in Table 3.

Table 3. Comparison of features of the PHR and EHR

PHR – Paper hand-held record		EHR – Electronic health record	
Pages are divided into sections of:		Icons viewed through patient portal:	
		<i>Information entered into EHR by health care providers</i>	
Pages 1 to 3	Mother and general practitioner details	Antenatal history	History recorded early in pregnancy
Pages 4 to 5	Important antenatal signs and symptoms of concern Birth preferences	Issues and plans	Identified medical and obstetric issues and management plans
Pages 6 to 7	Baby feeding intentions, glossary and what to bring to hospital, additional notes section	Health care providers	Details about the providers of maternal care
Pages 8 to 9	Antenatal visit schedule and care checklist	Antenatal visits	Summaries of visits to clinicians for antenatal care
Pages 10 to 11	Father and mother health history Previous pregnancy information	Test results	Results of laboratory and ultrasound tests
Pages 12 to 13	Laboratory and ultrasound results Medical and obstetric issues and management plans	Reports	Pregnancy reports to view and print
Pages 14 to 17	Fundal height chart Visit notes	<i>Details recorded by women</i>	
Pages 18 to 20	Tobacco and alcohol screening Additional scheduling section	Notes/questions	To record my notes and questions for providers
		Birth preferences	Preferences for birth and postnatal care

## Interviews

Women were interviewed using a semi-structured question format. This method gave direction during the interview and permitted a personalised account of using the maternity records, which informed the analysis<sup>31</sup>. The questions were predetermined and so provided avenues for keeping the interview on track and minimised the chances of the interview digressing from the topic.

Group interviews were used (including focus groups and small group interviews) which offered many advantages in this study for collecting information from hospital health care providers and GPs. The group size was flexible with a norm of around 8 participants within an acceptable range of 3 to 12<sup>31,32</sup>. The groups consisted of participants with a similar connection to the research issue and were users of the maternity health records.

The interview schedule outlined in Table 4 was developed to answer research questions, exploring the experiences of those using a PHR or EHR.

Table 4. Concise interview schedule

Research questions	Interview questions and probes
<p>1. What are the experiences when using a PHR or an EHR?</p>	<p>Tell me about the sections in the record:</p> <ul style="list-style-type: none"> <li>&gt; What do you think the good things are about the paper record?</li> <li>&gt; What parts of the record do you use?</li> <li>&gt; Are there parts of the record you don't understand?</li> <li>&gt; What could be improved?</li> </ul> <p>Do you think the record has provided resources for or assisted with preparation for delivery?</p> <ul style="list-style-type: none"> <li>&gt; What information do you want to find out about?</li> </ul>
<p>2. How does the integration of care differ between using a PHR and an EHR?</p>	<p>Does your partner look at the record?</p> <p>Do you think the record helps to co-ordinate your care between health care providers?</p> <ul style="list-style-type: none"> <li>&gt; Does it assist with communication?</li> <li>&gt; Is information reliable and who uses the record?</li> <li>&gt; Which of your providers have looked at the record?</li> </ul>

## Recruitment

### Women

Women were asked to participate in a face to face interview upon arrival for their 36 – 41 week clinic visit and were given an information sheet regarding the study. Women had a period of 15 minutes to read the information sheet and were given the chance to ask any questions about the study before deciding whether to participate.

### Hospital health care providers

Hospital providers including physiotherapists, social workers, dieticians and psychologists were informed of the focus groups through consultation with the appropriate managers. Managers were sent information sheets via email and copies were posted in areas common to the providers. The providers were informed of the location and time of the focus groups and were free to choose to participate.

## GPs

GPs had information sheets and consent forms provided via email, post or facsimile. All GPs aligned with the MMH have used the PHR and were eligible to participate in Phase 1 interviews. In 2011, aligned shared-care GPs were invited by the Mater EHR team to sign up for access to the electronic record. Those who signed up to use the EHR were eligible to participate in Phase 2 of the study. A breakdown of recruitment by the group is found in Table 5.

Table 5. Summary of recruitment by each group of women, hospital clinicians and GPs

Participants	Phase 1.				Phase 2.			
	Interviews		Focus Groups		Interviews		Focus Groups	
	Desired	Actual	Desired	Actual	Desired	Actual	Desired	Actual
Women	15	17			15	12		
Hospital providers								
<i>Midwives</i>			2	2			2	2
<i>Allied health</i>			1	1			1	1
<i>Doctors</i>			1	1			1	1
<i>Midwifery managers</i>			1	1			1	1
GPs	15	17			15	16		

## Procedure

If women were interested in participating in the study, they were interviewed following their antenatal visit and after consents were obtained. Interviews took approximately 20-30 minutes and were audio recorded with consent from the woman. At the conclusion of the interview, the woman was asked if she would like to add any further information and the main points of the interview were verbally summarized to ascertain if the interviewees' responses had been understood correctly. If any of the points were disputed, the interviewer clarified and adjusted the responses at the time of the interview, to ensure accurate reporting of what was said. No adjustments to the responses were required.

The focus groups with the hospital health care providers and small or individual group interviews were conducted in a familiar setting to the participants. The providers were given a paper consent form at the scheduled focus group interview and were asked to record demographic information such as their position at the MMH, gender and years of experience. An experienced moderator also assisted with the groups and a journal was kept to document additional information. It was possible that the same MMH provider would care for women in both Phases of the study and therefore participate in two focus groups. The focus groups took up to 60 minutes to complete.



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If a GP agreed to participate in the study, an individual or small group interview was conducted in their usual practice setting. A consent form was given to GPs to sign, prior to the interview commencing. The interview was audio recorded and an experienced moderator was present to assist with conducting the group and taking field notes and took up to 30 minutes to complete. All of the interviews were conducted by the same interviewer (also investigator), transcribed verbatim by an independent transcription service and coded using content analysis.

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## Results

### QUANTITATIVE - COMPLETENESS OF BEST PRACTICE VARIABLES

Of the 100 medical charts audited in Phase 1, two charts were missing and four did not have a PHR filed within, leaving a total of 94 charts available for audit. In Phase 2 all 100 records were available from the obstetric database.

#### Primary Outcome

##### Completeness of data available from the PHR

From the expected total of 31 variables identified from the guidelines, 21 were recorded in the designated fields in the PHR. Of the remaining ten variables, nine had results written in 'free text areas' of the PHR, rather than in specific data fields (folic acid, iron supplement advice, vitamin supplement advice, vitamin D deficiency assessment, oral health advice, pre-conception evidence of pertussis, hepatitis B, varicella immunisations and 'fluvax in pregnancy' recommendation). There were no results for one variable (iodine intake advice) in either a designated field or in free text. Of the 31 specific best practice variables, none of the 94 women included in the chart audit had a complete dataset.

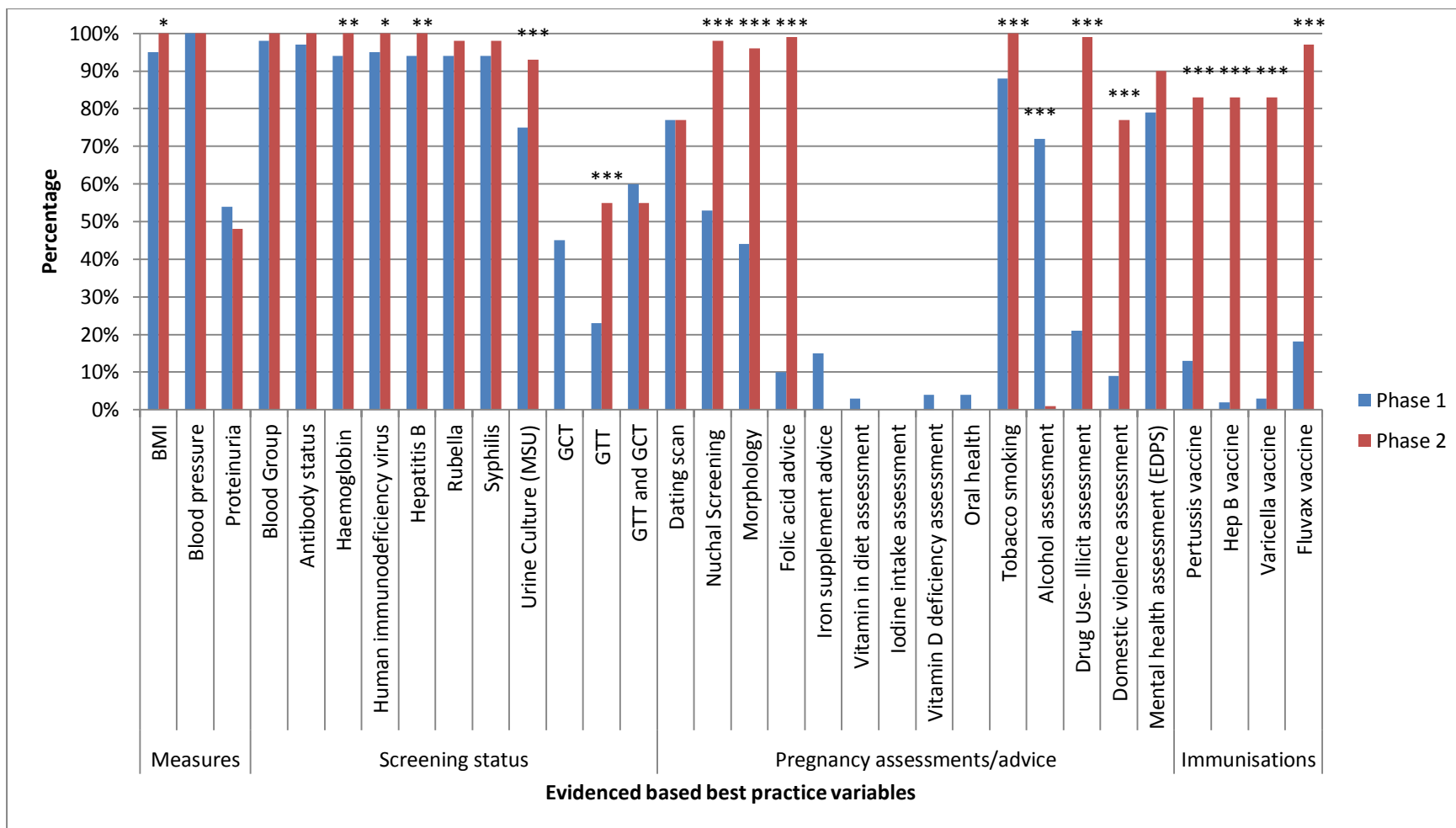
##### Completeness of data available from the EHR

In Phase 2 three best practice variables were not included in the composite score because they were no longer considered evidence level A or B in the National Clinical Practice Guidelines and changes were made to the ADIPS guidelines. These were glucose tolerance test (GCT), iodine intake advice and vitamin D deficiency assessment. Of the 28 variables remaining relevant in Phase 2, there were 26 that had available fields present in the EHR. No EHR had a complete dataset.

In consultation with an MMH statistician the primary outcome chi-square analysis could not be performed, as neither Phase 1 nor Phase 2 had a complete data set of best practice variables.

#### Secondary Outcomes

Individual variables present in the PHR and EHR are shown in Figure 2, where differences in variable completeness are demonstrated between Phase 1 and Phase 2.



\*\*\*p ≤ 0.001, \*\*p ≤ 0.01, \*p ≤ 0.05 for comparisons between PHR and EHR, BMI – Body mass index, MSU-Midstream urine, GCT – glucose challenge test, GTT – glucose tolerance test, EPDS–Edinburgh postnatal depression scale

Figure 2. Percentages of evidenced based best practice variables between Phase 1 (PHR) and Phase 2 (EHR)

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As shown in Figure 2, the only variable that did not have data recorded either in a specific data entry field or written in notes in the PHR was 'iodine intake assessment'. Clinical measurements and screening results, excluding proteinuria, GCT and glucose tolerance test (GTT) were recorded within a range of 70-92%, as were dating scan, tobacco screening, alcohol assessment and mental health assessment (all >74%). The remaining variables of assessments/advice and immunisations were recorded poorly, with a variation between 3% and 51%. In Phase 2, EHR data were more complete. Clinical measurements and screening variables, excluding proteinuria, were recorded with between 93% and 100% completeness. Two variables from the total of 28 included in the analysis that did not have a data entry field in the EHR (iron supplementation advice and vitamin in diet assessment), consequently had no data recorded. Although there was a field for oral health, no data were available. During the introduction of the EHR, numerous changes were made to the alcohol assessment entry fields resulting in data not being recorded well. The percentage of recorded values for the assessments/pregnancy advice and immunisation variables (pertussis, hepatitis B, varicella, fluvax) was high for the EHR, with a range of 77%-100% completeness.

Figure 2 also shows that the variables with significant improvement in completeness of documentation in the EHR compared with the PHR were measures of urine culture and GTT (both  $p=0.001$ ). Similarly, recording of nuchal screening and morphology scans were significant ( $p=0.001$ ), as were folic acid advice, tobacco smoking, illicit drug assessment and domestic violence assessment ( $p=0.001$ ). The documentation of immunisations (pertussis, hepatitis B, varicella, fluvax) was markedly improved in the EHR ( $p=0.001$ ). The remaining variables were recorded as: BMI ( $p=0.02$ ), haemoglobin ( $p=0.01$ ), human immunodeficiency virus ( $p=0.02$ ) and hepatitis B status ( $p=0.01$ ).

The variables of GCT, iron supplementation, iodine intake assessment and oral health were not compared for data completeness between the records. When GCT and GTT were combined to ascertain if variances in data entry existed due to the change in guidelines, no significant differences were found in data completeness between the PHR and EHR. Across both the PHR and EHR, there were no statistical differences between the clinical measurements of blood pressure, proteinuria, blood group, antibody status, rubella or syphilis. The assessment of mental health (using the Edinburgh postnatal depression scale) also demonstrated no significant differences in recording between the records.

While neither record resulted in complete capture of all required best practice variables, use of an EHR demonstrated improved access to antenatal clinical information and greater adherence to the collection of these variables. While the PHR does record best practice variables, many of these were difficult to locate in a free text form and only retrospectively found by an audit process. The EHR has the capacity to further improve data capture by ensuring there are specific fields in which to enter an increased number of best practice variables.

## QUALITATIVE - EXPERIENCES OF USERS

A summary of the main themes and sub-themes identified from the interviews are found in Table 6.

Table 6. PHR and EHR: summary of main themes and sub-themes

Theme	Sub-theme
<b>1. Purpose of the record</b>	1.1 Preparation and reflection
	1.2 Journal
	1.3 Empowerment
	1.4 Safety
<b>2. Perceptions of the record</b>	2.1 Physical attributes
	2.2 Positive attributes
	2.3 Negative attributes
	2.4 Empowerment
<b>3. Content in the record</b>	3.1 Missing information
	3.2 Quality of information
	3.3 Clinical results
	3.4 Education
<b>4. Sharing the record</b>	4.1 Communication between the woman and health care providers
	4.2 Communication between the woman and partner/family/friends
	4.3 Communication between health care providers

### Women using the PHR and EHR

In the period between 01 July 2013 and 30 June 2014, a total of 31 women were identified from clinic visit lists, using an EHR as their nominated preferred form of maternity health record. Twelve women agreed to participate in an interview to discuss using their EHR and how it assisted with integration of care between their GP and the hospital.

#### Purpose

The PHR was the maternity document in use prior to the introduction of the EHR and continued to be predominantly used after the EHR implementation June 2012. Using the PHR in Phase 1, women referred to the record to check the dates of pre-scheduled health care visits and to prepare them for what was expected to occur at those visits. Following an antenatal health visit women looked at the record to remind them about what had happened and/or reflect on what had been discussed with the health care provider.

In Phase 1 using the PHR, women found the meaning of some of the record's sections confusing and were unclear as to whether it was a tool they should be looking at themselves or if it was targeted at health care providers. Women explained that when they were given

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the PHR, midwives had not talked to them about how to use the record and there was also confusion about the roles the health care providers played in explaining the PHR. Women revealed they did not fully know the intent of the record or if they were expected to be looking at the record. They also did not think the PHR was applicable to them, but rather a document for the health care provider to refer to and write notes in.

Phase 2 of the study using an EHR, identified that all women in the shared-care model (regardless of whether their GP used the EHR) were provided with a brochure about how to get a log-in to their EHR in a 'booking in' information package. Women were eager to use the EHR and most were able to obtain access and login. However, many had not accessed their record since the initial login nor had they viewed it in any detail. At the 'booking in' visit or later visits, women were not instructed on how to use the EHR and were generally confused about the next steps involved in using it. Women expressed that the EHR was not discussed with them and they did not know what role the record played in their antenatal care. Additionally even if an EHR was the preferred mode of antenatal record, the women also received paper copies of information entered into the record.

Despite being under-utilised, women reported that the EHR was a good initiative and that they would attempt to use this record in subsequent pregnancies. Comments were predominantly positive and women who had not accessed the EHR prior to the interview suggested they were eager to go home and explore the EHR in more detail following the interview.

### **Perceptions**

Women unanimously talked about 'liking' the PHR. These views were general in nature and detailed descriptions were not provided. Women accepted the PHR was a useful document to store information and a normal part of antenatal care. The PHR was described favourably by most of the women due to it being a physically convenient size and easy to use. Women felt ownership in keeping the record with them and typically carried it in their bag. Although women's experiences of the PHR were overall favourable, there were some comments about how the record could be improved. The record was described as having limited space to write notes and there were suggestions on improving the organisation of the PHR. These encompassed the rearrangement/ordering or colour-coded sections to differentiate the sections intended for women from those intended for use by health care providers, in a similar way to other health care organisations. Generally though, the participants did not find the record difficult to use. As the interviews progressed some comments emerged that were characterised by indifference towards the use of the record. Although, women thought that carrying the PHR was beneficial and an effective tool for storing and sharing information, many did not look through the whole document or in any detail and so did not realise the full potential of the record.

Most of the responses from women described the EHR favourably and most did complete the sign up process to gain a login. Women reported a willingness to use the EHR but did not do so, due to lack of instruction or support. There were women who did not get their log-in to work but still considered the EHR to be an advantageous option over using the PHR and the way of the future. The women who had used the EHR did not identify any information on the EHR that was irrelevant. All of the women considered information on the record to be potentially of use. Generally, there were very few concerns over security issues, hindering access to or using their EHR. Women perceived the EHR to be the main type of antenatal record for the future.

### **Content**

Women mainly looked at the visit schedule and contact phone numbers in the PHR. Once the women identified that they did not refer to all of the PHR, they subsequently indicated that they would use the record more frequently in the future. Information that was recorded

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on the PHR and considered as being important clinical information by the women mostly included blood results. Women thought these results were important to have available for themselves, hospital clinicians and GPs. Women overwhelmingly reported that the PHR was not the source of educational material such as birthing plans, dietary considerations or breastfeeding information. Rather, this information was obtained from other booklets or pamphlets provided by the midwives at the booking-in visit, or from attending antenatal classes.

Similar to women's experiences of using the PHR, participants in Phase 2 focused on viewing appointments, blood results and looking back at previous pregnancy details when using their EHR. Women did however think that sufficient information was included in the EHR and were also interested in finding their clinical results. Women talked about what happened when data such as blood results were missing. When this occurred, women were asked by both the GP and midwives about where and when a blood or scanning test had been done. When these results were missing, women reported that both the GP and the hospital clinicians could retrieve results from another computer system. Women who used the EHR enjoyed looking at the links or tabs to inform them about what to expect in each Phase of the pregnancy. Women also looked for phone numbers and what to expect at antenatal visits. They did admit however that they had not been through all tabs or links closely on the EHR. Once the women were shown how to navigate the EHR and open the links, women thought the issues and plans tab was valuable for viewing any information that would be specific to them. Women were intrigued with the link where they could submit their birth preferences, but did not comment further as they had not entered information into this section.

### Allied health using the PHR and EHR

#### **Purpose**

This group of health care providers did not use the maternity records, but instead wrote their notes in a hospital chart. They did however consider that both the PHR and EHR would be useful tools to use in a referral process. They suggested that this would be beneficial so that both the woman and other health care providers could see all of those involved in the woman's maternity care.

#### **Perception**

A predominant message voiced by the allied health care providers was that they felt disconnected from the maternity records (PHR and EHR). They did not use either record and felt that they had no communication about or input or consultation into the design of either record. There were no sections on either record for allied health to write notes in.

#### **Content**

Maternity notes written by allied health care providers often contain sensitive information, such as drug use or domestic violence that is not appropriate to write in a document that can be accessed by the woman's family, partner or other health care providers. For this reason the psychologists and social workers did not find either the PHR or EHR useful for them. As previously mentioned, allied health care providers write notes in the hospital chart so further writing in a PHR or data entry into an EHR would lead to duplication and possible errors.

### Midwives and midwifery managers using PHR and EHR

#### **Purpose and perceptions**

The replies from midwives and midwifery managers were often synonymous as managers were closely aligned with the care of the woman in a consultative role. The focus groups demonstrated midwives and midwifery managers to be very accustomed to using the PHR to

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manually document maternity information such as blood results, birthing options and lifestyle considerations (e.g. smoking and alcohol use). Both groups of midwives considered the PHR to be an important journal or chronicle of care for women or the story of the women's pregnancy. Managers highlighted the necessity to file the PHR once the woman delivered her baby, to enable a record of the pregnancy care to be located for clinical or auditing purposes. Additionally midwives thought the PHR empowered women, although they mentioned that women did not always look at the record. Midwives thought the PHR served well as a back-up and was maternity information was retrievable if a woman presented to another clinic or hospital (not intending place of delivery). Both groups of midwives considered the PHR to be convenient and easy to use.

When midwives were asked about the EHR, they had limited understanding about what it really was. Predominantly, they thought it was Matrix. Midwives talked about the 'double action' or duplication of having to enter data into one view (Matrix) but open another screen to view output (Verdi). They also talked about data entry fields changing or being absent when modifications were made to the database, resulting in confusion about what data was required to be entered. Midwives were not aware of the view women could see if they logged in and consequently did not envisage the potential or purpose of the EHR. At the booking in visit, women were given a modified version of the PHR document, which included an antenatal visit schedule, list of phone contacts, birthing plan information and lifestyle factor information of smoking, alcohol and drug information. Additionally women were given a further PHR section that documents clinical data and antenatal visit information, (including blood and scanning results, gestation and blood pressure measurements) by the hospital doctor or the GP, resulting in the women having numerous, disjointed pages of antenatal information. As the sections all were the same colour and looked the same, midwives reported they had to search the PHR sections to find relevant information.

## **Content**

When the woman presented for an antenatal visit, it was an expectation her care be documented in the PHR. Further to this, midwives reported that they needed to document in the hospital chart and in the hospital obstetric database (Matrix) and that this caused duplication of information, with extra time demands placed on them. The midwives were familiar with the history of the design of the PHR and so considered all sections (results, birth planning, smoking and alcohol choices) to be relevant.

The midwives were not aware of the contents or fields available for viewing on the EHR, but when features of the EHR were shown to them, they considered the EHR a valuable tool and would make an effort to look at the record with women at future visits.

## **Hospital doctors using the PHR and EHR**

### **Purpose and perceptions**

The doctors as health care providers at the MMH were familiar with the PHR and found it easy to use. When asked about features of the PHR, doctors said that it was generally eye catching, found it quick to find clinical results information and found it useful to make small notes. The PHR was considered a good safety tool for identifying risks that might occur in the pregnancy. Doctors also thought that women mostly carried their PHR record and also thought it was useful and empowered the women to be involved in their own care.

During an antenatal visit, a doctor providing care to women would enter data into Matrix. Similar to midwives, the doctors noted the requirement to open Verdi, making the process tedious. Also, since Verdi provides doctors with a (hospital provider) specific view of the EHR data, they did not have an appreciation of the (different) EHR view that the women could see. To understand and appreciate how women interacted with their EHR profile, doctors were asked to watch the process a woman would undertake to log into their EHR through the hospital provided website patient portal. Once this was done, doctors were able



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to see how women could access the available information, such as blood and scan results, plans formulated for any issues along with the capability to submit preferences for the birth and infant feeding. Consequently doctors described the EHR as a worthwhile online medium for women, enabling them to access information readily, even from mobile devices.

### **Content**

Although the doctors considered the PHR favourably, they talked about the problems that were incurred if the woman forgot to bring her record with her to a clinic. In such cases, information was difficult to quickly retrieve. As there was no duplicate copy of the PHR stored at the hospital, alternate ways to retrieve information was sought, such as making phone calls, searching through hospital charts and relying on women to recall information. Doctors thought there were sections of pointless extra information, like the glossary, breast feeding information and birthing plans.

After being alerted to the capabilities of the EHR from a woman's perspective, doctors were enthused about the possible variances that could be applied to personalise the record. They discussed the additions that would allow the customising (addition or removal of fields) the EHR according to the needs of the woman. There were also comments about the EHR being valuable to access maternity information when the woman presents to another hospital or facility, without any form of paper record.

### **GPs using the PHR and EHR**

#### **Purpose and perceptions**

GPs had a similar perspective to the PHR as did the hospital doctors. They liked the PHR, were familiar with the document and thought it was useful to transfer antenatal visit information from the GP practice back to the hospital as needed. For GPs, the main purpose of the PHR was to record antenatal visit information captured at each visit at the GP practice. GPs considered it important for women to carry their PHR and most GPs did look at the record with them.

When GPs were asked about using the maternity EHR, most comments related to difficulty in accessing the EHR. When software upgrades were first implemented into the GP practices to enable the EHR to function within their own existing systems, technology support was also provided by the vendors. GPs reported that continued support would be beneficial to ensure any access or log-in issues could be addressed regularly. As GPs potentially may only care for two or three pregnant women at any time, they did not necessarily use the maternity EHR daily. Subsequently they found that they forgot the steps required to access or share the antenatal information with the hospital. If the GP encountered an issue with access, the GP contacted the MMH support services and at times experienced substantial delays in having the issue remedied.

### **Content**

Predominantly, the sections of the PHR used by the GPs were the visit notes pages. GPs recorded antenatal information including maternal blood pressure, weight and clinical measurements of fetal heart rate and movements, current gestation and presentation and recording of any issue that might be present. GPs did not routinely go through the sections of birth planning or breastfeeding as they considered this to be completed by the midwife at the hospital visit. The GPs discussed smoking, alcohol and drug consumption with women early in the pregnancy and if identified as needing follow up action, would usually manage the care themselves. If a woman needed follow-up action through the hospital, the GP would usually phone the hospital antenatal clinical to arrange this. With no allocated section on the PHR for referrals, GPs would write this information in the visit notes.

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As many of the GPs interviewed had an issue with accessing their EHR, it was difficult to ascertain the real essence of what content was viewed or utilised. The GPs who were able to access the maternity EHR found having access to hospital visit data helpful, but thought there was more benefit in the hospital having access to GP visit information. Once GP antenatal visit data was entered into the EHR, the GP (with the woman's consent) can share or transfer the information with the hospital. At interviews, GPs were shown the EHR from a woman's view and found this quite useful in appreciating the possibilities the EHR offered in terms of sharing information with them.

## INTEGRATION OF CARE USING THE PHR AND EHR

### Teamwork

#### Women

Women were interviewed about how they thought the PHR assisted in transferring or communicating information between themselves, their partners and their health care providers. Several women discussed the PHR as a communication tool that was used between themselves and their GPs, in terms of the GP reading and recording information in the PHR and explaining parts of the record to them. One woman encapsulated the comprehensiveness of the PHR and stated the GP referred to the record as a 'bible of care'. Responses overwhelmingly indicated that the PHR assisted with sharing information between the hospital and the GP. Women made it clear that they thought the PHR assisted communication between health care providers and referred to the example of GPs looking at the record to see what information had been recorded by the hospital care provider. Women gave varied responses regarding if and when they shared information contained in the PHR with their partners/families/friends. One woman described using the PHR with her friends because they were already familiar with it through their own pregnancies. However, most of the women clearly indicated that their partners did not look at the PHR nor did the women actively share the information with them.

When asked about the EHR being useful to share information, interestingly the record was overwhelmingly viewed as a helpful tool in integrating information between themselves and their GP. There were also suggestions the EHR was useful to assist GPs to communicate, as they could view information easily, did not have to write on paper and could update information during the antenatal visit. The record also assisted the hospital providers to ascertain what had happened at the GP visit. Some women thought their partner would be interested in looking at their EHR but were unsure.

#### Hospital health care providers and GPs

The PHR has been a part of the maternity shared-care model since the early 1990's and is now considered integral to successful communication between the health care providers. Maternity health care providers are familiar with the PHR and have regularly been involved in version updates where additional information has been added or moved to a different location in the record. Midwives considered the PHR integral to sharing information, checked the GP visit notes for any correspondence recorded and also transcribed blood and scan results from paper results attached to the PHR. Hospital doctors and GPs also considered the PHR integral to maternity shared-care and a useful reference tool, although they also reported that there were parts of the record that were superfluous.

As the EHR was not accessed or utilised well, the study has not demonstrated an improvement in sharing of maternity information between maternity health care providers.

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## Clinical input

### Hospital health care providers and GPs

GPs reported that they predominantly looked at and wrote in the visit notes, recording measurements such as blood pressure and urine sample results. Additionally, some GPs reported that they referred only to the medical and obstetric issues and management plan. Other sections of the PHR were considered to be irrelevant for them and intended for the hospital providers or the women. Sections such as the birthing options were reported to be specific to the midwives' frame of reference. GPs reported that they would also avoid the pages relating to smoking and alcohol, citing that they talked to women routinely about these issues but did not record this on the PHR. Midwives interacted with the PHR routinely and reported that they use the record as a prompt to ask women questions about their pregnancy and to collect notes on their birthing and immediate postnatal preferences. When data were missing, midwives and GPs would need to phone the other provider for the necessary information.

As mentioned earlier, the allied health care providers did not use either the PHR or the EHR and so considered either record was not useful for sharing maternity visit information with midwives or GPs. There is no allocated section on the PHR where notifications of referrals can be written. If a midwife referred a woman to see an allied health care provider, the GP would not necessarily be informed. The allied health care provider would endeavour to keep the GP informed by means of a written letter or a phone call. GPs reported that predominantly they would refer women to a local allied health care provider rather than allied health at the hospital. In these cases the GP would write a referral letter. The PHR or EHR did not play a role in any part of the referral process.

While the hospital health care providers and GPs consider the EHR to be an ideal initiative in the maternity setting, issues of accessing up to date and reliable information were evident. Hospital providers did report however that they rarely saw any recorded data on the EHR from GPs. They instead would refer to the modified PHR insert of visit notes. GPs also considered sharing information with the MMH via the EHR to be useful, however all of the GPs interviewed talked about the EHR being tedious to open, as access required a 'side-bar' and extra steps to log-in. GPs also commented that the EHR at times was slow to respond or perform a command, which caused time constraints and frustration.

## Process deliverables

### Hospital health care providers and GPs

Hospital providers and GPs both talked about referring to the antenatal checklist pathway (at each visit) as being useful to guide their care. While this pathway is still utilised on the PHR, the EHR does not include a pathway in the women's or health care provider's screen views or incorporated in a link. All GPs spoke about the management of inpatient admission and discharge summary processes needing refinement. Presently, these summaries are faxed or posted from the hospital to the GP practice. This is thought to be inefficient and unreliable. GPs spoke about the EHR being an ideal means to upload these summaries, to ensure they are reliably and succinctly available for all users with access to view. Currently a GP may not know about a woman presenting to the hospital for assessment or the woman might present to the GP practice before the summary had arrived, leaving the GP unaware of what had happened at the hospital. This is particularly important if there had been a premature delivery or a stillbirth. To address this, usually the GP is notified by phone however this is not always satisfactorily addressed and recommended improvements be made in this area.

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## Discussion

Although neither the PHR nor EHR captured all of the required variables as recommended by national antenatal guidelines, the comparison between the two record types did demonstrate significant improvements in the quality/completeness of data captured when using an EHR. While there have been studies reporting on quality of data in an EHR <sup>25,27-29</sup>, this was the first international study to compare quality of data between a paper based and electronic record in a hospital GP shared-care setting.

This report has reinforced the usage of the PHR as a tool to promote collaborative care between women, hospital providers and GPs. As reported in previous studies, women continued to 'like' carrying their PHR as it gave them a sense of control over their pregnancy and a feeling they were more informed <sup>1-3</sup>. This study has found that women referred to the PHR to prepare them for clinic visits and also to reflect upon what happened at the visit. However, this study has identified that women do not use the PHR to its full potential, thinking it was a tool for information transfer between the hospital and the GP. Women also did not routinely use the PHR to access birthing educational information, instead relying on antenatal classes and additional brochures supplied at the 'booking in visit'. Additionally, health care providers also thought the PHR was important for transfer of pregnancy information, but consider there to be superfluous sections of the record that are not required. This issue has been raised previously and subsequently resulted in the re-design of the PHR to have segregated sections for the care provider and the woman. With the introduction of the EHR at the MMH, a modified PHR was also introduced to replace the version referred to in this study. The PHR is now in three separate sections for: 1) Health care provider clinical information, including obstetric history and clinic visit data and sections 2) and 3) For women to have access to contact phone numbers, a glossary and to document birthing and breastfeeding preferences (see Annex B). This has improved the identification and delineation of pertinent information but has still caused confusion as sections are the same colour and become disorganised pieces of paper and difficult to navigate when looking for information. Although this PHR was designed with good intentions to make access to information easier, it continues to need refinement in design.

When discussing use of the EHR, this study does reflect other studies that suggest both women and health care providers are in favour of using an EHR. Pregnant women are a group of patients that are information 'savvy', along with patients in the child-health or disability group or those who want to monitor their diabetes, chronic disease and mental illness <sup>33-37</sup>. This is reinforced in a recent review suggesting that Internet use and availability of medical information on the web have made patients more aware of symptoms, diagnostic tests and treatments. Although this review encompasses mainly doctor-oriented studies, it does highlight that there is still little consensus on the information that should be included on an electronic record, but there is agreement that it should be easy to understand for the patient <sup>36</sup>. Also identified in the literature surrounding the introduction of the EHR have been issues of e-health security <sup>36,38,39</sup>. These papers have suggested that security of data and privacy issues were a concern to care providers and users. Participants in this study however, did not consider these issues to hinder their use of the EHR. As with the national PCEHR, the MMH EHR was originally planned to incorporate referral and discharge summary functionality <sup>9,40</sup>, but this capability has not yet been included. GPs expressed the desire for these programs to be included in the MMH EHR.

This study did however identify issues of complexity intertwined in data entry and viewing of information in the EHR. Data in the EHR is entered in different screen views depending on the user and the location of the data entry. Hospital providers enter data through the Matrix database and view through a separate Verdi interface while GPs enter data through their own practice database. The woman views her EHR information through a patient portal and can enter a small amount of data through this view. Interviews revealed that at no time did

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the health care providers view the EHR through the woman's patient portal view and so had no comprehension of what information she could access and view.

A recently published survey examining the MMH patient portal usage and perceptions from women has been reinforcing research findings regarding access to maternity information by women<sup>35</sup>. Although this research encompasses responses from all women visiting the antenatal clinic at the MMH and not specifically those participating in GP shared-care, it does verify our findings that women do not generally have issues with registering or obtaining a login to their online record. It also reassures us that women want to view their online record to prepare for a clinic visit or to reflect on what happened at a visit, as they did using the PHR.

The women in our study did get a login to their EHR but did not receive education on how to use it and so had limited exposure to the record or did not view their information on an ongoing basis throughout their pregnancy. Conducting the interviews one year following the introduction of the EHR and at the 36 week visit has provided sufficient time to determine if the EHR was a useful maternity tool throughout the pregnancy. The interviews revealed inadequacies in the support needed to facilitate ongoing understanding and usage of the record, from the women's and health care provider's perspectives. Our study also went a step further to determine the usage of and sharing of information on an EHR between women and health care providers, finding that GPs were having difficulty accessing the EHR or that it was time consuming. Consequently, GPs were not sure if the MMH EHR was operating at all. Concerns such as this have also been reported at the national level with interest in the PCEHR appearing to have subsided<sup>41</sup>.

The significance of this study is that it is the first to compare both: completeness of data collected and experiences of women, hospital care providers and GPs using the PHR and EHR in a maternity shared-care environment. The study is the first to elicit rich, meaningful in-depth data about barriers and enablers to using the records by means of face to face interviews and focus groups. While this study demonstrated that the PHR has wide approval from women and health care providers, the EHR is considered to be favoured and the 'way of the future' in health care<sup>6,35,42,43</sup>. The EHR provides the ideal platform on which to accurately and succinctly capture the recommended maternity variables that can then be available to all users of the record. The issues identified in using the PHR to its full potential and the barriers identified in using the EHR, has provided an opportunity to inform hospital administrators, managers and software developers about strategies to improve the integration of maternity information. Additionally, improved shared viewing of information from a woman's perspective would promote them to be empowered and foster improved interest and awareness of care processes in their pregnancy.

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## Future research

Finding the issues associated with the introduction of a new EHR has provided the opportunity to optimise the full potential of the record. The data entry fields in the EHR need to be modified to better capture the recommended best practice variables. These fields need to be consistent across different systems to enable a quality-standardised data set to be reliably available and in accordance with national and local guidelines. Health care providers require continued education and support for using the EHR in terms of understanding the value of best practice data entry requirements. Once providers are aware of the benefits of improved data availability and access, they are more likely to participate in using the EHR.

Additionally the new or modified systems need to be compatible with current or legacy systems and reliable for use in the GP practices. It is recommended that further development of the EHR be undertaken to facilitate using the record to the full capability intended by developers. Incorporating discharge summaries into the functionality EHR would enhance the usability and acceptance of the record by GPs.

Furthermore the users of the EHR revealed that despite being aware of the EHR, they had not actually used it or had limited use of the record. Providers also need support in understanding how the hospital EHR systems operate together and instructions on how women access and interact with their view of the EHR. To facilitate an improved usage by women, hospital providers need to be aware of the EHR recruitment process and at antenatal visits, discuss use of the record. Subsequently, women also need to be educated about the functionality and capability of the EHR while at the hospital and GP clinic visits.

In order to move the MMH EHR system forward, local and achievable changes can be implemented through collaboration with hospital managers and health care providers. To tackle the challenges of software compatibility and capability, collaboration with the original creators of the EHR program is required. These co-creators include NEHTA and business representatives, MMH Information Technology, Medicare Locals representatives, Indigenous and consumer advocates.

# Appendix 1: Mater Mothers Hospital Pregnancy Health Record Antenatal Checklist

(affix identification label here)

Unit:  
 Family name:  
 Given name(s):  
 Address:  
 Medicare number:  
 Date of birth:

Medical information

## Antenatal Care Checklist

Additional appointments may be required according to individual need. Please discuss any questions or concerns you have during your antenatal, labour or postnatal period with your care providers.

Visit	Activity	Notes
<b>First Visit</b> Preferably before 12 weeks	<input type="checkbox"/> Discuss/outline/perform routine investigations and genetic counselling <b>Bloods</b> —group and antibodies, FBC, syphilis, hepatitis B&C, rubella, HIV and urine dipstick/MSU <b>Antenatal screening</b> —Nuchal Translucency + Bloods at week 11–13 <sup>19</sup> Diagnostic morphology 18–20 weeks <input type="checkbox"/> Offer pap smear if due <input type="checkbox"/> Discuss normal breast changes / examination <input type="checkbox"/> Send hospital referral. Note interest in birth centre care if applicable. <input type="checkbox"/> Discuss folate and iodine supplementation	
<b>12–18 Week Midwife Booking in Visit</b>	<input type="checkbox"/> Discuss preferred model of care <input type="checkbox"/> Commence smoking/alcohol cessation counselling <input type="checkbox"/> Complete SAFE Start or similar tool and EDS (EPDS) <input type="checkbox"/> Discuss recommended weight gain/nutrition <input type="checkbox"/> Discuss physiotherapy <input type="checkbox"/> Discuss reasons to breast feed <input type="checkbox"/> Offer antenatal classes: <input type="checkbox"/> Accepted <input type="checkbox"/> Declined	
<b>20 Week Visit</b>	<input type="checkbox"/> Obtain consent for Anti D prophylaxis <input type="checkbox"/> Confirm expected date of birth <input type="checkbox"/> Confirm model of care <input type="checkbox"/> Review blood/scan results <input type="checkbox"/> Discuss skin to skin contact <input type="checkbox"/> Discuss initiation of breast feeding/baby led feeding <input type="checkbox"/> Discuss positioning and attachment of baby	
<b>Subsequent Visits</b> A minimum of every 4 weeks until 28 weeks	<input type="checkbox"/> Discuss benefits of rooming-in (baby/mother staying together) <input type="checkbox"/> Discuss exercise and rest <input type="checkbox"/> Week 26–28: Obtain GCT/FBC/antibodies (GTT when indicated) <input type="checkbox"/> Review blood results <input type="checkbox"/> Week 28: Provide first dose Anti D if applicable <input type="checkbox"/> Discuss home safety and hazard identification for injury prevention	
<b>30–32 Week Visit with Midwife</b>	<input type="checkbox"/> Discuss birth preferences <input type="checkbox"/> Discuss discharge planning including post-natal supports <input type="checkbox"/> Discuss exclusive breast feeding for six months	
<b>34 Week Visit</b>	<input type="checkbox"/> Week 34: Provide second dose Anti D if applicable <input type="checkbox"/> Discuss expressing breast milk and safe storage <input type="checkbox"/> Review EDS (EPDS)	
<b>36 Week Visit</b> Then as clinically indicated every 1–2 weeks until 41 weeks	<input type="checkbox"/> Discuss signs of early labour, when to come to hospital <input type="checkbox"/> Book elective caesarean section (if applicable) <input type="checkbox"/> Review blood results <input type="checkbox"/> Review breastfeeding information	
<b>41 Week Hospital Visit</b>	<input type="checkbox"/> Discuss induction of labour for week 40 +10–14 days plus or minus membrane sweep <input type="checkbox"/> Monitoring if indicated as per current fetal surveillance guidelines	

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Extract from the Mater Mothers Hospital Pregnancy Health Record, Version 2, 12/2010<sup>1</sup>.

<sup>1</sup> A full copy of the Mater Mothers Hospital Pregnancy Health Record document is provided in Annex A.

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## Appendix 2: Systematic Literature Review Abstract

An abstract of the systematic literature review is provided below. A full version of the review is found at <http://www.biomedcentral.com/1471-2393/14/52>

Hawley et al.: In a maternity shared-care environment, what do we know about the paper hand-held and electronic health record: a systematic literature review. BMC Pregnancy and Childbirth, 2014 14:52.

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**Background:** The paper hand-held record (PHR) has been widely used as a tool to facilitate communication between health care providers and pregnant women. Since its inception in the 1950s, it has been described as a successful initiative, evolving to meet the needs of communities and their providers. Increasingly, the electronic health record (EHR) has dominated the health care arena and the maternity general practice shared-care arrangement seems to have adopted this initiative. A systematic review was conducted to determine perspectives of the PHR and the EHR with regards to data completeness, experiences of users and the integration of care between women and health care providers.

**Method:** A literature search was conducted that included papers from 1985 and 2012. Studies were chosen if they fulfilled the inclusion criteria, reporting on: data completeness; experiences of users and integration of care between women and health care providers. Papers were extracted by one reviewer in consultation with two reviewers with expertise in maternity e-health and independently assessed for quality.

**Results:** A total of 43 papers were identified for the review, from an initial 6,816 potentially relevant publications. No papers were found that reported on data completeness in a maternity PHR or maternity EHR, in a shared-care setting. Women described the PHR as important to their antenatal care and had a generally positive perception of using an EHR. Hospital clinicians reported generally positive experiences using a PHR, while both positive and negative impressions were found using an EHR. The few papers describing the use of the PHR and EHR by community clinicians were also divergent and inconclusive with regards to their experiences. In a general practice shared-care model, the PHR is a valuable tool for integration between the woman and the health care provider. While the EHR is an ideal initiative in the maternity setting, facilitating referrals and communication, there remain issues such as fragmentation of care and continued paper use.

**Conclusions:** There was a surprising gap in knowledge surrounding data completeness in maternity PHRs or EHRs. There was also a paucity of available impressions from community clinicians using both forms of the records.



## Appendix 3: Description of best practice variables and timing of collection

Best practice variable	Description	Data collection time
Body mass index (BMI)	Measure weight and height and calculate body mass index (BMI).	At first antenatal visit
Blood pressure	Measure blood pressure to identify existing high blood pressure.	At first antenatal visit
Proteinuria	Use an automated analyser if available, or urinary dipstick as less accurate method to detect true proteinuria.	At first antenatal visit or subsequent visits
Blood Group	Important to prevent haemolytic disease of the newborn	At first antenatal visit
Antibody status	As above	At first antenatal visit
Haemoglobin	To assess anaemia	At first antenatal visit
Human immunodeficiency virus(HIV)	Offer and recommend HIV testing	At first antenatal visit
Hep B	Offer and recommend hepatitis B virus testing.	At first antenatal visit
Rubella	Offer and recommend testing for rubella immunity	At first antenatal visit
Syphilis	Offer and recommend syphilis testing	At first antenatal visit
Urine Culture (MSU)	Use urine culture testing wherever possible as it is the most accurate means of detecting asymptomatic bacteriuria.	At first antenatal visit or subsequent visits
Glucose challenge test (GCT)	To screen for diabetes in pregnancy	Measured at 26-26 week visit
Glucose tolerance test (GTT)	To screen for diabetes in pregnancy	Measured at 26-26 week visit
Dating scan	Offer an ultrasound scan to determine gestational age, detect multiple pregnancies and accurately time fetal anomaly screening.	between 8 weeks 0 days and 13 weeks 6 days
Nuchal translucency scan	Offer nuchal translucency thickness ultrasound scan	Between 11 weeks 0 days and 13 weeks 6 days.
Morphology	To check for abnormalities in your baby.	Scan at 18-20 week gestation

Folic acid supplementation advice	Inform women of / determine if dietary supplementation with folic acid, from 12 weeks before conception and throughout the first 12 weeks of pregnancy occurred	At first antenatal visit
Iron supplement advice	Do not routinely offer iron supplementation to women during pregnancy.	At first antenatal visit
Vitamin D deficiency	Offer vitamin D screening to women with limited exposure to sunlight, have dark skin or a pre-pregnancy BMI of >30.	At first antenatal visit
Oral health	Advise / ask about oral health checks and treatment.	At first antenatal visit
Tobacco smoking	Assess the woman's smoking status and exposure to passive smoking.	At first antenatal visit
Alcohol	Advise women who are pregnant or planning a pregnancy that not drinking is the safest option. Discuss alcohol consumed during pregnancy.	At first antenatal visit
Drug Use- Illicit assessment	Determine if ever used illicit drugs or requires assistance.	At first antenatal visit
Domestic violence assessment	Explain to all women that asking about domestic violence is a routine part of antenatal care.	At first antenatal visit

# Appendix 4: EHR Sample Screen

The screenshot displays the Mater EHR patient portal. At the top, the Mater logo is on the left, and navigation tabs for Home, Health Record, Health Information, Contact Us, and Messages (with a red notification badge '2') are in the center. A 'Welcome' message is on the right. Below the navigation is a user profile section for 'Mater Testmother' with a birth date of 'DOB 08-Dec-1971'. To the left is a vertical menu with options: Personal Information, Appointments, Pregnancy (with a dropdown arrow), My Pregnancy, Prior Pregnancies, Personal Control (with a dropdown arrow), User access, Block Health Care Providers, and Audit Trail. The main content area is titled 'Information recorded about my pregnancy' and contains six interactive cards: 'My Antenatal History' (History recorded early in my pregnancy), 'My Antenatal Visits' (Summaries of my visits to clinicians for antenatal care), 'Issues and Plans' (Identified medical and obstetric issues and management plans), 'My Test Results' (Results of my laboratory and ultrasound tests), 'My Healthcare Providers' (Details about the providers of my antenatal care), and 'My Reports' (Pregnancy reports to view and print). Below this is a section titled 'Details that I record' with two cards: 'My Notes/Questions' (To record my notes and questions for providers) and 'My Birth Preferences' (My preferences for birth and postnatal care). On the far right, a vertical list of pregnancy-related topics is visible, including 'only', 'Fetal Movements', 'Labour and birth - what to bring to hospital.', 'Rhesus Factor', 'Anaemia', 'Wellbeing in pregnancy: coping and stress management', 'Exercising in Pregnancy', 'Labour and birth - information for women and families', 'Breastfeeding and your new baby', 'Healthy eating during pregnancy', 'Child safety restraints', and 'Correct use of seatbelts'.

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