A retrospective cohort study to evaluate the effect of 'Place Presenting in Labour' and 'Model of Midwifery Care' on maternal and neonatal outcomes for the low risk women birthing in Counties Manukau District Health Board facilities 2011-2012

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Abstract

The Place of Birth has been debated for decades by health professionals, consumer groups, the media and the general public, both in New Zealand and internationally. This research uses a retrospective cohort methodology to examine the effect of Place of Birth on five perinatal outcomes; birth method, maternal admission to theatre and high dependency unit, maternal blood loss, neonatal admission to neonatal unit, and finally Apgar scores at 5 minutes. *Method*: the study took advantage of data that had been collected and stored as part of routine maternity care. After exclusions, the final cohort consisted of 4207 well women with a singleton, cephalic pregnancy who went into spontaneous labour. An accuracy assessment was undertaken to ascertain the accuracy of the database. Binary regression analysis was used to examine an association between Place Presenting in Labour and the five outcomes, controlling for potential confounding variables (age; parity; ethnicity; smoking status; body mass index (BMI); and deprivation). *Results:* Low risk women presenting in labour to the primary unit are four times less likely to experience an emergency caesarean section (OR 0.25, 95% C.I: 0.157-0.339) almost one and a half times less likely to experience a PPH (OR 0.692, 95% C.I: 0.534 – 0.898) five times less likely to be admitted to high dependency unit/intensive care/theatre (OR 0.201, 95% C.I: 0.102-0.398) than women presenting in labour to the tertiary hospital. Babies of low risk women presenting in labour to the primary units are three times less likely to have an Apgar below 7 at 5 minutes (OR 0.313, 95% C.I: 0.124 -0.791) and, correspondingly, two times less likely to be admitted to the neonatal intensive care (OR 0.492, 95% C.I: 0.324-0.747) than babies of women presenting in labour to the tertiary hospital. *Conclusions:* Primary units; Papakura Maternity Unit, Botany Downs Maternity Unit and Pukekohe Maternity Unit offer low risk women a level of protection from operative birth, postpartum haemorrhage, admission to theatre or other tertiary services when compared to the tertiary unit Middlemore Hospital. The primary units offer a level of protection to the babies of low risk women from admission to neonatal intensive care and an Apgar below 7 at 5 minutes. There is a pressing need for a health promotion campaign that will re-educate women about their birth choices and reinvigorate the midwifery profession to promote birth outside of large tertiary institutions. Contemporary, high quality, contextual information promoting the safety of alternative birth settings should be made readily

available to women and their families as a matter of priority. The Place of Birth has been debated for decades by health professionals, consumer groups, the media and the general public, both in New Zealand and internationally. This research uses a retrospective cohort methodology to examine the effect of Place of Birth on five perinatal outcomes; birth method, maternal admission to theatre and high dependency unit, maternal blood loss, neonatal admission to neonatal unit, and finally Apgar scores at 5 minutes. *Method*: the study took advantage of data that had been collected and stored as part of routine maternity care. After exclusions, the final cohort consisted of 4207 well women with a singleton, cephalic pregnancy who went into spontaneous labour. An accuracy assessment was undertaken to ascertain the accuracy of the database. Binary regression analysis was used to examine an association between Place Presenting in Labour and the five outcomes, controlling for potential confounding variables (age, parity, ethnicity, smoking status, body mass index and deprivation). *Results:* Low risk women presenting in labour to the primary unit are four times less likely to experience an emergency caesarean section (OR 0.25, 95% C.I: 0.157-0.339) almost one and a half times less likely to experience a PPH (OR 0.692, 95% C.I: 0.534 – 0.898) five times less likely to be admitted to high dependency unit/intensive care/theatre (OR 0.201, 95% C.I: 0.102- 0.398) than women presenting in labour to the tertiary hospital. Babies of low risk women presenting in labour to the primary units are three times less likely to have an Apgar below 7 at 5 minutes (OR 0.313, 95% C.I: 0.124 -0.791) and, correspondingly, two times less likely to be admitted to the neonatal intensive care (OR 0.492, 95% C.I: 0.324-0.747) than babies of women presenting in labour to the tertiary hospital. *Conclusions:* Primary units; Papakura Maternity Unit, Botany Downs Maternity Unit and Pukekohe Maternity Unit offer low risk women a level of protection from operative birth, postpartum haemorrhage, admission to theatre or other tertiary services when compared to the tertiary unit Middlemore Hospital. The primary units offer a level of protection to the babies of low risk women from admission to neonatal intensive care and an Apgar below 7 at 5 minutes. There is a pressing need for a health promotion campaign that will re-educate women about their birth choices and reinvigorate the midwifery profession to promote birth outside of large tertiary institutions. Contemporary, high quality, contextual information promoting the safety of alternative birth settings should be made readily available to women and their families as a matter of priority.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously publishes or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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"In questions of science, the authority of a thousand is not worth the humble reasoning of a single individual."

— Galileo Galilei

Chapter 1

1.1 Introduction

Giving birth in New Zealand is safer than it has ever been for mothers and their babies. New Zealand's maternity system has a high level of quality and safety and a robust infrastructure for the recording of adverse outcomes.

The Perinatal and Maternal Mortality Review Committee (PMMRC) is an independent committee that reviews all maternal deaths and deaths of babies up to 28 days after birth. It advises the Health Quality & Safety Commission on how to reduce the number of deaths. The PMMRC reports annually on national data. The 2015 review reported on data collected for 2013 and found perinatal related mortality to be 10/1000 which is the "lowest rate reported since the PMMRC began collecting annual data in 2007" (PMMRC, 2015, p. 4) and "similar to the rate reported by England and Wales for 2013 and by Australia for 2012" (p. 16). The 2015 review also placed the New Zealand direct maternal mortality ratio (i.e. the rate of maternal deaths directly attributable to diseases or complications of pregnancy) at 2.7/100,000 maternities which was "very similar" to England and Ireland whose rate was 3.25/100,000 maternities for the same three year period (i.e. 2009-2012) (p. 112). It is also important to note that there has been a "non-significant trend towards a reduction of direct maternal mortality (p. 112).

The number of women and babies dying is thankfully so small that, while these devastating events are investigated at every level possible, in this country they will never provide the statistical power to draw meaningful conclusions around the relative safety of various places of birth or models of care. This is a privileged position with more poorly resourced countries reporting perinatal mortality rates as high as 52/1000 births and, shockingly, the World Health Organisation's (WHO's) *goal* is for the global maternal mortality ratio to drop to 70/100,000 live births by the year 2030. It is currently as high as 240/100,000 births in developing countries (Alkema et al., 2015). However, no matter how low New Zealand rates are by comparison, they are still not low enough. It is obviously crucial to continue to improve services for mothers and their babies and to do this it is logical to investigate the prevalence of maternal and neonatal morbidity which brings us to the research question.

This research intends to determine whether certain exposure variables namely "place presenting in labour" and "model of midwifery care" affect the rate of certain morbidities measured as "birth outcomes" for healthy Counties Manukau women and their babies.

Three maternal birth outcomes (birth method, blood loss, and admission to theatre/high dependency unit/intensive care) and two newborn birth outcomes (Apgar score at five minutes and admission to neonatal unit) are analysed by;

I. The place women present in labour; primary unit or tertiary hospital
II. The Model of Care the women receive; Continuity of Midwifery Care or Fragmented Midwifery Care.

The above comparisons are made within a retrospective cohort of women considered to be at low risk for intrapartum complications, termed low-risk hereon, from Counties Manukau District Health Board (see Glossary p.141 for definition of low risk).

1.2 Phases of the research

The following section will outline the phases of the research in chronological order. Phase 1 includes the necessary preparatory steps for Phase 2 which encompasses the main research questions.

Phase 1:

- Establishing a low-risk cohort
- Accuracy assessment of the low-risk cohort
- Rates of treatments/interventions by "Place Presenting in Labour" and "Model of Care"

Phase 2:

- Characteristics of the low-risk cohort
- Testing the hypotheses

1.3 Purpose of Phase 1

1.3.1 Establishing the low-risk cohort

In order to be eligible for phase 2 women needed to have experienced a low-risk pregnancy up to the point of the spontaneous onset of labour. In this way, all women in the final cohort were equally eligible to birth in the primary or tertiary setting.

1.3.2 Accuracy Assessment of low-risk cohort:

The Healthware™ database was intended to provide the data for most of the fields required to answer the hypotheses in Phase 2. A random sample was selected from the low-risk cohort and the clinical notes for this sample were sourced from medical records. The Healthware™ fields were compared with the corresponding fields in the clinical notes in order to determine the level of accuracy.

1.3.3 Rates of treatments/interventions

Before collapsing the variables into dichotomous outcomes for logistic regression the rates of selected treatments and interventions by "Place Presenting in Labour" and "Model of Care" were generated with the intention of adding some contextual information to the findings within the discussion.

1.4 Purpose of Phase 2

1.4.1 Characteristics of the low-risk cohort

Phase 2 encompasses the main research questions. Before testing the hypotheses the frequency distributions of the characteristics of the cohort are summarised followed by the distribution of primary and tertiary births. Next the characteristics of the low-risk women were cross-tabulated against the two birth sites and the two models of care to determine if there were significant associations. Finally the two models of care were cross-tabulated against the two birth sites to determine if there was a significant association between the exposure variables.

1.4.2 Testing the hypotheses

The four hypotheses investigated in Phase 2 are stated below.

Hypothesis 1: Compared with low-risk women presenting in labour to a tertiary hospital, low-risk women presenting in labour to a primary unit are less likely to;

a) experience a caesarean section
b) experience a blood loss greater than 500ml

c) be admitted to high dependency unit (HDU)and/or intensive care unit (ICU) and/or theatre

Hypothesis 2: Compared with the babies of low-risk women presenting in labour to the tertiary hospital, babies of low-risk women presenting in labour to a primary unit are less likely to;

a) have a five-minute Apgar of less than seven
b) be admitted to a neonatal unit (NNU) within 12 hours of birth

Hypothesis 3: Compared with low-risk women receiving fragmented care, low-risk women receiving continuity of care are less likely to;

a) experience a caesarean section
b) experience a blood loss greater than 500ml
c) be admitted to HDU, and/or ICU and and/or theatre

Hypothesis 4: Compared with the babies of low-risk women receiving fragmented care, babies of low-risk women receiving continuity of care are less likely to;

a) have a five-minute Apgar of less than seven
b) be admitted to a neonatal unit (NNU) within 12 hours of birth

1.5 Background

Maternal and neonatal outcomes in relation to "Place of Birth" and "Model of Care" have been challenging researchers for years for the following five reasons. Firstly women are reluctant to be randomised as they have strong feelings about where they want to give birth and who they want to care for them during this paramount life event (Hendrix et al., 2009). Secondly, maternal and neonatal outcomes interrelate and are affected by a myriad of internal and external factors which are both physical and psychological (van der Hulst, van Teijlingen, Bonsel, Eskes, & Bleker, 2004). Thirdly, obstetricians do not practice outside of secondary or tertiary facilities whereas midwives assist women to give birth across all possible birth place options. Fourthly, it is difficult to identify differences in rates of neonatal mortality and morbidity because of the infrequency of these outcomes. Many studies use a composite of morbidities or proxies (e.g. admission to the neonatal unit) to achieve the necessary study power. Fifthly, determining what is meant by low risk, in order to limit studies to women within this

definition at the outset of labour, can also be challenging. The National Institute for Clinical Excellence (NICE) guidelines out of the United Kingdom, which are well accepted in many countries in the world, consider women to be at low risk of complications if their pregnancy is straightforward, they are in good health and have no serious health conditions, pregnancy-related or otherwise (NICE, 2014). However the term 'good health' is difficult to quantify. What are the parameters of variables such as Body Mass Index (BMI), smoking, deprivation and nutritional status and what about common comorbidities such as asthma and anaemia?

The above challenges mean that existing databases have limited capacity to determine detailed parameters which means retrospective studies can sometimes include participants that should have been eliminated and eliminate participants that should have been retained, resulting in bias. Prospective studies are preferable as risk, "model of care" and "planned place of birth" are assessed at the point of inclusion/exclusion rather than retrospectively but these studies are costly and time consuming. Even when prospective studies are undertaken there are endless and often unresolvable debates attempting to define the multitude of confounding variables. However there are certain generally accepted confounding variables that are traditionally controlled for in retrospective research which will be outlined further in the next section.

In 2009, a retrospective study of the Counties Manukau District Health Board (CMDHB)[1] low-risk birthing community, led by Dr David Bailey, reported improved outcomes for nulliparous women labouring in primary units and that low-risk women are at reduced risk of having a caesarean section if they commence labour in a primary setting rather than a tertiary unit (Bailey & Fenton, 2009). Their research was limited, however, in that potential confounding factors were not addressed.

In addressing the limitations of the previous research by Bailey and Fenton (2009) it is the intention of the researcher to provide representative, rigorous and reliable information about place of birth and model of midwifery care for low-risk women in Counties Manukau by controlling for age, parity, ethnicity, smoking status, maternal BMI and deprivation Decile using logistic regression analysis.

[1] The title of Counties Manukau District Health Board (CMDHB) changed to Counties Manukau Health (CMH) during the writing of this thesis. CMDHB will be used through most of this thesis as this was the official name at the time the data was gathered. The discussion chapter will use CMH when it is focussed on current observations and recommendations

1.6 Potential confounding variables

As already explained the data for this research being undertaken was collected retrospectively. Six potential confounding variables thought to have a controlling effect on the dependent variables were included in the logistic regression analysis: age, smoking status, body mass index, ethnicity, Decile and parity. These will now be briefly examined.

1.6.1 Age

Age has an impact on intrapartum outcomes at either extreme. Pregnant women who were 15–19 years old have been shown to have greater odds for postpartum haemorrhage, and fetal distress (Cavazos-Rehg et al., 2014). As women become older there is an increase in the rate of caesarean section (Roberts, Rowlands, & Nguyen, 2012). The New Zealand PMMRC report (2015) shows that "maternal deaths are more common among Maori and Pacific mothers aged 40 years and over" (p.18).

1.6.2 Smoking status

Pregnancy burdened with smoking is associated with a high risk due to many toxins contained in tobacco crossing the placenta and entering the fetal circulation, e.g. carbon monoxide which jeopardizes the oxygen supply to the fetus (Schneider & Schütz, 2008) Interestingly, Aliyu et al. (2010) found the risk for intrapartum stillbirth among smoking adolescents <15 years of age to be twice the risk for older adolescent and more mature smoking mothers. In addition, smoking during pregnancy has been linked to placental abruption, low birth weight as well as perinatal and infant mortality (Salihu, Aliyu, Pierre-Louis, & Alexander, 2003). Habek, Jasna Cerkez, Ivanisevic, and Djelmis (2002) confirmed smoking, especially >20 cigarettes/day, is associated with the development of maternal anaemia, fetal hypoxia and polycythaemia which in turn result in a significantly poorer perinatal outcome in infants. These researchers also found the rate of delivery by Caesarean section to be significantly higher among women who smoke irrespective of the number of cigarettes per day. Also, the occurrence of meconium in the amniotic fluid as a sign of fetal hypoxia was found to be significantly greater among smoking mothers. The birth weight was lower by 250-350 grams and the five-minute Apgar and umbilical arterial blood pH were found to be lower in babies of mothers of heavy smokers. Furthermore NNU admission and treatment were required in more than 50% of babies born to heavy smokers (Habek et al., 2002). Smoking during pregnancy

also impairs placental development directly or indirectly by reducing blood flow, which can create an hypoxic environment and lead to reduced provision of oxygen and micronutrients Zdravkovic (as cited inVardavas et al., 2010)

1.6.3 Body Mass Index

The Perinatal Mortality and Morbidity Review Committee (PMMRC) found that increasing BMI over 25kg/m^2 is an independent risk factor for stillbirth after adjusting for confounding due to ethnicity, maternal age, smoking, parity and socioeconomic deprivation decile(2014). Approximately 30% of the current low risk cohort have a BMI ≥30kg/m^2 which has been defined as obese (Mission, Marshall, & Caughey, 2015) There are other well-documented intrapartum risks associated with obesity in pregnancy including increased rates of emergency caesarean section, labour dystocia, and postpartum haemorrhage(Mission et al., 2015). Postpartum complications that appear to be higher in this group include infection, thromboembolism as well as prolonged hospital stay, and/or hospital readmission (Vinayagam & Chandraharan, 2012). Infants born to women with a BMI ≥ 30Kg/m^2 are more likely to be large for gestational age, require neonatal intensive care, or be diagnosed with a congenital anomaly (Dodd, Grivell, Crowther, & Robinson, 2010).

1.6.4 Ethnicity

A recent CMDHB study showed the odds of women booking in for antenatal care late in their gestation (>18wks) was almost six times higher among Māori (OR=5.70; 95% CI=2.57-12.64) and Pacific (OR=5.90; 95% CI=2.83-12.29) women compared to those of European and other ethnicities (Corbett, Chelimo, & Okesene-Gafa, 2014). This compromises the opportunity to screen for sexually transmitted infections, family violence, maternal mental health issues and congenital abnormalities and to educate about nutrition, smoking and drug use during pregnancy. Lack of early antenatal care has been linked to poor pregnancy outcomes, including low birth weight and foetal or neonatal death (Stacey et al., 2012). At the same time Maori have the highest rate of primary unit births of all NZ ethnicities (Hunter et al., 2011). The New Zealand PMMRC report (2015) shows that maternal deaths are more common among Maori and Pacific mothers (p.18). The demographics of the low-risk cohort currently being examined show that women presenting in labour to CMDHB primary units are more likely to be Māori or European than Pacific or Asian. The New Zealand PMMRC report (2015) also showed that the risk of maternal mortality increased significantly with increasing deprivation quintile in 2006–2013. The risk for women living in the

most deprived 20 percent of residential areas was 2.4 times that of those in the least deprived 20 percent (p.177).

1.6.5 Decile and Social Deprivation

Counties Manukau District Health Board serves the most economically deprived suburbs as well as some of the fastest developing suburbs in Auckland, with a high proportion of young mothers, and women of Māori and Pacific ethnicity. Nearly 34% of the Counties Manukau population (i.e. 170,260 people) are living in areas that are very deprived, 57% of all Counties Manukau Māori and 73% of Counties Manukau Pacific people live in Decile 9 and 10 areas (CMDHB, 2012).

The population around Botany Downs Maternity Unit (BDMU) is relatively wealthy with very low rates of deprivation. In contrast the suburbs around Middlemore hospital (Mangere, Otara and Manurewa) have very high rates of deprivation, particularly skewed to the most deprived. Papatoetoe is also relatively deprived, but not quite to the same extent. The population around Papakura Maternity Unit (PMU) has an excess in decile 10, while the population of Franklin (served by Pukekohe Maternity Unit - PukMU) has an excess at the less deprived end of the scale (CMDHB, 2012).

Socially disadvantaged women, as defined by factors such as low levels of education, employment, income, or residence in a deprived area, are more likely to have language and health literacy barriers which were worsened by experiences of hostility from health professionals expressed by consumers in the 2013 Counties maternity report (Jackson, 2011) This results in “late booking” to receive antenatal care and consequently suffering increased morbidity and mortality during childbirth when compared to women from socially advantaged backgrounds. Babies of disadvantaged women have higher perinatal and neonatal morbidity and mortality and are more often born with lower Apgar scores and birth weight and are overrepresented in neonatal intensive care units (Overgaard, Fenger-Grøn, & Sandall, 2012).

1.6.6 Parity

Nulliparity is associated with increased intrapartum risks. Nulliparous women have a higher rate of caesarean section, longer labours, higher risk of dystocia, higher rate of intrapartum transfer to obstetric services a higher rate of instrumental delivery and some studies show a higher rate of postpartum haemorrhage (Hashim, Naqvi, Khanam, & Jafry, 2012)

The above confounders are measurable variables. There are many more potential confounders that could not be controlled for due to the retrospective nature of the sample. The literature review will continue by outlining terminology in relation to "Place of Birth" and "Model of Care" before discussing the literature that attempts to compare outcomes.

1.7 Context

The following section will look at the physical and social context of this research, focussing on the basic demographics of the population, the structure of the maternity services and the role of the media in influencing women's choice.

1.7.1 Physical Context

Counties Manukau District Health Board (CMDHB) covers an area of approximately 55,200 hectares and is home to a large and culturally diverse population (both urban and rural) covering a broad socioeconomic spectrum (CMDHB, 2012).

Counties Manukau has one of the fastest growing populations of any New Zealand DHB, with an annual growth rate of 1.7% (Wang & Jackson, 2008). Fourteen per cent of all births in New Zealand are to women residing in Counties Manukau (CMDHB, 2012). Women of childbearing age (15–49 years) make up 30.4% of the total CMDHB population (Statistics New Zealand, 2006). Consequently, the combined CMDHB birthing facilities form one of the largest providers of birthing services within Australasia(Jackson, 2011). Furthermore, approximately 8,500 babies are born each year to women living in CMDHB, of whom more than 50% are born to Māori or Pacific mothers (25% and 32% respectively in 2007–9) and to mothers who predominantly live in areas of high socioeconomic deprivation (Jackson, 2011).

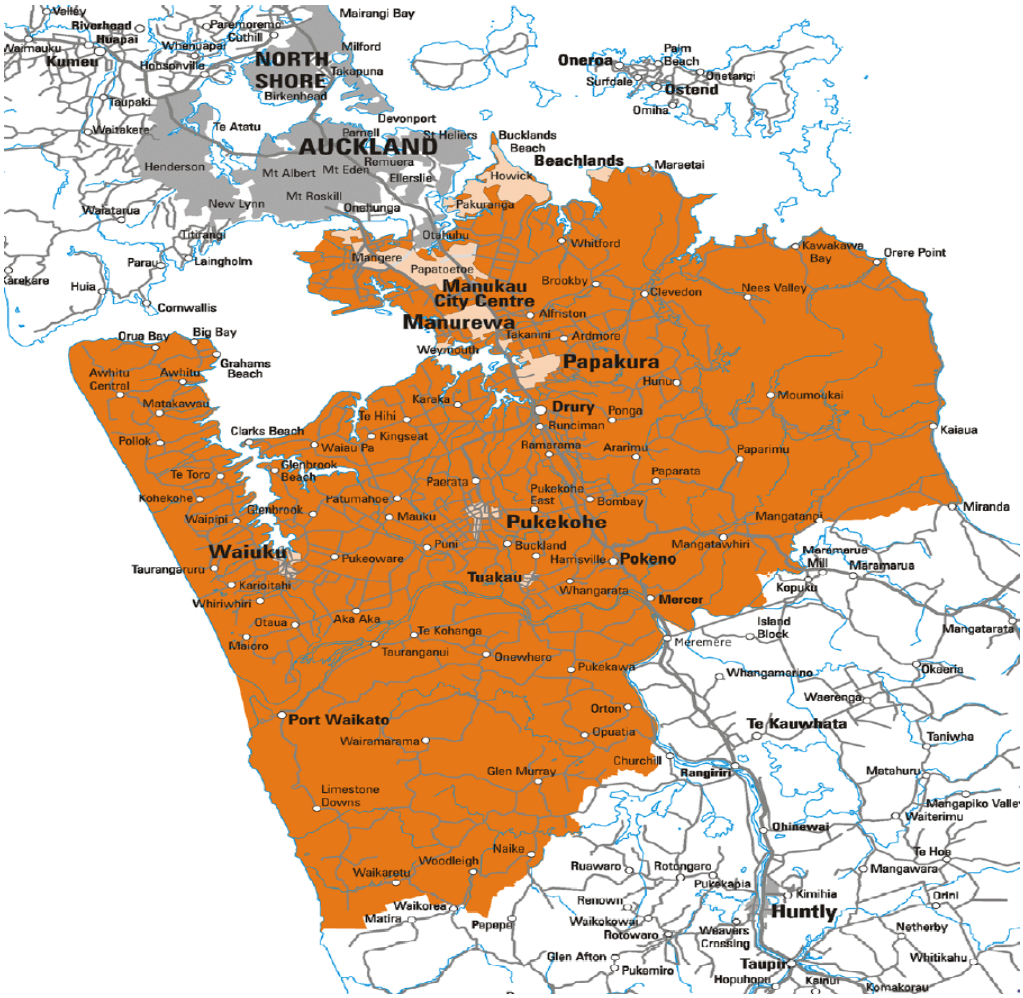

Figure 1. Counties Manukau District Health Board (CMDHB) boundary map. Adapted from "Our Place," by Counties Manukau District Health Board, retrieved 2013, August 8, from http://www.countiesmanukau.health.nz/About_CMDHB/Overview/district-boundarymap.htm

1.7.2 Social Context

Twenty-five years ago the Nurses Amendment Act of 1990 resulted in the development of an autonomous midwifery workforce. This major legal shift opened up the "place of birth" and "model of care" options for low risk women as Midwives were now (along with General Practitioners) able to care for healthy women across all the possible sites of birth using various models of care.

Midwives are guided as to the appropriate model of care and place of birth by the Referral Guidelines (Ministry of Health, 2012a) and the women's informed choice, within the midwifery partnership (Guilliland & Pairman, 2010). Alongside these existing guidelines, The External Review of Maternity Care in the Counties Manukau District (2012) makes the following guiding statement in their recommendations:

> "Women with low medical risk should be actively encouraged to receive midwifery led care and to birth at a primary birthing unit. It is also essential that all pregnant women receive clear and culturally appropriate information about the pregnancy care options available to them, so they can make an informed choice about their maternity care provider" (Paterson et al., 2012, p. 7)

This reflects a groundswell of evidence which supports not only the comparable safety of birthing at home and in primary community units but the *improved* outcomes in these settings. Research also suggests that continuity rather than fragmented models of midwifery care protects women and babies from intervention and provides improved outcomes (this research will be explored next in the literature review). However, despite the recommendations and the evidence, 85% of births in NZ currently take place in large hospitals (Ministry of Health, 2012b) and many of these women receive fragmented models of midwifery care.

There is limited research looking at why New Zealand women are reluctant to birth in primary units despite the now overwhelming research to suggest improved outcomes in these settings. It is possibly partly due to fear generated by social and societal factors and fuelled by inequitable media reporting of adverse events.

The media

When a woman dies in a primary setting the medicolegal enquiry process almost inevitably places blame on the setting and the subsequent media response leads the public to conclude that primary settings are unsafe. In contrast, when a woman dies giving birth in a base hospital the death is perhaps not as heavily critiqued and is consequently reported as though it was inevitable, even when it wasn't.

This year (2015) two women died of one of the most rare, unpredictable and dangerous complications of pregnancy, amniotic fluid embolism. One woman was in a primary unit and the other in a base hospital. The New Zealand Herald headline for the death of the mother and baby in the primary unit reads "Mother and newborn deaths preventable"(Ryan, 2015). In this article the coroner is quoted as saying "specialist care in a hospital could possibly have meant a better outcome for both mother and baby". This same case consequently elicited the following headline "Coroner slams midwife"(Wilson, El-Gamel, & Leaman, 2015) and multiple reports can be found online pertaining to the coroner finding of a "litany of errors" in the midwifery care provided to this woman, many directly related to the setting. One of the three expert

medical witnesses bought in to deconstruct the events leading up to the deaths states that "The complications were too complex for the LMC's training, experience *or the resources in the low risk birthing unit*" [Italics added]. (Baird cited in Wilson et al 2015)

In contrast, in the Bay of Plenty Times the headline reporting the death of the mother at the local base hospital reads “Tragedy as mum dies during childbirth, baby survives with seconds to spare”. This article is written as more of a human interest story and the reason for this mother’s death is simply stated thus: “Complications meant the amniotic fluid flooded Kate's blood stream and then her heart leading to her death.” There was no enquiry into this case, there is no analysis of the events leading up to this woman’s death, no one is held accountable; inevitability is implied.

The woman who died in the primary care setting had risk factors that, in retrospect, made her more suited to birth in a base hospital. It is reasonable to suggest that the midwife should have picked up on these risks and that the medicolegal and media response simply reflected the midwife’s level of professional culpability. But it would seem that this type of media reaction is not equally applied to births in all settings.

This can be seen in an earlier article in the NZ Herald (2009) entitled “Woman dies giving birth at hospital”. Astoundingly this article actually reports on *two* maternal deaths at Auckland Hospital. For one of these women the article states “the hospital admitted that her death was preventable” and that “blood had not been put aside for her despite her specific request”. For the other maternal death there is a statement that “the woman had a medical condition that the staff were previously unaware of”. Both cases were “before the coroner” but, despite these two deeply concerning oversites there have been no further articles to publicise the coroner’s findings. There are no headlines that read “Coroner slams registrar for fatal oversight” or even “Hospital to blame for two maternal deaths”. Instead the Herald reports the following statement: “the hospital said it had implemented recommendations including setting up a new process for obtaining emergency blood, improving handover procedures between staff and checking all pregnant women for risk of post-birth haemorrhage”. In other words, no one person is responsible and the institution, as an entity, owns the systemic failure. Even more interestingly this article begins with the following blanket statement: “Maternal deaths during pregnancy or childbirth or in the weeks afterwards are very rare”. It then goes on to give the following statistics from PMMRC:

> "In 2006, the latest year for which statistics have been published, there were 14 maternal deaths nationally. Of those, six were found to have been directly related to pregnancy or birth, and eight were "indirect" maternal deaths including four suicides."

The article says very little else even though it is supposedly covering one definitely preventable and one probably preventable maternal death that, by its own admission, the "hospital system" failed to recognise.

It is true that hospital employees seldom stand alone in the wake of a catastrophic outcome unless they have acted in way that is grossly negligent. This is entirely appropriate. No disaster is ever one person's fault. But why is there a different understanding when it comes to a publically paid midwife assisting a woman to birth in a publically funded primary birthing unit?

Headlines such as "Midwife criticised for baby's death"(Taylor, 2012) are extraordinarily powerful and possibly used to satisfy the immediate shock value that sustains modern media. If we are to believe the independently gathered statistical findings outlined above (which do not make the headlines as they are more complex and take time to interpret) then it could be argued that there is a public responsibility to protect and promote maternity care and birthing as it is currently occurring. Unfortunately, it would seem the media usually choose to take the contrary approach. This is possibly responsible for a proportion of the childbirth fear that seems prevalent in the contemporary birthing population and possibly results in current trends that see healthy women and autonomous midwives electing to birth in the tertiary hospitals despite evidence clearly guiding them to remain outside of this environment.

Due to the inflammatory nature of anecdotal evidence relating to place of birth and midwifery care in New Zealand, it is ever more important to uncover empirical evidence that can be used to properly inform the birthing population, the general public and the key stakeholders associated with maternity care.

1.8 Significance of Study

If presenting to birth at a particular place or being cared for in a particular way increases a woman or her baby's risk of morbidity she and her partner/support people need to be made aware of this risk in a way that allows them to make an informed choice about where to give birth and how their care is provided. Informed consent is a central

principle of the New Zealand health care system. The development of the Health and Disabilities Code of Consumer Rights (Health and Disability Commissioner, 2006) provides clear requirements that sharing appropriate information is the responsibility of the maternity care provider. Without current, contextual research it is impossible to give evidence-based guidance that can allow women and their families to choose their Place of Birth and their Model of Care.

New Zealand midwives work across the facilities and across the models of care so it is interesting to consider outcomes in relation to both of these variables as separate issues thereby contributing to the planning of new birthing facilities and the development of the midwifery workforce in order to make available the safest options for the birthing community.

1.9 Aims and Objectives

Aims

- To investigate the accuracy of the Counties Manukau Healthware™ database in relation to 31 fields;
- To identify the Counties Manukau low-risk birthing population;
- To identify the characteristics of this population;
- To establish the way this population is distributed across birth sites and models of care;
- To determine the significance of "Place Presenting in Labour" and "Model of Midwifery Care" to five key outcome measures.
- To examine the influence of potential confounding factors on the five outcome measures.

Objectives

Employ rigorous, robust contemporary scientific methods to:

- Provide benchmark figures on the five outcome measures
- Heighten the awareness of the key maternity stakeholders of the impact of "Place Presenting in Labour" and "Model of Midwifery Care"
- Disseminate findings not only to academic audiences, but also to individuals and organisations involved with maternity care in New Zealand;
- Promote discussion and ultimately inform appropriate intervention and policy decisions.

1.10 **Thesis Outline**

Beyond this introduction, the thesis is structured into 6 further chapters.

Chapter 2 presents a review of the current literature in relation to terminology around "Model of Care" and "Place of Birth" followed by a comparison of the outcomes in relation to these variables.

Chapter 3 provides details of Phase 1; the process of data collection and the inclusion/exclusion process that resulted in the final cohort of 4207 low-risk women and their babies followed by the methodology and results of the accuracy assessment undertaken to estimate the accuracy of the data in the Counties Manukau database Healthware™. Finally the rates of selected treatments and interventions by "Place Presenting in Labour" and "Model of Care" are compared.

Chapter 4 provides the methodology of Phase 2. Descriptive statistics are followed by inferential statistics and the measurement levels of the independent, dependent and potential confounding variables are reported. Binary logistic regression is outlined and the associated tests are described.

Chapter 5 presents the results beginning with the characteristics of the cohort and moving on to frequency distributions according to Place Presenting in Labour and Model of Midwifery Care.

Chapter 6 presents the statistical evidence to test the four stated hypotheses in the form of 10 binary logistic regression models.

Chapter 7 is the overall discussion chapter, where the findings and implications of the logistic regression models are explored. This chapter considers the implications of this research to the future direction of childbirth and maternity service and facility provision in Counties Manukau.

1.11 **Summary**

Chapter 1 is introduced by placing the NZ maternity system in context in terms of maternal and perinatal mortality. Relevant national recommendations are then outlined and the tension between these recommendation and the perceived safety of our maternity system is discussed. The inception of this research by Dr David Bailey and Debra Fenton is then acknowledged and the intention to extend this work by adjusting for confounders. These confounders are then discusses. The context of this research is

then explored in relation to the demographics of the Counties Manukau birthing population. The significance of this study to offer some clarity for medically low-risk women and their families about preferred options when deciding on a Model of Midwifery Care and Place of Birth is explained followed by the phases of the research and the purpose of each phase. Finally the aims and objectives are stated and an outline of the thesis is presented.

Chapter 2 Literature Review

2.1 Introduction

This research investigates maternal and newborn outcomes for low-risk women labouring in a primary maternity unit or tertiary hospital in the Counties Manukau District. The research process was undertaken to answer four hypotheses (stated in full in Chapter 1.7.2).

The first two hypotheses propose improved outcomes for women and their babies who presented to birth at a primary maternity unit compared with women and their babies who presented to birth at a tertiary hospital. The second two hypotheses propose improved outcomes for women and their babies who received Continuity of Midwifery Care compared with women and babies who received fragmented care. This literature review will therefore include the research that examines maternal and neonatal outcomes in relation to "Place of Birth" and "Model of Care". These two complex terms present a number of contentious issues both in and of themselves and in relation to each other.

In an attempt to make meaningful comparisons between multiple pieces of research which examine "Place of Birth" the literature review will discuss and define the terminology being used to describe "Place of Birth" nationally and internationally. There are four possible birthplace options investigated in the literature, home, primary midwifery units, alongside midwifery units and obstetric units. While the first two hypotheses under investigation only involve primary units and tertiary hospital the researcher has included literature examine the available research comparing freestanding midwifery unit, homebirth *and* alongside midwifery unit outcomes with obstetric unit outcomes. The literature review will pay particular attention to research that has found an increase in perinatal mortality and morbidity in home and primary unit births. The findings of these studies, while they are in the minority, have created the most controversy. Particular attention will also be given to meta-analyses and each section will begin by examining the related Cochrane review (where one is available).

In an attempt to make meaningful comparisons between multiple pieces of research which examine "Model of Care" the literature review will go on to discuss and define the terminology being used to describe "Model of Care" nationally and internationally.

The review will then look at the context of New Zealand midwifery care and outline the type of care being provided in Counties Manukau at the time this data was collected.

The midwifery Model of Care is now well established in the literature as safe, preferred by the majority of consumers and cost effective (D Davis & K Walker, 2010; Hatem, Sandall, Devane, Soltani, & Gates, 2008). However, the effectiveness of continuity of care in lowering the rate of Caesarean birth is still in question (Beckmann, Kildea, & Gibbons, 2012; McLachlan et al., 2012; Tracy et al., 2013). Again, particular attention will be given to meta-analyses.

There are vast amounts of literature available on both "Model of Care" and "Place of Birth". This review will be focussed on defining "Place of Birth" and "Model of Care" in a way that is relevant to the current research questions and then discussing the literature in relation to these concepts and their impact on maternal and neonatal outcomes.

2.2 Search Strategies

An electronic search of the AUT library databases CINAHL; Medline; EBSCO, PubMed, SCOPUS, Science Direct; and the Cochrane Library was carried out for the period January 2000 to January 2014. A combination of the following key words and phrases were used: Place of Birth, perinatal and maternal outcomes, perinatal mortality and morbidity, planned Place of Birth, home birth, low risk pregnancy, midwifery-led care, and consultant-led labour ward. Results were restricted to English language, peer-reviewed papers. A review of references in relevant studies was also conducted. Some studies were located via the Google Scholar internet search engine. Counties Manukau District Health Board provided relevant resources and guidelines.

2.3 Place of Birth terminology

Place of Birth terminology varies considerably. The Birthplace in England Collaborative Group (2011) have facilitated a consensus as to sensible and transferable terminology around Place of Birth. The terminology developed by Rowe (2011) for the Birthplace in England Collaborative Group (2011) will be used throughout this literature review in place of the various terminology used in other national and international studies (Table 1). This will not only provide a sense of the trends within the literature but also provide a consistent and meaningful picture regarding the Place of Birth.

This literature review will use the terms Alongside Midwifery Unit (AMU) to describe a ward inside a base hospital being led by midwives using a midwifery Model of Care, Freestanding Midwifery Unit (FMU) to describe a birthing facility totally separate from (but within 30 minutes of) its associated base hospital, being led by midwives and a midwifery Model of Care. The term Obstetric Unit (OU) will be used to describe a birthing facility inside a base hospital with all women (high and low risk) being cared for by midwives, with obstetricians, paediatricians, anaesthetists and the full range of medical services being involved or becoming involved as or if the need arises.

Table 1 Place of Birth definitions adapted from Rowe (2011)

Term	**Abbreviation**	**Definition from Rowe (2011).**	**Examples of terms the abbreviation will substitute and the country/study in which they are used**
Alongside midwifery unit	AMU	A clinical location offering care to women with straightforward pregnancies during labour and birth in which midwives take primary professional responsibility for care. During labour and birth diagnostic and treatment medical services, including obstetric, neonatal and anaesthetic care are available should they be needed, in the same building, or in a separate building on the same site. Transfer will normally be by trolley, bed or wheelchair.	Midwife-led ward (Norway) Midwife–led normal birth unit (China) Midwifery-led birth centre (Australia) Modified birth centre (Sweden)
Freestanding midwifery unit	FMU	A clinical location offering care to women with straightforward pregnancies during labour and birth in which midwives take primary professional responsibility for care. General Practitioners may also be involved in care. During labour and birth diagnostic and treatment medical services including obstetric, neonatal and anaesthetic care are not immediately available but are located on a separate site should they be required. Transfer will normally involve a car or ambulance.	Primary unit (NZ) Metropolitan stand-alone primary childbirth units (Australia)
Obstetric unit	OU	Care is provided by a team with obstetricians taking primary responsibility for women at high risk of complications during labour and birth. Midwives offer care to all women in an OU whether or not they are considered high or low risk, and take primary responsibility for women with straightforward pregnancies during labour and birth. Diagnostic and treatment medical services including obstetric, neonatal and anaesthetic care are available on site 24 hours an day.	Conventional delivery ward (Norway) Hospital labour ward (Australia) Standard care unit (China) Standard delivery ward (Sweden) Secondary Unit (NZ) Tertiary Unit (NZ)

2.4 Comparing Outcomes by Place of Birth

2.4.1 Freestanding midwifery unit vs obstetric units

In 2012, Dixon et al. undertook a structured literature review to "identify, compare and critically evaluate published studies on freestanding midwifery-led units to determine the evidence that contributes to safety and may be useful for the New Zealand/Aotearoa maternity context" (Dixon et al., 2012, p. 13). They identified three studies that were of particular significance; Overgaard, Møller, Fenger-Grøn, Knudsen, and Sandall (2011), Birthplace in England Collaborative Group (2011) and Davis et al. (2011). These three studies will now be considered in turn.

Overgaard et al. (2011) conducted a retrospective cohort study of 839 low-risk women intending to birth at a freestanding midwifery unit and a matched control group of 839 low-risk women intending to birth in an obstetric unit in Denmark. They found no increase in perinatal morbidity in the FMU group and significantly reduced incidences of: maternal morbidity and birth interventions including caesarean section (RR 0.6, 95% CI: 0.3 to 0.9), instrumental delivery (RR 0.4, 95% CI: 0.3 to 0.6), postpartum haemorrhage >500 ml (RR 0.4, 95%CI: 0.3 to 0.6), oxytocin augmentation (RR 0.5, 95% CI: 0.3 to 0.6) and epidural analgesia (RR 0.4, 95% CI: 0.3 to 0.6). They concluded that freestanding midwifery unit care may be considered as an alternative to obstetric unit care for low-risk women and suggested that pregnant prospective mothers should be given an informed choice of Place of Birth, including information on transfer.

Davis et al. (2011) analysed a retrospective cohort of 16,453 low-risk women birthing across New Zealand between 2006 and 2007 and found the risk of emergency caesarean section for women planning to give birth in an obstetric unit was 4.62 (95% CI: 3.66–5.84) times that of a woman planning to give birth in a freestanding midwifery unit. They also found that babies of women planning to give birth in obstetric units had a higher risk of admission to a neonatal intensive care unit (RR:1.40, 95% CI: 1.05–1.87; RR: 1.78, 95% CI: 1.31–2.42) than women planning to give birth in a freestanding midwifery unit(the RR's refer to secondary and tertiary units respectively). No differences were found in any birth setting for an estimated blood loss of more than 1,000 mL or a 5-minute Apgar score less than 7.

The Birthplace in England Collaborative Group (2011) published a large prospective cohort study of 64,538 women with low-risk pregnancies who gave birth between April 2008 and April 2010 in England. This study compared perinatal outcomes, maternal outcomes and interventions by planned Place of Birth at the start of care in labour (home, freestanding midwifery unit, alongside midwifery unit or obstetric unit). Results were adjusted for maternal age, ethnicity, woman's understanding of English, BMI in pregnancy, parity, gestational age at birth, marital or partner status and index of multiple deprivation score.

Only 8% of women gave birth in non-obstetric settings; 2.8% at home, around 3% in alongside midwifery unit's and fewer than 2% in freestanding midwifery unit's. The proportion of women who had a 'normal birth' (defined as birth without induction of labour, spinal or epidural analgesia, general anaesthesia), forceps or ventouse delivery, caesarean section or episiotomy, varied from 58% in planned obstetric unit births to 76% in alongside midwifery units, 83% in freestanding midwifery units and 88% for planned home births.

In 2015, Davis and Hunter offered a commentary on the Birthplace Collaborative Group study (2011) noting that obstetric intervention increased incrementally as the location of birth increased in proximity to the obstetric unit. The proportion of low-risk women having a caesarean section in labour in each setting increases from 2.8% for the home-birth group, 3.5% for the freestanding birth centre group, 4.4% for the alongside birth centre group to 11.1% in the obstetric unit. The same pattern is evident for other assisted modes of birth and childbirth interventions including augmentation of labour, epidural or spinal analgesia and episiotomy (Davis & Hunter, 2015). Interestingly a recent cross-sectional Australian study by Biró, Knight, Wallace, Papacostas, and East (2014) showed the opposite trend; the lower the acuity of the hospital, the higher the odds for the caesarean section They concluded that "higher-level maternity care may not necessarily equate to higher rates of intervention"(Biró et al., 2014, p. 69). However, this study compared rates of Caesarean section for low-risk women birthing in different levels of obstetric units, no freestanding units were even included, therefore their conclusion is impossible to justify.

Overall, The Birthplace in England study (2011) reported a low rate of adverse events. There were no significant differences in the adjusted odds ratios of primary outcome (a composite of perinatal mortality and intrapartum related morbidities) for any of the non-obstetric unit settings compared with obstetric units. There were 250 primary outcome events, with an overall weighted incidence of 4.3 per 1,000 births. The odds of a primary outcome event were higher among women who planned to give birth to their first baby at home compared with birth planned in an obstetric unit (adjusted OR 1.75, 95% confidence interval 1.07–2.86), but not for either of the midwifery settings. Nulliparous women also had a higher rate of transfer from non-obstetric unit settings (36–45%) compared with multiparous women (9–13%). Interventions during labour were substantially lower in all of the non-obstetric settings. The Birthplace in England study (2011) concludes that there should be a policy of offering healthy nulliparous and multiparous women with low risk pregnancies a choice of birth setting because safety is equal across obstetric led and midwifery led sites.

While the Birthplace in England research has provided detailed information on outcomes for Place of Birth in England there are problems generalising the results to New Zealand due to difference in context, culture and models of maternity care. A recent retrospective observational study (Dixon, Prileszky, Guilliland, Miller, & Anderson, 2014) compares the demographic characteristics, planned birth place setting, transfer rates and neonatal outcomes for a cohort of 61,072 low risk women birthing across New Zealand between 2007 and 2010 with those of the Birthplace in England study (2011). Demographics were in part similar to the Birthplace in England study, the notable difference was ethnicity; a greater proportion of indigenous New Zealand women planned to birth at home or in a freestanding midwifery unit (the proportion of Māori was 17.4% and 27.2% for home and primary unit respectively) compared to the Birthplace in England Collaborative Group cohort where less than 3% were categorised as other than ‘white.’

Dixon et al. (2014) point out that significantly fewer women were transferred in labour in the New Zealand study – 16.9% from home and 12.6% from a freestanding midwifery unit, compared to 21% from home and 21% from a free standing midwifery unit in the Birthplace in England cohort. They conclude that “Perinatal

mortality was low across all settings for low risk women in New Zealand and differences with Birthplace in England were not statistically significant ($p < 0.14$)" (Dixon et al., 2014 p.15). In this review the New Zealand cohort compared favourably with the Birthplace in England which reinforces the evidence that, where a low risk woman plans to birth in New Zealand does not significantly increase adverse outcomes for her baby.

The above research is particularly relevant to the first two hypotheses proposing improved outcomes for women and babies presenting in labour to free standing midwifery led (or primary) units in CMDHB. Several large prospective studies have agreed that birthing in these setting does not compromise safety while decreasing the risk of intervention and morbidity for both mother and baby (Birthplace in England Collaborative Group, 2011; Davis & Hunter, 2015; Overgaard et al., 2011).

2.4.2 Alongside midwifery unit vs obstetric unit

Hodnett, Downe, and Walsh (2012) evaluated ten randomised/quasi randomised trials involving 11,795 women in the UK, Denmark, Sweden, Norway, Canada and Australia. They compared labour and birth outcomes in alongside midwifery units with labour and birth outcomes in obstetric units. The alongside midwifery units were associated with reduced likelihood of medical interventions, increased likelihood of spontaneous vaginal birth, increased maternal satisfaction, and greater likelihood of continued breastfeeding at one to two months postpartum, with no apparent risks to mother or baby. The reviewers noted that it was not possible to draw conclusions about the independent effects of the design of the birth environment due to differences in the organizational models of care including separate staff and more continuity of caregiver in the alongside midwifery units, but concluded that "women and policy makers should be informed about the benefits of institutional settings which focus on supporting normal labour and birth" (Hodnett et al., 2012, p. 2).

Two of the more recent studies included in the above review,Begley et al. (2011) andS. Bernitz et al. (2011) will now be outlined. Begley et al. (2011) carried out an unblinded, randomised trial involving two Irish maternity hospitals with 1,300 and 3,200 births annually. One thousand six hundred and fifty three consenting women were centrally randomised on a 2:1 ratio to alongside midwifery unit or obstetric unit

care, (1101:552). ‘Intention-to-treat’ analysis was used to compare nine key neonatal and maternal outcomes. No statistically significant difference was found between the two groups in seven key outcomes: rate of caesarean birth, induction, episiotomy, instrumental birth, Apgar scores < 8, postpartum haemorrhage; breastfeeding initiation. Women in the alongside midwifery unit were significantly less likely to have continuous electronic fetal monitoring (397 [36.1%] vs 313 [56.7%]; RR 0.64 [0.57 to 0.71]), or augmentation of labour (436 [39.6%] vs 314[56.9%]; RR 0.50 [0.40 to 0.61]). Begley et al. (2011) concludes that midwife-led care, as practised in this study, is as safe as consultant-led care and is associated with less intervention during labour and delivery.

S. Bernitz et al. (2011) studied 1111 women assessed to be at low risk at onset of spontaneous labour and randomised into one of three birth units in the same hospital: alongside midwifery unit, the normal unit or the obstetric unit. The normal unit is a smaller version of an obstetric unit whereby obstetric, anaesthetic and paediatric services are not on duty but on call. S. Bernitz et al. (2011) found no significant differences in total operative deliveries, postpartum haemorrhage, sphincter injuries or in neonatal outcomes. However, the study was over 500 participants short to achieve a power of 80% and a probability of $P < 0.05$. Potential participants showed an unwillingness to be randomised. Recruitment proceeded more slowly than anticipated and 300 women changed their minds about participating in this study as their pregnancies progressed. Never-the less the study did find some statistically significant differences. Augmentation and epidural analgesia were less likely in the alongside midwifery unit and the use of acupuncture was more likely. S. Bernitz et al. (2011) conclude that, women who are low risk and have no “expressed preference” as to their level of birth care will experience the same rate of operative deliveries no matter the style of unit and the Model of Care to which they are exposed. It could be argued that the women who did not mind where they were and who they were with would also not have a strong conviction about birthing physiologically and thus be less motivated to avoid an epidural. Hendrix et al. (2009) studied over 116 nulliparous women who almost universally declined randomisation, their main reason being that they value their autonomy and they wish to reserve the right to change their mind as the pregnancy progresses. Perhaps consent to be

randomised was obtained from the 1111 women in the Bernitz study because the women understood the ease with which they could transfer should the need arise.

Similarly, Eide, Nilsen, and Rasmussen (2009) used a prospective, non-randomised observational study to compare outcomes of low risk primiparous women admitted to, either an alongside midwifery unit or an obstetric unit on the same floor of a Norwegian hospital. The "final allocation" of women occurred in labour. Eide et al. (2009) state "If the woman requests or needs epidural analgesia at arrival to the reception ward, she is admitted to the obstetric unit" (n.p.) but there is no analysis as to how this assessment was made or how many participants it affected. Every time a woman was admitted, by her own choice, to the alongside midwifery unit the next eligible woman who wanted to birth in the obstetric unit was allocated to that cohort. Among the 252 women in the midwife-led ward cohort, 74 (29%) women were transferred to the conventional delivery ward during labour. This high transfer rate would suggest that women's choice to birth in the alongside midwifery unit was influenced by its proximity to the obstetric unit, a limitation acknowledged by the researchers themselves. It is not therefore surprising that emergency caesarean and instrumental delivery rates were not statistically different. More women admitted to the obstetric unit had episiotomy, epidural analgesia, pudendal nerve block and nitrous oxide, while more women in the alongside midwifery unit received opiates and non-pharmacological pain relief. The researchers claim that time from regular contractions to delivery and duration of the second stage of labour, rates of excessive post-partum bleeding (=1000 ml), Apgar scores <7 5 minutes postpartum and transfer to the neonatal intensive care unit were statistically non-different between the two cohorts. However this data was not presented.

Gaudineau, Sauleau, Nisand, and Langer (2013) used a case control design when they studied 316 low risk women admitted to an alongside midwifery unit and 890 low risk women admitted to an obstetric unit in France. The alongside midwifery unit and the obstetric unit share midwifery staff. Women in the alongside midwifery unit had spontaneous vaginal deliveries more often (88.6 vs. 82.8 %, p value 0.034) and perineal lesions less often (60.1 vs. 62.5 %, p value 0.013). The frequency of adverse neonatal outcomes did not differ statistically between the two groups, although the mean clamped at birth umbilical arterial pH level was higher in the

alongside midwifery unit group. The transfer rate from alongside midwifery unit to obstetric unit was high at 31.3 % of which 75.8 % were nulliparae.

Cheung et al. (2011) used action research that led to implementation of an alongside midwifery unit in China. A retrospective cohort and a questionnaire survey provided data for thematic analysis. The outcomes of the first 226 women accessing the alongside midwifery unit were compared with a matched retrospective cohort of 226 women accessing obstetric unit care. The vaginal birth rate was 87.6% in the alongside midwifery unit compared with 58.8% in the obstetric unit. All women who accessed the alongside midwifery unit were supported by both a midwife and a birth companion. None of the women labouring in the obstetric unit were identified as having a birth companion. The women birthing in the alongside midwifery unit reported high satisfaction, but this survey was not offered to the women in standard care. Cheung et al. (2011) highlights the potential of alongside midwifery units to reduce obstetric intervention and increase women's satisfaction in the context of China's extraordinarily high caesarean section rates.

Tracy et al. (2007) studied 1,001,249 women who gave birth in Australia between 1999 and 2002. Twenty-one thousand eight hundred women gave birth in an alongside midwifery unit. The perinatal death rate was significantly lower in the alongside midwifery unit than in the obstetric unit regardless of parity. This study was heavily criticized because it was not able to include the outcomes of women who intended to give birth in an alongside midwifery unit but were transferred to an obstetric unit. In response to this criticism Laws, Tracy, and Sullivan (2010) used the same population database to access the records of 822,955 women who gave birth between 2001 and 2005, of whom 2.7% (22,222) intended to birth in an alongside midwifery unit. This time they were able to include the outcomes from the women who transferred and included them in the alongside midwifery unit outcomes. Laws et al. (2010) reported lower rates of Caesarean birth, epidural analgesia and adverse perinatal outcomes (including preterm birth and low birth weight) for women planning to birth in an alongside midwifery unit. No statistically significant difference was found in perinatal mortality for term babies of mothers intending to give birth in an alongside midwifery unit compared with term babies of low-risk women intending to give birth in an obstetric unit.

M. Ryan and Roberts (2005) used a retrospective cohort study to compare 720 alongside midwifery unit women with 2963 obstetric unit women. Labour was more likely to commence spontaneously in the alongside midwifery unit group and forceps and caesarean section births were also less likely to occur in this group. A greater proportion of infants of alongside midwifery unit mothers had higher birth weights and resuscitation was required less frequently. Intervention rates in the alongside midwifery unit were lower than those in the obstetric unit without any evidence of adverse infant outcomes.

Gottvall, Grunewald, & Waldenström (2004) analysed 10 years of retrospective data involving 126,818 Swedish women (180,380 pregnancies). They found that intrapartum death rates were higher in babies of nulliparous women who commenced labour in an alongside midwifery unit compared with the nulliparous women who commenced labour in an obstetric unit. However, Gottvall et al. (2004) failed to acknowledge that some women who had intrapartum fetal deaths had been under obstetrician care for many hours prior to the delivery (Gilkison, Crowther, & Hunter, 2011).

Subsequently Gottvall, Waldenström, Tingstig, and Grunewald (2011) used a prospective cohort study to compare 2,555 women who signed in for birth in an alongside midwifery unit during pregnancy with 9,382 low-risk women who gave birth in an obstetric unit in the same hospital from March 2004 to July 2008. The alongside midwifery unit group included fewer emergency caesarean sections (primiparas: OR: 0.69, 95% CI: 0.58–0.83; multiparas: OR: 0.34, 95% CI: 0.23–0.51), and in multiparas the vacuum extraction rate was reduced (OR: 0.42, 95% CI: 0.26–0.67). In addition, epidural analgesia was used less frequently (primiparas: OR: 0.47, 95% CI: 0.41–0.53; multiparas: OR: 0.25, 95% CI: 0.20–0.32). Fetal distress was less frequently diagnosed in the birth centre group (primiparas: OR: 0.72, 95% CI:0.59–0.87; multiparas: OR: 0.45, 95% CI: 0.29–0.69), but no statistically significant differences were found in neonatal hypoxia, low Apgar score less than 7 at 5 minutes, or proportion of perinatal deaths (OR: 0.40, 95% CI: 0.14–1.13). Anal sphincter tears were reduced (primiparas: OR: 0.73, 95% CI: 0.55–0.98; multiparas: OR: 0.41, 95% CI: 0.20–0.83). Gottvall et al. (2011) concluded that midwife-led

comprehensive care with the same medical guidelines as in standard care reduced medical interventions without jeopardizing maternal and infant health.

The research outlined above supports the safety of alongside midwifery units with no apparent risks to mother or baby. Alongside midwifery units can reduce medical interventions, increase spontaneous vaginal birth and maternal satisfaction (S. Bernitz et al., 2011; Cheung et al., 2011; Eide et al., 2009; Gaudineau et al., 2013; Gottvall et al., 2011; Hodnett et al., 2012; Laws et al., 2010; M. Ryan & Roberts, 2005).

2.4.3 Homebirth vs obstetric unit

(Olsen & Clausen, 2012) could only include two very small randomised trials in their Cochrane review comparing planned hospital and planned home birth and only one trial contributed data to the review which did not allow conclusions to be drawn. Perinatal outcomes and the autonomy of birthing women interrelate in a complex bio/social framework making it difficult, perhaps impossible, to design a randomised experiment comparing planned hospital and planned home birth. Olsen and Clausen (2012) suggest that it might be worthwhile for Cochrane Pregnancy and Childbirth Group to consider some evidence from observational studies as "values are so different among and between women, clinicians, scientists and policy makers, it is difficult to prioritise between the research approaches" (Olsen and Clausen, 2012 p.16) They finally conclude that both randomised controlled trials and observational research methodologies are "probably best undertaken in tandem" (ibid).

Johnson and Daviss (2005) looked at the outcomes of 5418 women planning a homebirth in North America. Six hundred and fifty-five (12.1%) of these women were transferred to hospital. Medical intervention rates included epidural (4.7%), episiotomy (2.1%), forceps (1.0%), vacuum extraction (0.6%), and caesarean section (3.7%); these rates were substantially lower than for low risk women having obstetric unit births. The intrapartum and neonatal mortality among women considered at low risk at start of labour, excluding deaths concerning life threatening congenital anomalies, was 1.7 deaths per 1000 planned home births, similar to risks in other studies of low risk home and hospital births in North America. There were no maternal deaths. Johnson and Daviss (2005) conclude that planned home birth for low risk women in North America using certified professional midwives was

associated with lower rates of medical intervention but similar intrapartum and neonatal mortality to that of low risk hospital births in the United States.

Lindgren et al. (2008) used a population-based study using data from the Swedish Medical Birth Register. A total of 897 planned home births were compared with a randomly selected group of 11,341 planned hospital births between 1992 and 2004. Lindgren found the neonatal mortality rate was 2.2 per thousand in the home birth group and 0.7 in the hospital group (RR 3.6, 95% CI 0.2 - 14.7). No cases of emergency complications were found in the home birth group. The risk of having a pelvic floor injury was lower in the planned home birth group (RR 0.2, 95% CI 0.0 - 0.7). The risk of having a caesarean section (RR 0.4, 95% CI 0.2 - 0.7) or instrumental delivery (RR 0.3, 95% CI 0.2 - 0.5) was significantly lower in the planned home birth group. Lindgren concluded that the intrapartum and neonatal mortality in planned home births was 2.2 per thousand. The proportion was higher compared to hospital births but no statistically significant difference was found. However, this research was widely publicised and the source of much debate. Two studies in the following yearde Jonge et al. (2009) andJanssen et al. (2009) continued the discussion.

A nationwide retrospective cohort study from the Netherlands byde Jonge et al. (2009) compared perinatal mortality and morbidity in a large Dutch cohort of 529,688 low-risk women who had planned to birth either at home or in a hospital setting. Because the Netherlands has one of the highest perinatal mortality rates in Europe, there had been some suspicion that the high rate of homebirths (approximately 30%) in the country was to blame. The authors found that there was no justification for this suspicion. They found no significant differences in mortality or morbidity between planned home births and planned hospital births (after controlling for known confounders such as age of the mother and socioeconomic status).

Janssen et al. (2009) looked at perinatal outcomes for women planning a home birth in Canada between 2000 and 2004. All homebirths were attended by registered midwives (n = 2889). Janssen et al. (2009) compared them to hospital births meeting the eligibility requirements for home birth that were attended by the same cohort of midwives (n = 4752). A matched sample of physician-attended planned hospital

births (n = 5331) were also compared. The rate of perinatal death per 1000 births was 0.35 (95% CI 0.00–1.03) in the group of planned home births; the rate in the group of planned hospital births was 0.57 (95% CI 0.00–1.43) among women attended by a midwife and 0.64 (95% CI 0.00–1.56) among those attended by a physician. Women in the planned homebirth group were significantly less likely than those who planned a midwife-attended hospital birth to have obstetric interventions (e.g., electronic fetal monitoring, relative risk [RR] 0.32, 95% CI 0.29–0.36; assisted vaginal delivery, RR 0.41, 95% 0.33–0.52) or adverse maternal outcomes (e.g., third- or fourth-degree perineal tear, RR 0.41, 95% CI 0.28–0.59; postpartum haemorrhage, RR 0.62, 95% CI 0.49–0.77). The findings were similar in the comparison with physician-assisted hospital births. Newborns in the home-birth group were less likely than those in the midwife-attended hospital-birth group to require resuscitation at birth (RR 0.23, 95% CI 0.14–0.37) or oxygen therapy beyond 24 hours (RR 0.37, 95% CI 0.24–0.59). The findings were similar in the comparison with newborns in the physician-assisted hospital births; in addition, newborns in the home-birth group were less likely to have meconium aspiration (RR 0.45, 95% CI 0.21–0.93) and more likely to be admitted to hospital or readmitted if born in hospital (RR 1.39, 95% CI 1.09–1.85). Janssen et al. (2009) conclude that planned home birth attended by a registered midwife was associated with very low and comparable rates of perinatal death and reduced rates of obstetric interventions and other adverse perinatal outcomes compared with planned hospital birth attended by a midwife or physician.

Wax et al. (2010) meta-analysis reviewed 12 studies from Western nations (Europe, Australia, Canada, US) involving 342,056 planned home and 207,551 planned hospital deliveries. The reviewers found planned home births were associated with fewer maternal interventions including epidural analgesia, electronic fetal heart rate monitoring, episiotomy, and operative delivery. These women were less likely to experience lacerations, haemorrhage, and infections. Neonatal outcomes of planned home births revealed less frequent prematurity, low birth weight, and assisted newborn ventilation. Planned home and hospital births exhibited similar perinatal mortality rates, but Wax et al. (2010) concluded that “less medical intervention during planned home birth is associated with a tripling of the neonatal mortality rate”. This aspect of the meta-analysis has been criticised as neonatal mortality was

not limited to low-risk women or those in the care of qualified midwives. When studies including home births attended by those other than qualified midwives were excluded, the increase in neonatal mortality did not reach statistical significance (Davis et al., 2011).

Finally, a recent population-based cohort study by Homer et al. (2014) was undertaken in Australia using routinely collected linked data from population databases. Eight years of data provided a sample size of 258,161 full-term women and their infants. The primary outcome was a composite outcome of neonatal mortality and morbidity as used in the Birthplace in England study. Women who planned to give birth in an alongside midwifery unit or at home were significantly more likely to have a normal labour and birth compared with women in the labour ward group. There were no statistically significant differences in stillbirth and early neonatal deaths between the three groups, although they had insufficient statistical power to test reliably for these differences (Homer et al., 2014).

Research comparing homebirth with obstetric unit birth has provided the most controversial results. The settings are viewed as polar opposites in countries where primary maternity care is not well established or where there are barriers to the referral process. A well-integrated maternity service, providing equal respect to primary and secondary services would seem to improve outcomes.

2.5 Summary

Reviewing the literature around Place of Birth has found sufficient evidence to support the conclusion that low risk women in midwifery-led (alongside midwifery unit or freestanding Maternity Units or homebirth) settings experienced fewer obstetric interventions and were more likely to have a normal birth than low risk women receiving standard hospital or obstetric care (Begley et al., 2011; Stine Bernitz, Aas, & Øian, 2012; Cheung et al., 2011; Davis et al., 2011; Eide et al., 2009; Gottvall et al., 2011; Homer et al., 2014; Janssen et al., 2009; Johnson & Daviss, 2005; Laws et al., 2010; Lindgren et al., 2008; M. Ryan & Roberts, 2005; Symon, Paul, Butchart, Carr, & Dugard, 2007; Symon, Winter, Inkster, & Donnan, 2009; Wax et al., 2010). Only a handful of studies have found an increase in neonatal morbidity and mortality (Evers et al., 2010; Gottvall et al., 2004; Lindgren et al., 2008; Wax et al., 2010) and these researchers have either used questionable designs

or subsequently gone on to find more favourable neonatal outcomes in low risk settings. Two Cochrane reviews have also found that birth in settings other than large hospitals are associated with several benefits for mothers and their babies (Hodnett et al., 2012; Olsen & Clausen, 2012).

2.6 Model of Care terminology

Similar to "Place of Birth" a lack of clarity in definition and measurement of "Model of Care" has caused confusion. The current hypotheses compare two models of care: Fragmented Midwifery Care and Continuity of Midwifery Care. The concept of continuity of care has been described in the literature in several ways. In New Zealand however the term "continuity of care" is well defined and part of the maternity services structure. A primary maternity care contract (known as Section 88) details the service specifications for primary maternity care, which standardizes care across the country (Ministry of Health, 2002). Women choose a lead maternity caregiver (LMC), who may be a midwife, general practitioner, or an obstetrician, although most (85%) choose a midwife (New Zealand Health Information Service, 2007). The midwifery workforce is guided by core principles outlined in the Standards for Midwifery Practice (New Zealand College of Midwives (NZCOM), 2008b) and Midwifery Code of Ethics (New Zealand College of Midwives (NZCOM), 2008a).

Continuity of care is one of the fundamental principles underpinning woman-centred care and a midwifery partnership. Guilliland and Pairman (1995) describe partnership as a "relationship of 'sharing' between the woman and the midwife involving trust, shared control and responsibility and shared meaning through mutual understanding" (Guilliland & Pairman, 1995, p. 7). To formulate a midwifery partnership Pairman (1998) suggests that there needs to be the pre-existence of certain conditions or philosophical beliefs held by the midwife and sometimes by the woman. Guilliland and Pairman (2010) contend that continuity of carer is one of these philosophical underpinnings because the midwife and the woman require time and the opportunity to develop a trusting relationship before the birth of the baby. The principles informing the midwifery LMC Model of Care are outlined in Table 2:

Table 2. Central Principles of the New Zealand Midwifery LMC Model

Principle	**Explanation of principle**
Woman/whanau centred care	The woman/whanau will choose her/their Place of Birth. The midwife is able to assist her at home with support from a fully funded second midwife or follow her into any facility provided she has an "Access Agreement" as specified in the service specifications for Maternity Facility Services and Birthing Unit Services issued by the Ministry of Health. The Access Agreement sets out the obligations of both the facility and the practitioner
Continuity of care	The lead maternity care-giver provides continuity of care throughout the woman's pregnancy, labour, birth, and postpartum period. Midwives consult directly with obstetric or other consultants when the need arises. An agreed set of referral guidelines list the conditions (pre-existing, antenatal, intrapartum, or postpartum), for which a consultation or transfer of care is recommended. If transfer to secondary care is recommended the midwife can choose to stay as support or hand over to hospital (closed unit) midwifery services.
Turanga Kaupapa	A set of principles that describe a Maori world view and work with the standards to bring midwives close to a culturally safe indigenous perspective.

(Ministry of Health, 2002; New Zealand College of Midwives (NZCOM), 2008b)

The LMC model, committed to continuity of care, is in place and working well across most of New Zealand (Davis et al., 2011; Dixon et al., 2014; Hunter et al., 2011). However, in Counties Manukau (the setting of the current research) in the year July 2011-June 2012, owing to a lack of available Lead Maternity Carer's a number of other models of care were in place to cope with the demands of the rapidly growing population. There were four ways fully funded maternity care was provided in Counties Manukau. Two of these "models of care" could be defined as fragmented care, and the other two as continuity of care. These models are outlined in Table 3.

Table 3. Type of care available to women birthing in Counties Manukau District Health Board between July 2011 and June 2012

Name of care	Explanation of care	Model of Care
Self-employed lead maternity carer (LMC)	The LMC is a registered midwife (or very occasionally a GP with an obstetric diploma) and works usually with a small group of colleagues to provide continuity of care to a caseload of women. The LMC claims her income from the government via Section 88.	Continuity of care
Shared care	Employed community midwives provide three antenatal visits spread across the pregnancy. The remainder of the antenatal visits are provided by the GP in his/her practice rooms. The GP claims for the antenatal care from the government via Section 88. The women do not experience continuity of care as neither the GP nor the community midwife provides birthing service. Rather the woman is cared for in labour by core staff at one of the primary maternity unit's or Middlemore Hospital, depending on her choice.	Fragmented care
Closed unit care	Employed community midwives see women antenatally and postnatally. Core staff provide intrapartum and postnatal inpatient care.	Fragmented care
Team care	A small team of midwives provide continuity of care to a caseload of women. Similar to LMC except the midwife is paid a wage rather than claiming via section 88.	Continuity of care

Note: There is a fifth possible Model of Care which is least common in CMDHB: Private obstetric LMC. This Model of Care was not considered in the current research.

At any stage during the maternity care in any of the above models of care the midwife LMC, general practitioner LMC, core staff or employed staff can refer women or their babies to the obstetric or neonatal specialist services using the Guidelines for Consultation with Obstetric and Related Medical Services (Ministry of Health, 2012a). The obstetric care provided is fully funded provided the recipient of the care is a citizen of NZ.

Shared care (responsibility for the organisation and delivery of a woman's care, from booking to discharge is shared between midwives and a GP) and closed unit care (women are cared for by midwives working shift work at various wards and facilities) are fragmented in their approach. In contrast self-employed LMC or team midwifery provides continuity of care. The literature review will use only the terms "continuity of care" and "fragmented care" replacing the variety of terminology with the same meaning that occurs in the literature to provide the reader with consistency and clarity (see Table 4).

Table 4. Model of Care definitions

Term	**Definition**	**Examples of terms the abbreviation will substitute and the country/study in which they are used**
Fragmented care	Routine care is offered by midwives working in designated separate ward or clinic areas; they do not have the opportunity to follow individual women through the duration of care.	Standard care
Continuity of care	Women receive continuity of care from a named midwife or her small group practice of midwives for duration of pregnancy, labour, birth, and postnatal care.	Case loading Team Self-employed LMC

2.7 Comparing Outcomes by Model of Care

Evidence from randomised controlled trials (RCTs) shows that midwife-led care is associated with a reduction in analgesia during labour, episiotomy and instrumental vaginal delivery, and an increase in spontaneous vaginal births, initiation of breastfeeding and women's feeling of being in control during labour (Hatem et al., 2008). Many of these RCTs have also reported increased satisfaction for women (Biró, Waldenström, & Pannifex, 2000; Homer et al., 2001; Waldenström, Brown, McLachlan, Forster, & Brennecke, 2000) with no statistically significant differences in neonatal

morbidity, although the numbers of deaths are small and hence estimates of effect have wide confidence intervals (Hatem et al., 2008). An Australian RCT of team midwifery demonstrated a decrease in caesarean sections from 18% to 13% (Rowley, Hensley, Brinsmead, & Wlodarczyk, 1995) but when combined with other RCT's in a Cochrane review of midwife-led care, no differences were found in caesarean rates compared with standard care (Hatem et al., 2008). In the Cochrane review 78% of women in the fragmented Model of Care groups were cared for by midwives and this may have attenuated a difference in caesarean birth between the continuity and fragmented care models (Faucher, 2013). Two of the studies from the Cochrane review are discussed below:

Biró et al. (2000) used a randomized controlled trial including 1000 women allocated to receive Continuity of Midwifery Care or fragmented maternity care within a tertiary hospital setting. The primary outcome measures were; procedures in labour, maternal outcomes, neonatal outcomes, and length of hospital stay (birth method was not reported in this research). The results of this research showed that women assigned to the continuity group experienced less augmentation of labour, less electronic fetal monitoring, less use of narcotic and epidural analgesia, and fewer episiotomies but more unsutured tears. Women receiving continuity of care stayed in hospital seven hours less than women receiving fragmented care. More babies of fragmented care mothers were admitted to the special care nurseries for more than 5 days because of preterm birth, and more babies of continuity of care mothers were admitted to the nurseries for more than five days with intrauterine growth restriction. No differences occurred in perinatal mortality between the two groups. Biro et al (2000) conclude that Continuity of Midwifery Care was associated with a reduction in medical procedures in labour and a shorter length of stay without compromising maternal and perinatal safety and further state that Continuity of Midwifery Care is realistically achievable in a tertiary obstetric referral service.

Also in 2000 a comparison study with area randomisation conducted in England by a group of researchers called the North Staffordshire Changing Childbirth Research Team (known as "North Stafford") found no difference between continuity and fragmented care groups in 'normal vaginal delivery' rates (542/770 (70%) cf. 509/735 (69%).There were fewer 'obstetric interventions' in the continuity group, particularly epidural analgesia (80/770 (10%) cf.110/735 (15%) p=0.01) and oxytocin augmentation (351/77

(46%) cf. 387/735 (53%), p=0.01). There were no significant differences found in terms of neonatal outcome (North Staffordshire Changing Childbirth ResearchTeam, 2000).

Since this Cochrane review McLachlan et al. (2012) carried out a randomised controlled trial (known as "COSMOS") including 2314 Australian women. Women randomised to the continuity model (n=1156) received antenatal, intrapartum and postpartum care from a primary midwife with some care by 'back-up' midwives. Women randomised to fragmented model (n=1158) received either midwifery or obstetric-trainee care with varying levels of continuity, or community-based general practitioner care. The groups were similar in age, gestation at booking, parity, and marital status. McLachlan et al (2012) found that women allocated to the continuity model were less likely to have a caesarean section (19.4% versus 24.9%; risk ratio [RR] 0.78; 95% CI 0.67–0.91; P = 0.001); more likely to have a spontaneous vaginal birth (63.0% versus 55.7%; RR 1.13; 95% CI 1.06–1.21; P < 0.001); less likely to have epidural analgesia (30.5% versus 34.6%; RR 0.88; 95% CI 0.79–0.996; P = 0.04) and less likely to have an episiotomy (23.1% versus 29.4%; RR 0.79; 95% CI 0.67–0.92; P = 0.003). Infants of women allocated to the continuity model were less likely to be admitted to special or neonatal intensive care (4.0% versus 6.4%; RR 0.63; 95% CI 0.44–0.90; P = 0.01). No infant outcomes favoured the fragmented Model of Care. Contributing to the significance of this study is the fact that almost 70% of the women in each group were primiparous compared with 33% and 54% in the caseload trials included in the Cochrane review. This is significant because rates of caesarean birth have consistently been higher in primiparous women compared with multiparous women(MacDorman cited in Faucher, 2013). On the other hand, the setting of this research (Melbourne Hospital) had a relatively high baseline caesarean section rate, which the researchers suggest may have impacted on their findings. They conclude that, in areas with a high baseline caesarean rate, continuity of care for women at low obstetric risk in early pregnancy shows promise for reducing caesarean births.

Beckmann et al. (2012) found similar findings to the Cochrane review using a retrospective cohort study of routinely collected data of all term births between 2006 and 2010 in an obstetric unit in New South Wales. Outcomes for 1545 women under a continuity model were compared with 13,880 women cared for in fragmented models. Significant differences were demonstrated in the demographic and clinical characteristics of the groups. These researchers found no difference in the mode of birth. When adjusted for confounders, women in the continuity group had similar rates

of unassisted vaginal birth (OR 1.07; 95% CI 0.92—1.24; p = 0.397), birth assisted by instrument (OR 1.02; 95% CI 0.86—1.21; p = 0.852) or emergency caesarean section (OR 0.89; 95% CI 0.74—1.06; p = 0.193). However, in the subgroup of women who did not receive epidural analgesia, women in the continuity group had an increased likelihood of an unassisted vaginal birth (OR 1.29; 95% CI 1.06—1.58; p = 0.013). Beckmann et al. (2012) conclude that women receiving a continuity of care model are no more or less likely to have an unassisted vaginal birth.

Tracy et al. (2013) carried out an unblinded, randomised, controlled, parallel-group trial (known as Midwives @ New Group practice Options or "M@NGO) across two Australian hospitals. From 2008 until 2011, 1748 pregnant women were randomly assigned, 871 to Continuity of Midwifery Care and 877 to fragmented maternity care. Tracy et al. (2013) also found the proportion of caesarean sections did not differ between the groups (183 [21%] in the caseload group vs 204 [23%] in the fragmented care group; odds ratio [OR] 0·88, 95% CI 0·70–1·10; p=0·26). Proportions of instrumental birth were similar (172 [20%] vs 171 [19%]; p=0·90), as were the proportions of unassisted vaginal births (487 [56%] vs 454 [52%]; p=0·08) and epidural use (314 [36%] vs 304 [35%]; p=0·54). Neonatal outcomes did not differ between the groups. Tracy et al. (2013) also included a cost analysis and found that the total cost of care per woman was AUS$566·74 (95% 106·17–1027·30; p=0·02) less for Continuity of Midwifery Care than for fragmented maternity care.

2.8 **Summary:**

A substantial body of evidence now exists showing that continuity of care provided by midwives in high-income countries contributes to high-quality, safe and cost effective care. Continuity of care is associated with significant benefits for mothers and babies, and had no identified adverse effects. Women who received continuity of care have been shown to be less likely to experience antenatal hospitalization, regional analgesia, episiotomy, and instrumental birth and were more likely to experience no intrapartum analgesia or anaesthesia with spontaneous vaginal birth, to feel in control during childbirth, to be attended at birth by a known midwife, and to initiate breastfeeding. They were less likely to experience fetal loss before 24 weeks' gestation, and their babies were more likely to have a shorter length of hospital stay. No differences were observed in perinatal mortality outcomes.

However, there is still debate as to whether continuity of care has any impact of mode of birth. One Cochrane review (Hatem et al., 2008) and two subsequent large and well-designed studies (Beckmann et al., 2012; Tracy et al., 2013) have shown no improvement in rate of Caesarean section when women have received continuity rather than fragmented care. It may be unrealistic to expect a Model of Care in and of itself to impact on mode of birth and caesarean section rates given the complexity of this matter.

2.9 What will this research contribute?

The intention of evaluating Model of Care *and* Place of Birth for the same cohort but in separate analyses is to determine which of these variables have the greater impact on the measurable perinatal outcomes after controlling for confounders. Multiple pieces of national and international research evaluate Place of Birth and discuss Model of Care as one of the confounding variables. Only two pieces of research were found evaluating Model of Care by discussing Place of Birth as a confounding variable. Miller and Skinner (2012) found that despite being cared for by the same group of midwives women having their first baby at home were more likely to give birth with no intervention when compared to women having their first baby in a tertiary hospital (Miller & Skinner, 2012). Janssen et al. (2009) whose findings are discussed more fully above, also found that despite being cared for by the same group of midwives women having their baby at home had a lower rate of obstetric intervention and the perinatal death rate was significantly lower when compared to women having their first baby in a secondary or tertiary hospital. After an extensive search no research was discovered that investigates the Model of Care and Place of Birth separately for the same cohort of women.

2.10 Conclusion

This chapter began by discussing the challenges inherent in studying the complex notions of "Place of Birth" and "Model of Care". This was followed by a discussion about "Place of Birth" terminology and a statement, adapted from a previously developed consensus statement, detailing the terminology that would be used when discussing "Place of Birth". The literature review then continued by comparing freestanding midwifery unit, alongside midwifery and homebirth outcomes with obstetric unit outcomes. The next section included a discussion about terminology and a statement detailing the terminology that would be used when discussing "Model of Care" followed by a comparison of outcomes for women experiencing various models

of care. Finally, the contribution that this research could make to the already existing body of knowledge was considered.

Chapter 3 Phase 1: Data collection; determining the low risk cohort; accuracy assessment; and rates of treatments/interventions

This chapter will begin by explaining how the raw data was collected from Healthware (CMDHB database), and how the low risk cohort was determined from this raw data. It will then present the methods and findings of an accuracy assessment undertaken to determine the quality of the data for the remaining low risk cohort. Finally this chapter will use the accurate data fields (not used in phase 2) to compare the rate of treatments/interventions in the primary and tertiary environment.

3.1 Data Collection

The data for the research came from two closely related but distinct Counties Manukau District Health Board (CMDHB) databases; Healthware™ and Patient Information Management System (PiMS™). Healthware™ is primarily concerned with recording and storing clinical data whereas PiMS™ is a patient management database primarily concerned with tracking, coding and determining resource distribution. A clinical analyst for CMDHB Health Intelligence and Informatics Department was asked to generate an Excel spreadsheet from Healthware™ maternity database with the required demographic and clinical data for 1 July 2011 until 30 June 2012 (N=8063). A patient systems manager provided the diagnostic codes for the same National Health Index numbers (NHIs) and the same time period from PiMS™. Both spreadsheets were placed on an external hard drive which was kept in a locked cupboard in the researcher's office when not in use.

Unfortunately, the NHI number of the mother and of the baby were not able to be immediately removed. This would have been preferable as it would have ensured anonymity from the outset but the process of exclusions using diagnostic codes required that the researcher and research assistant match the NHIs from PiMS™ with the NHIs from Healthware™. For this reason the research assistant helping the primary researcher signed a confidentiality agreement from AUTEC (Appendix D) and a Confidentiality Deed from CMDHB (Appendix E) before viewing the data. As soon as the low risk cohort was identified and all relevant fields were merged the mothers and the babies NHIs were removed from the clinical data and kept in a secure encrypted file and each woman and baby in the low risk cohort were assigned unique identification codes. These de-identified data were used for the remainder of the research.

3.1.1 Ethical and cultural considerations

When conducting research in New Zealand, it is important to consider the Treaty of Waitangi principles of Partnership, Protection and Participation (Health Research Council, 2008). At the outset guidance was sought from Kawa Whakaruruhau (AUT Cultural Safety Committee). The committee was supportive of the study and made comment about the high rate of Maori women choosing to birth in primary settings. The committee requested that, once the project is complete, findings are shared in a way that is accessible to this population. The researcher is thus in the process of creating a resource which will incorporate the findings and be available to all women wishing to access one of the CMDHB birthing sites.

According to Emanuel, Wendler, and Grady (2000) there are seven principles required for clinical research to be deemed ethical: (1) the study must be of value; (2) be scientifically valid; (3) have fair subject selection; (4) have a favourable risk-benefit ratio; (5) be independently reviewed (6) receive informed consent from participants; and (7) afford privacy and respect to enrolled subjects.

Counties Manukau DHB Research Office approved the study protocol based on low ethical risk (expedited review number NTX/12/EXP/078 Appendix A). Approval to undertake the study was also gained from The Ministry of Health Northern X Regional Ethics Committee (NTX/11/EXP/284 (Appendix B) and Auckland University of Technology Ethics Committee (AUTEC) (Appendix C).

The study design did not allow informed consent to be sought from each of the participants. This was because the study involved data from approximately 8,000 births which took place over a 1 year period. To contact each woman individually to request permission to use her data was not a requirement of the ethics approval. Of course, the data from public hospitals is often used to make statistical analyses and there is not an expectation of any researcher to gain individual approval once ethical approval has been awarded by the appropriate body but nevertheless the researcher was aware of the deeply personal nature of the information being investigated.

Extra care in the study protocol was devoted to data management and security to ensure privacy and anonymity were maintained. Data was de-identified as soon as it was practically possible.

The above section discussed cultural and ethical considerations involved in undertaking this research and the sampling procedure and privacy protection undertaken by the research team. The next section will explain the process involved in determining women who were "low risk at onset of spontaneous labour".

3.2 Determining the low risk cohort

Accurately determining the women in the sample who were low risk was one of the more difficult requirements of the data preparation. Women's risk status can change at any stage in their pregnancy. The challenge was to remove the women who became high risk at any point before spontaneous establishment of labour.

As mentioned the initial sample included all women who had given birth at one of the Counties Manukau District Health Board birthing facilities (*Figure 2*) between 1 July 2011 and 30 June 2012 (N = 8063).

Figure 2. Locations of the Study; Middlemore Hospital, Botany Downs Maternity Unit, Papakura Maternity Unit, Pukekohe Maternity Unit.(Counties Manukau District Health Board, 2012)

3.2.1 Exclusion process

The first exclusions were made by isolating the women who had experienced a multiple birth and separating them from the dataset. This step was performed by a strategic analyst in the CMDHB Programme Management Office. This took the cohort from

8063 to 7967 singleton births as there were 95 sets of twins and one set of triplets. Twelve singleton births being in the same year to the same woman were counted as separate birth events and retained in the sample.

The next exclusions that were made involved coding data sourced from PiMS™. Problematically, there is no field in Healthware™ that accurately captures the risk status of the woman during pregnancy and up to the point of spontaneously establishing labour. The next section describes how diagnostic codes sourced from PiMS™ were used to first exclude women with high risk pregnancies.

Diagnostic codes

Diagnostic codes (Appendix E) were used to determine women who needed to be excluded from the cohort due to a condition or conditions during their pregnancy requiring admission to the tertiary hospital. A diagnostic code exists for every diagnosis that leads to a hospital admission. A code is assigned to each diagnosis made in the woman's clinical notes and then recorded against the women's National Health Index (NHI) in a database named Patient Information Management System (PiMS™). This database collects information pertaining to the patient's use of the system rather than their clinical picture. The diagnostic codes are assigned to generate reports that in turn generate funding allocation, they are not a clinical record. Coders are not clinicians. It is also important to point out that if a woman is admitted and given a diagnostic code it does not automatically mean her pregnancy has become high risk. For the purposes of this research the codes have been sorted into primary and secondary care categories (also shown in Appendix F) by an employed midwife who works across primary and secondary services at CMDHB using the Referral Guidelines (Ministry of Health, 2012a)to validate the allocations. Women were excluded if they had at least one secondary diagnostic code made during the course of the pregnancy but were retained even with multiple primary diagnostic codes.

In total, 3403 exclusions (Table 5) were made from the cohort of 7967 using the diagnostic codes leaving 4562 women.

Table 5. Diagnostic codes indicating secondary care in pregnancy

Diagnostic code*	**n**
Anaemia complicating childbirth and the puerperium	69
Antepartum haemorrhage, unspecified	139
Diabetes mellitus arising during pregnancy, insulin treated	132
Diabetes mellitus arising during pregnancy, oral hypoglycaemic therapy	122
Diabetes mellitus arising during pregnancy, other	92
Diseases of the digestive system complicating pregnancy, childbirth and the puerperium	70
Duration of pregnancy 26-33 completed weeks	124
Duration of pregnancy 34-36 completed weeks	339
Endocrine, nutritional and metabolic diseases complicating pregnancy, childbirth and the puerperium	82
Gestational [pregnancy-induced] hypertension without significant proteinuria	110
Maternal care due to uterine scar from previous surgery	639
Maternal care for breech presentation	125
Maternal care for excessive fetal growth	189
Maternal care for other specified fetal problems	101
Maternal care for poor fetal growth	337
Mental disorders & diseases of the nervous system comp preg c/birth & puerperium	44
Oligohydramnios	161
Other specified diseases and conditions complicating pregnancy, childbirth and the puerperium	246
Polyhydramnious	53
Pre-eclampsia, unspecified	190
Premature rupture of membranes, onset of labour between 1-7 days later	369
Preterm delivery without spontaneous labour	159
Preterm spontaneous labour with preterm delivery	340
Prophylactic immunotherapy	62
Supervision of pregnancy with other poor reproductive or obstetric history	218
Vaginal delivery following previous caesarean section	297
Other diagnostic codes e.g. rhesus isoimmunisation, thrombocytopenia, cerviclagia	398
Total number of secondary diagnoses	**5207**
Total unique NHIs	**3403**

*Note: codes are not mutually exclusive, a total of 3403 women were excluded for one or more of the above 5207 secondary diagnoses.

The Guideline for Registering and Birthing at a CMH Primary Birthing Unit

At this stage further exclusions were then made based on "The Guideline for Registering and Birthing at a CMH Primary Birthing Unit" (Appendix G). This guideline was used to carry out the next level of exclusions using the following parameters: Cephalic presentation, singleton and well grown fetus, establishment of labour, gestation of pregnancy, Body Mass Index (BMI), age and booking gestation.

Cephalic presentation, singleton and well grown fetus

The CMDHB Guideline for Registering and Birthing at a Primary Unit states that a woman is suitable to birth at a primary unit where the fetus is in a cephalic presentation, singleton and well grown. As outlined above the first exclusions made were multiple births, this information was easily sourced from the Healthware™ database. The babies not in a cephalic presentation were removed using the diagnostic codes as were the mothers who had been admitted to the tertiary hospital for concerns around fetal growth.

Establishment of labour

The CMDHB Guideline for Registering and Birthing at a Primary Unit states that a woman is suitable to birth at a primary unit where she has established in labour spontaneously. The Healthware™ data field "induction procedure" was used to isolate and remove any remaining inductions after the application of the diagnostic code exclusions.

Booking Gestation

The CMDHB Guideline for Registering and Birthing at a Primary Unit states that a woman is suitable to birth at a primary unit where no risk factors are identified following full assessment. The researcher decided after consultation with midwives working in CMDHB that 14 days (2 working weeks) is a reasonable amount of time to complete a full booking assessment and ascertain a woman's risk status. Therefore women who booked 13 days or less before the birth of their baby were excluded. Unfortunately the researcher found that the Healthware field entitled booking gestation was not mandatory and was almost entirely blank. The researcher used two mandatory fields in Healthware™ "Baby's Date of birth" and "Booking Date" to calculate retrospectively the booking gestation. Women who had 13 days or less between their booking date and their baby's DOB were excluded.

Maternal Age

The CMDHB Guideline for Registering and Birthing at a Primary Unit states that a primiparous woman is suitable to birth at a primary unit provided she is under the age of 40 and that women under the age of 17 are assessed individually for fetal and maternal wellbeing. For this reason women who were 40 years or older and nulliparous were excluded and women who were under 17 were not excluded as if they had been admitted for fetal or maternal wellbeing they would have been excluded using the diagnostic codes.

No upper limit to age is stated in the Guideline but the researcher consulted with senior CMDHB staff and decided that multiparous women who were 45 years or older at the time of birth should be excluded. Only 4 women were excluded on these grounds.

Body Mass Index

The CMDHB Guideline for Registering and Birthing at a Primary Unit states that a woman is suitable to birth at a primary unit where her BMI <17 as long as maternal weight gain is good and fetal growth is proven and where her BMI >35 as long as she has a well grown fetus and IV access is possible. For this reason women with a BMI between 35 and 40 were not excluded unless the diagnostic codes had previously excluded them for fetal growth issues or other comorbidities. Women who had a BMI of greater than 40 at the time of booking were excluded.

Gestation of pregnancy

The CMDHB Guideline for Registering and Birthing at a Primary Unit states that a pregnancy that has reached 36.5 weeks but not gone beyond 42+0 weeks is suitable to birth in the primary unit. The Healthware database was used to isolate the preterm and post term pregnancies and these were excluded.

The process of exclusion is summarised along with the numbers of women excluded at each stage in Figure 3 below.

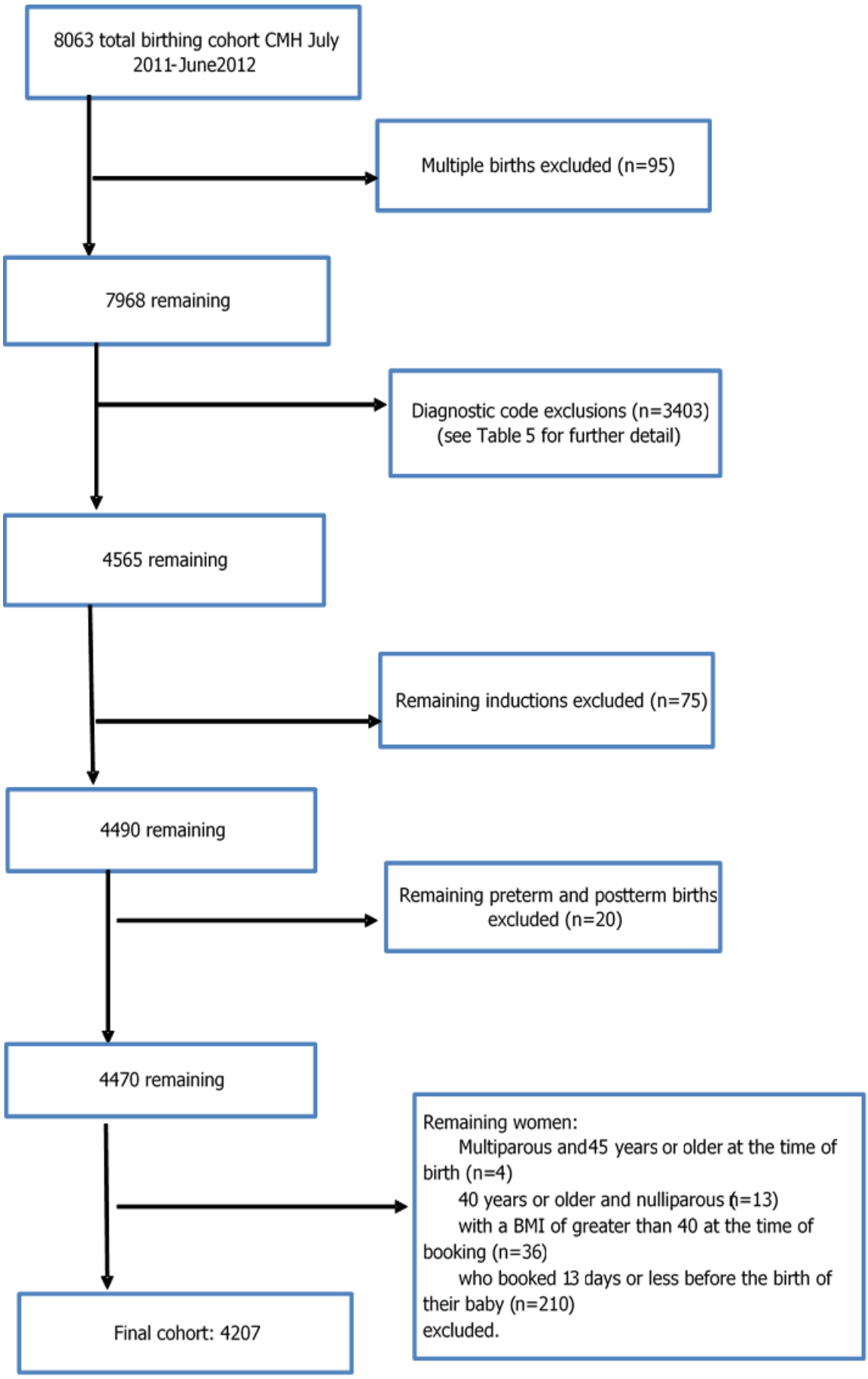

Figure 3. Flow chart showing the process of exclusion with the chronology of exclusions, the justification for exclusions as well as the number of women excluded at each stage.

3.3 Summary

The above section discussed the process of determining the low risk cohort required to answer the research question in Phase 2. No field in Healthware™ captured the risk status of the woman during pregnancy and up to the point of going into spontaneous labour. This was assessed from a set of coding data, not intended to be used to make clinical judgement.

For the purposes of this research the term low risk describes the women who became full term (37 weeks) without developing any illness that required admission to hospital or referral to secondary services. The women needed to have been booked for at least two full weeks to allow for adequate screening and to have gone into labour spontaneously with a cephalic, singleton pregnancy. She needed to have a BMI less than 40 and be no older than 40 if she is nulliparous and no older than 45 if she is multiparous.

3.4 Accuracy Assessment

Once the low risk cohort was determined the research turned to discovering the accuracy of the data fields sourced from Healthware™ in the hope that this phase of the research would improve the validity of the findings of Phase 2. The number chosen to sample was a compromise between maintaining high accuracy and feasibility (due to limited time and resources). Two hundred and fifty was the chosen figure as it allowed the researcher to estimate the accuracy of a variable for which 80% percent of the records are correct to within +/- 5% at the 0.05 level of significance.

A sample of 250 low risk women were randomly selected and crosschecked against clinical records to estimate the accuracy of the Healthware™ data. A predetermined level of accuracy (90%) was required of each of the variables in order to be included in Phase 2. The 90% level of accuracy was sensible because, given that we'd chosen +/- 5% as the accuracy measure then if a variable was 95% accurate (surely close to the best we could hope for over a range of variables) then with +/- 5% the lower limit of the CI would be 90%, and those variables were used in to the analysis. If this accuracy was not met the required information was obtained from elsewhere or the research questions were modified so as to only include the appropriately accurate variables.

3.4.1 Background

Women planning to give birth at Counties Manukau DHB are required to complete with their Lead Maternity Carer (LMC) a "Registration Form" (see Appendix H Part 1 and Part 2). These data fields are then recorded onto the CMH maternity database Healthware™ by clerical staff. The Registration Form collects the first 14 fields included in the accuracy assessment.

The labour and birth data is summarised immediately after the birth by the attending Midwife and recorded onto a "Labour and Birth Record" (Appendix I). This form collects the remaining 17 fields included in the accuracy assessment. These fields are recorded onto the CMH maternity database, Healthware™ either by a midwife or clerical staff.

3.4.2 Sampling

A computer programme was used to generate a simple random sample of 250 National Health Index numbers (NHIs) from the 4207 low risk women. The clinical notes for these 250 women were sourced from Medical Records. As clinical notes are contemporaneous and hand written by the practitioner they are considered the gold standard in terms of accuracy. The number chosen to sample (250) allowed the researcher to estimate the accuracy of a variable for which 80% percent of the records are correct to within +/- 5% at the 0.05 level of significance.

3.4.3 Method of Accuracy Assessment

The medical records could not be taken off site so the researcher and an assistant met at Middlemore Hospital Medical Records Department and compared the 33 Healthware™ fields to the "Registration Form" (Appendix H) and "Labour and Birth Summary Form" (Appendix I) in the clinical notes. Table 6 below states the fields included in the accuracy assessment and the source of each field.

Table 6. Healthware™ data fields included in the accuracy assessment and the source of the field in clinical notes

Healthware™ Data Field	Source of field in Clinical notes
Patient details	
Maternal Age	Registration Form
Ethnicity	Registration Form
Home Address (Suburb)	Registration Form
Pregnancy Details	
LMP Date	Registration Form
EDD agreed best	Registration Form
Gravida	Registration Form
Parity	Registration Form
Antenatal booking	
Smoking status	Registration Form
Booking date	Registration Form
Intended Place of Birth	Registration Form
Booking gestation	Registration Form
Height	Registration Form
Weight	Registration Form
Labour and delivery mother	
Delivery date and time	Labour and Birth Summary
Delivery method	Labour and Birth Summary
Location changed	Labour and Birth Summary
Changed reason	Labour and Birth Summary
Labour anaesthesia	Labour and Birth Summary
Labour analgesia	Labour and Birth Summary
LMC	Labour and Birth Summary
Delivery position	Labour and Birth Summary
Labour and delivery of baby	
Babies DOB	Labour and Birth Summary
Gestation by exam	Labour and Birth Summary
Delivery site	Labour and Birth Summary
Delivery outcome	Labour and Birth Summary
Birth weight	Labour and Birth Summary
Fetal monitoring	Labour and Birth Summary
Labour and delivery 3rd stage	
Estimated blood loss	Labour and Birth Summary
Third stage problems	Labour and Birth Summary
Third stage procedures	Labour and Birth Summary
PPH prophylaxis	Labour and Birth Summary
Baby birth examination	
Apgar 1 min	Labour and Birth Summary
Apgar 5 min	Labour and Birth Summary
Resuscitation	Labour and Birth Summary

The researcher and an assistant used an Excel spreadsheet containing the Healthware™ data for the 250 randomly selected women. A second cell was generated against each field to record a 1 for accuracy and a 0 for inaccuracy. The researcher read aloud each relevant data field in the clinical notes and the research assistant read aloud the equivalent data field in the spreadsheet sourced from Healthware™. In this way the researcher and the research assistant were able to confer on each individual field.

3.4.4 Guiding Principles throughout Accuracy Assessment

The following guiding principles were applied throughout the accuracy assessment:

a) If a Healthware™ field was blank and the clinical notes confirmed that the condition/intervention had not occurred then Healthware™ was considered accurate.

e.g. If "Labour Analgesia" is left blank in Healthware™ and the notes record no analgesia used in labour, Healthware™ was considered accurate. If "Labour Analgesia" was left blank but the notes recorded the use of analgesia in labour, Healthware™ was considered inaccurate.

b) If a field was automatically calculated by Healthware™ the fields used to calculate were assessed for accuracy rather than the generated field, e.g. Body Mass Index (BMI) field is generated when the height and weight are entered. Therefore the height and weight fields were assessed separately for accuracy.

c) Some fields were simplified to capture only the level of detail required for Phase 2, e.g. smoking status became either "non-smoker" or "currently smoking" even though Healthware™ (the number of cigarettes smoked per day added unnecessary complexity). If this was captured correctly Healthware™ was considered accurate.

d) On the Registration Form women fill out at their booking visit they self-identify up to three ethnicities in priority order. All three ethnicities are entered into PiMS™ (Patient Information Management System) but only the primary ethnicity (no. 1 in priority order) is carried through into Healthware™. The primary ethnicity was checked in the registration form in the clinical notes and if it matched with the Healthware™ ethnicity, Healthware™ was considered accurate.

The Accuracy Assessment took several sessions to complete with the researcher and assistant eventually managing to assess 25-30 clinical notes per day.

3.4.5 Results of Accuracy Assessment:

Once the 250 notes had been assessed the results were collated on the excel spreadsheet and a percentage accuracy was calculated along with confidence intervals (Figure 4).

Confidence Intervals

For each field investigated, the proportion of entries correct in the sample of 250 was used to calculate 95 percent Agresti-Coull confidence intervals for the proportion correct in the entire database (Agresti & Coull, 1998; Brown, Cai, & DasGupta, 2001). These confidence intervals were used because the standard (Wald) confidence intervals are known to be inaccurate when the sample proportions are close to 1.

Inaccurate fields

Fields were deemed “accurate” if the lower limit of the CI was above 90%, “undetermined” if the CI straddles 90% and “inaccurate” if the upper limit of the CI was below 90%. The following variables were excluded from the analysis, because they were inaccurate: Intended Place of Birth; booking gestation; third stage procedures; location changed; reason for changed location. Of the undetermined variables, smoking status and ethnicity were simplified and used in phase 2 as potential confounding variables while parity and booking date were used only in phase 1 for making exclusions.

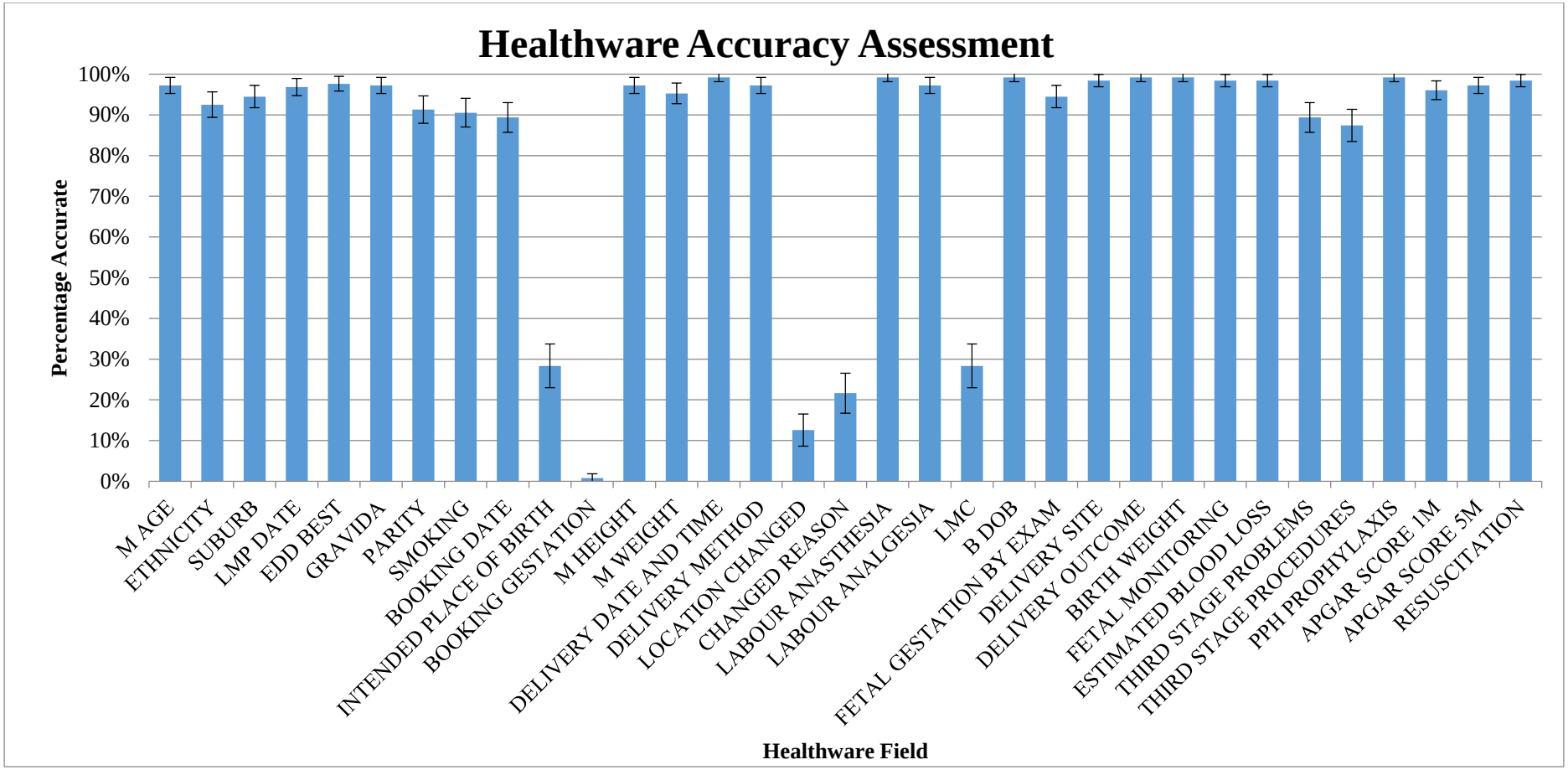

Figure 4. Percentage accuracy for each Healthware™ field. Bars give point estimates and error bars give 95% Agresti-Coull confidence intervals.

Several of the fields found to be inaccurate in phase 1 were required for phase 2 of the research to proceed. If the research hypotheses were to be tested, an alternative source of accurate information needed to be found. After consultation with the Midwifery Manager and the Women's Health Research Co-ordinator at CMDHB it was decided that most of the missing data could be sourced via Patient Information Management Systems (PiMS™).

Patient Information Management Systems (PiMS™)

PiMS™ is a database linked to but separate from Healthware™ that became a valuable source of data for determining the low risk cohort. As discussed in the previous chapter, diagnostic codes which determine resource distribution were used to exclude the women experiencing a high risk pregnancy. PiMS™ again became a valuable alternative source of data for Phase 2 after the accuracy assessment exposed multiple, inaccurate fields in Healthware™.

Table 7: Percentage accuracy including 95% CI for the 33 variables in Healthware™ database

Healthware™ Data Field	%Accuracy (95%CI)	Accurate, undetermined or inaccurate*	Data used in Logistic regression	Comment
Patient details				
Maternal Age	97 (0.95, 0.99)	accurate	Yes	Controlled for in phase 2
Ethnicity	93 (0.89, 0.96)	undetermined	Yes	Used in phase 2 as potential confounding variable, simplified to five ethnic groups
Home Address (Suburb)	94 (0.92, 0.97)	accurate	Yes	Only suburb checked for accuracy, used to generate decile and MeSH block data
Pregnancy Details				
LMP Date	97 (0.95, 0.99)	accurate	Yes	Used to calculate gestation
EDD agreed best	98 (0.96, 0.99)	accurate	Yes	Generated from LMP
Gravida	97 (0.95, 0.99)	accurate	No	Not required for Phase 2
Parity	91 (0.88, 0.95)	undetermined	Yes	Used only for determining exclusions and controlled for in phase 2
Antenatal booking				
Smoking status	91 (0.88, 0.95)	undetermined	Yes	Controlled for in phase 2
Booking date	89 (0.86, 0.93)	undetermined	Yes	Used only for determining exclusions
Intended Place of Birth	28 (0.23, 0.34)	inaccurate	No	Research question changed from “planned Place of Birth” to “Place Presenting in Labour” as intention of woman not recorded.
Booking gestation	1 (0, 0.02)	inaccurate	No	“Booking date” and “birth date” used instead to exclude “late bookers”.
Height	97 (0.95, 0.99)	accurate	Yes	Used to calculate BMI controlled for in Phase 2
Weight	95 (0.93, 0.98)	accurate	Yes	Used to calculate BMI controlled for in Phase 2
Labour and delivery mother				
Delivery method	97 (0.95, 0.99)	accurate	Yes	Outcome measure phase 2
Location changed	13 (0.09, 0.17)	inaccurate	No	Sourced from PiMS™ for Phase 2

Changed reason	22 (0.17, 0.27)	inaccurate	No	Sourced from PiMS™ for Phase2
Labour anaesthesia	99 (0.98, 1)	accurate	No	Used to compare interventions/treatments
Labour analgesia	97 (0.95, 0.99)	accurate	No	Used to compare interventions/treatments
LMC	28 (0.23, 0.34)	inaccurate	No	"Model of Care" sourced from PiMS™ for Phase 2
Delivery position	94 (0.92, 0.97)	accurate	No	Used to compare interventions/treatments by place
Labour and delivery of baby				
Babies DOB (including time)	99 (0.98, 1)	accurate	Yes	Babies time of birth used to determine IP or PP transfer
Gestation by exam	94 (0.92, 0.97)	accurate	Yes	Not required for Phase 2
Delivery site	98 (0.96, 0.99)	accurate	Yes	Used along with "location changed" and "changed reason" and "changed time" all sourced from PiMS™, to determine IP and PP transfer rates
Delivery outcome	99 (0.98, 1)	accurate	Yes	All babies in the low risk cohort were born alive
Birth weight	99 (0.98, 1)	accurate	No	Not required for Phase 2
Fetal monitoring	98 (0.96, 0.99)	accurate	No	Used to compare interventions/treatments
Labour and delivery 3rd stage				
Estimated blood loss	98 (0.96, 0.99)	accurate	Yes	Outcome measure phase 2
Third stage problems	89 (0.86, 0.93)	undetermined	No	field inaccurate and no other source of information
Third stage procedures	87 (0.83, 0.91)	undetermined	No	field inaccurate and no other source of information
PPH prophylaxis	99 (0.98, 1)	accurate	No	Used to compare interventions/treatments
Baby birth examination				
Apgar 1 min	96 (0.94, 0.98)	accurate	No	Not required for Phase 2
Apgar 5 min	97 (0.95, 0.99)	accurate	Yes	Outcome measure phase 2
Resuscitation	98 (0.96, 0.99)	accurate	No	Not required for Phase 2

*Accurate (lower limit of CI above 90%) undetermined (CI straddles 90%) inaccurate (upper limit of CI below 90%

3.4.6 Creating accurate and replacing inaccurate fields

The results of the accuracy assessment informed the progress of Phase 2 (Hypothesis Testing) in a number of important ways that will now be discussed.

Decile

The suburb of the patient address was found to be an accurate field. The low risk NHIs were sent to a senior business analyst in the Programme Management Office at CMDHB who generated a Decile for each NHI from their suburb address. This information was required as a potential confounding factor. MeSH block data was also generated as it is more accurate than Decile data but unfortunately this information was not able to be used in phase 2 as it was too complex to adapt to the logistic regression models.

Model of Care at time of birth

It was initially thought that these data could be sourced from the LMC field in Healthware™. Unfortunately this field listed practitioner names only without their designation so it was impossible to determine whether they were in an employed role or a self-employed role or if they were an obstetrician, general practitioner or midwife. Furthermore the accuracy assessment found that the LMC name only matched the LMC providing care at the time of birth in 28% (95% CI 0.23, 0.34) of the sample. The information for Model of Care was available but had not initially been requested and so was not included in the data.

Unfortunately there was no way of merging this information with the already established low risk cohort and therefore the researcher was forced to add the "Model of Care at time of birth" manually for the entire low risk cohort. This was done in the Excel spreadsheet by placing the total NHIs for each month with the "Model of Care" code attached beside the NHIs for that month for the low risk cohort and deleting every NHI that was not in the low risk cohort.

The following three fields relied on PiMS™ to provide data but (much like diagnostic codes used in determining the low risk cohort) PiMS™ data was collected for planning, management and resourcing rather than clinical reasons therefore they needed to be adapted before they were suitable for analysis. The next section will describe the way each of the 3 fields listed below were adapted for phase 2:

Intrapartum and postpartum transfer rates from primary to tertiary

Phase 2 required the following information:

Women/babies who:

a) transferred from primary to tertiary in labour i.e. intrapartum transfers
b) transferred from primary to tertiary postnatally i.e. postpartum transfers

Unfortunately the fields in Healthware™ entitled "Location changed" and "Reason for changed location" were inaccurate, only reaching 13% (95% CI 0.09, 0.17) and 22% (95% CI 0.17, 0.27) respectively. The researcher needed to find an alternative way of determining maternal transfers. A clinical analyst for CMDHB Health Intelligence and Informatics Department sourced "transfer times" and "transfer destinations" for the low risk cohort from PiMS™. This information was then used to subtract transfer time from delivery time. If the time between delivery and transfer is positive it was a postnatal transfer and if the time between delivery and transfer was negative then it was counted as an intrapartum transfer.

For example:

Delivery 01/01/2012 10.00 - Transfer 01/01/2012 12.00=2 hours so transfer was postnatal

Delivery 01/01/2012 10.00 - Transfer 01/01/2012 07:00 = -3 hours so transfer was antenatal

It was then necessary to check if the women who transferred postnatally were transferring for a complication she was experiencing or to accompany her newborn who was experiencing a complication or if both mother and baby were compromised. This was decided by consulting the "reason for the changed location", captured in PiMS™

In an effort to isolate transfers to birth related concerns the research question only considered transfers that happened within 12 hours of birth. Any transfers that happened more than 12hours after the birth were not included in the analysis.

Maternal admission to theatre/Intensive care unit (ICU)/High dependency unit (HDU) within 12 hours of birth

Women from the low risk cohort who were admitted to either to ICU, HDU or theatre were included as one group. While the researcher would have liked to consider the level

of admission and the reasons for admission, numbers were not high enough to analyse to this level of detail.

This information was relatively easy to source from PiMS™ and due to the lower numbers was not difficult to merge with the low risk cohort.

Neonatal admission to Neonatal unit (NNU) within 12 hours of birth

This information was also relatively easy to source from PiMS™ and merge with the low risk cohort due to the lower numbers. The researcher also collated level of admission to NNU (1, 2 or 3) but again this information could not be used in Phase 2 as the numbers were too low.

3.5 Summary

The above section discusses the methods and results of the accuracy assessment. While this part of the research was only to ascertain accuracy it raised many important considerations about the terminology used in Phase 2 as well as providing data that could inform the context for the discussion of the Phase 2 findings. The complexity within many of the fields, although accurate, could not be used in the Logistic Regression of Phase 2 but still offered valuable, contextual information to the research findings. It was therefore decided to explore the rate of treatments and interventions by Place Presenting in Labour and Model of Midwifery Care.

3.6 Treatments and interventions

Once the low risk cohort was determined, the Accuracy Assessment was complete and inaccurate fields sourced from PiMS™ the data was de-identified and transferred from Excel to IBM SPSS Statistics 22™. It was now possible to run some simple cross tabulations and chi squared analyses on the accurate fields to compare the rates of certain interventions and treatments by Place Presenting in Labour and Model of Care (Appendix J) before collapsing the variables into dichotomous outcomes for logistic regression. The rates of selected treatments and interventions by "Place Presenting in Labour" and "Model of Care" were generated with the intention of adding some contextual information to the findings.

It is important to clarify that the rates of continuous CTG, instrumental births and epidural occurring in the cohort of women presenting in labour to a primary unit occurred after transfer to the tertiary hospital. The results of the cross tabulations are shown in table 8 and indicate that:

- The rate of continuous CTG with or without the scalp electrode is 5.5% at the primary unit and 39% at the tertiary hospital, 28.3% in the cohort receiving Continuity of Midwifery Care and 28.6% in the cohort receiving Fragmented Midwifery Care.
- In the tertiary hospital 75% of women are subject to an admission CTG compared to 14% at the primary units, 32.7% in the cohort receiving Continuity of Midwifery Care and 30.8% in the cohort receiving Fragmented Midwifery Care.
- The rate of epidural, spinal, and pudendal analgesia in primary is just 3% compared with 17% in tertiary hospital, 13.4% in the cohort receiving Continuity of Midwifery Care and 15% in the cohort receiving Fragmented Midwifery Care.
- The rate of instrumental births are 2.7% at the primary unit and 6.7% for women presenting in labour to the tertiary hospital, 5.4% in the cohort receiving Continuity of Midwifery Care and 5.9% in the cohort receiving Fragmented Midwifery Care.
- The use of hydrotherapy is 16% at the primary units and only 1.5% at the tertiary hospital, 5.2% in the cohort receiving Continuity of Midwifery Care and 5.9% in the cohort receiving Fragmented Midwifery Care.
- The rate of an upright posture for birth is 55% in the primary units compared with 23% in the tertiary hospital, 33.0% in the cohort receiving Continuity of Midwifery Care and 31.6% in the cohort receiving Fragmented Midwifery Care.

Table 8. Treatment or intervention as a percentage of total by Place Presenting in Labour and Model of Care

Intervention/treatment	Rate as a percentage of total							
	Primary % (n)		Tertiary % (n)		Continuity % (n)		Fragmented % (n)	
Admission CTG	14%	(160)	75%	(1110)	32.7%	(860)	30.8%	(484)
Continuous CTG	5.5%	(62)	39%	(1200)	28.3%	(744)	28.6%	(448)
Intermittent auscultation	89%	(994)	52%	(1636)	32.0%	(842)	32.9%	(516)
Epidural/spinal/pudendal analgesia	3%	(34)	17%	(554)	13.4%	(351)	15%	(236)
Instrumental birth	2.7%	(30)	6.7%	(204)	5.4%	(141)	5.9%	(93)
Hydrotherapy	16%	(182)	1.5%	(47)	5.2%	(137)	5.9%	(92)
Upright posture at birth	55%	(610)	23%	(724)	33.0%	(835)	31.6%	(496)

The Chi square analysis (Appendix J) indicates significant differences between the treatments/interventions occurring in primary units compared with tertiary hospital but non-significant differences in the treatments/interventions occurring in the cohort of women receiving Continuity of Midwifery Care compared with the cohort of women receiving Fragmented Midwifery Care. These results will contribute to the discussion.

3.7 Summary

Chapter 3 has outlined the data collection process including ethical and cultural considerations and approval. It then explained the steps involved in identifying the low risk cohort and applying the accuracy assessment to this cohort to determine the fields that reached a 90% accuracy criterion. The accurate fields were then identified and those that were accurate were used to calculate the rates of relevant treatments and interventions by Place Presenting in Labour and Model of Midwifery Care. These results will be included in the discussion in an attempt to give context to the findings.

The data now needed to be screened for missing data, outliers, errors and normality and then organised into meaningful categorical, ordinal and dichotomous data groups able to

be presented as descriptive statistics including the frequency and percentage of the variables. This process is described in the next chapter.

Chapter 4 Phase 2: Methodology

The four hypotheses (see Chapter 1.7.2) investigated in Phase 2 compare outcomes for the cohort of 4207 low risk women in relation to place presenting in labour (primary or tertiary) and Model of Midwifery Care (fragmented or continuity) after adjusting for: age, ethnicity, deprivation, BMI, smoking status and parity.

4.1.1 Hot deck imputation

The researcher decided to use hot deck imputation to ensure that each participant was included in the analysis thus increasing the accuracy of the model. The process finds other records in the data set that are similar in other parts of their responses to the record with the missing value or values. Often there will be more than one record that could be used for hot deck imputation and the record that could potentially be used for filling a cell are known as donor records. Hot deck imputation often involves taking, not the best match, but a random choice from a series of good matches and replacing the missing value or values with one of the records from the donor set (Reilly, 1993).

4.1.2 Descriptive Statistics

The characteristics of the retrospective cohort are described in terms of age, ethnicity, Decile, BMI, parity and smoking status. An evaluation is conducted to determine the associations between “Place Presenting in Labour” and “Model of Care” with respect to five perinatal outcomes (a) birth method; (b) maternal blood loss; (c) maternal admission to theatre/ High Dependency Unit (HDU)/ Intensive Care Unit (ICU) (d) neonatal admission to Neonatal Unit (NNU); and (e) Apgar scores at five minutes.

4.1.3 Collapsing variables

As discussed, in order to use binary logistic regression, it is necessary that the outcome (dependent) variables are dichotomous or binary i.e. having only two categories. For ease of interpretation it is also preferable, although not essential, for the exposure (independent) variables to be dichotomous. The Healthware and PiMS™ data therefore needed to be manipulated to this effect. The rearrangement of the five outcome (dependent) variables (a) birth method; (b) maternal blood loss; (c) maternal admission to theatre/ High Dependency Unit (HDU)/ Intensive Care Unit (ICU); (d) neonatal admission to Neonatal Unit (NNU); (e) Apgar scores at five minutes along with the two exposure (independent) variables, (a) Place Presenting in Labour and (b) Model of Care are outlined in the following section. The frequencies of each category for each variable

as they were originally presented in the data set are presented followed by an explanation as to how and why they were recoded into their respective dichotomous format to satisfy the binary logistic regression requirements.

Recoding of the dependent variables:

1. Birth method

"Birth method" originally had nine categories: occipito anterior, occipito posterior, breech, ventouse, forceps, classical lower segment caesarean section (LSCS), internal version, LSCS and not stated. As previously stated, all babies known to be in the breech position antenatally were excluded. The four breech births in Table 9 below were not diagnosed until after the spontaneous establishment of labour. Table 10 shows the frequency distribution of "birth method" once it was recoded into dichotomous variables.

Table 9. Frequency distribution and recoding of birth method

Birth method	Frequency	Percent	Recode
Occipito anterior	3643	86.6	Vaginal birth
Occipito posterior	66	1.6	Vaginal birth
Breech	4	.1	Vaginal birth
Ventouse	193	4.6	Vaginal birth
Forceps	41	1.0	Vaginal birth
Classical LSCS	2	.0	Caesarean section
Internal version	1	.0	Vaginal birth
Lower segment caesarean section	251	6.0	Caesarean section
Not stated	5	.1	System missing
Missing	1	.0	System missing
Total	**4207**	**100**	

Table 10. Frequency distribution of recoded birth method

Birth method recoded	Frequency	Percent
Vaginal birth	3948	93.8
Caesarean section	253	6.0
Total	4201	99.9
Missing	6	.1
Total	**4207**	**100.0**

2. Blood loss

"Blood loss" was originally captured as a scale variable. Blood loss volumes are estimated by the practitioner and are usually rounded up or down to the nearest 100ml. Fifty-six categories originally existed within the scale that captured blood loss volumes ranging from 50ml to 3000ml. The frequency distribution of this scale variable is not presented below as it would add little value to the discussion. The 56 categories were collapsed into two: Blood loss ≥ 500ml and blood loss < 500ml (Table 11). The 500ml volume was used as it is an accepted value beyond which a woman is said to have suffered a postpartum haemorrhage (PPH). A difficulty with this measurement is the possibility that blood loss may be greater in an emergency Caesarean section and may confound the blood loss results as the rate of caesarean section is so much higher in the tertiary hospital. For these reasons blood loss, as an outcome variable in the logistic regression, will be considered for the entire cohort but a separate analysis will be conducted for those women who experienced vaginal birth. In this way the confounding influence of surgery will be mitigated and a clearer picture of blood loss in relation to Place Presenting in Labour and Model of Care can emerge.

Table 11. Frequency distribution of recoded blood loss

Blood loss recode	Frequency	Percent
< 500 ml	3602	85.6
>=500 ml	601	14.3
Total	4203	99.9
Missing	4	.1
Total	**4207**	**100.0**

3. Maternal admission to theatre/HDU/ICU within 12 hours of birth

"Maternal admission to theatre/HDU/ICU" is a proxy for morbidity. The frequency of the most common morbidities is shown in Table 12. The "other" category included the following diagnostic codes (in order of prevalence): retained placenta without haemorrhage, morbidly adherent placenta, spinal and epidural anaesthesia-induced headache during the puerperium, infection of obstetric surgical wound, obstetric haematoma of pelvis, and torsion of ovary, ovarian pedicle and fallopian tube. Fifty further admissions occurred within the low risk cohort over the 30 days following birth, mostly due to breast abscess, mastitis and other infections. These 50 later admissions were not included in this analysis. Table 13 shows the rates of maternal admission to the

various levels of tertiary maternity services. Two of the three High Dependency Unit (HDU) admissions were for PPH with the third being for a third degree perineal laceration. The HDU& Intensive Care Unit (ICU) admission was due to a Caesarean wound infection. Table 14 shows the recoding of the maternal admission to tertiary services into dichotomous variables for logistic regression.

Table 12. Reasons for Maternal Admission to theatre/HDU/ICU within 12 hours of birth

Reason for maternal admission to tertiary services	Frequency
PPH	50
PPH + 2nd/3rd/4th degree/ Cx/HV Laceration	15
2nd/3rd/4th degree/ Cx/HV Laceration	53
Other	67
Total	**135**

Table 13. Frequency distribution and recoding of maternal admission to theatre/HDU/ICU within 12 hours of birth

Admission to theatre/HDU/ICU	Frequency	Percent	Recode
Nil Admission	4072	96.8	Not admitted
HDU	3	.1	Admitted
HDU&ICU	1	.0	Admitted
Theatre	124	2.9	Admitted
THSW (theatre)	7	.2	Admitted
Total	**4207**	**100.0**	

Table 14. Frequency distribution of recoded maternal admission to theatre, HDU/ICU within 12 hours of birth

Admission to tertiary services recode	Frequency	Percent
Nil Admission	4072	96.8
Admission to tertiary services	135	3.2
Total	**4207**	**100.0**

4. Apgar at five minutes

Tables 15 and 16 show that over 98% of the Apgar's at Five minutes in the low risk cohort were equal to or greater than seven. An Apgar of less than seven at five minutes often indicates a significantly compromised baby who has required a level of

resuscitation. An Apgar below seven at five minutes is therefore one of the measured outcome variables.

Table 15. Frequency distribution and recoding of Apgar at five minutes.

Apgar at 5 minutes	Frequency	Percent	Recode
0	1	.0	<7
1	1	.0	<7
2	1	.0	<7
3	4	.1	<7
4	4	.1	<7
5	9	.2	<7
6	31	.7	<7
7	52	1.2	>/=7
8	88	2.1	>/=7
9	1805	42.9	>/=7
10	2193	52.1	>/=7
Missing	18	.4	
Total	**4207**	**100.0**	

Table 16. Frequency distribution of recoded Apgar at five minutes

Apgar at 5 minutes recode	Frequency	Percent
>/=7	4138	98.4
<7	51	1.2
Total	4189	99.6
Missing	18	.4
Total	**4207**	**100.0**

5. Neonatal admission to Neonatal Unit (NNU) within 12 hrs of birth

One hundred and seventy seven (4.3%) neonates were admitted to NNU. This is a proxy for morbidity. The reason for admission was difficult to source without accessing the NNU records which would have required a new ethics application. However, level of admission was available via PiMS. A level 1 admission indicates the most severe morbidity. Table 17 shows that 12 (0.3%) babies were admitted at Level 1, 45 (1.1%) at level 2 and 120 (2.8%) at level 3. Table 18 shows the recoding of the neonatal admission to tertiary services into dichotomous variables for logistic regression.

Table 17. Frequency distribution and recoding of levels of NNU admission within 12 hrs of birth

Admitted to NNU within 12 hrs	Frequency	Percent	Recode
No admission	4027	95.7	Not admitted
Level 1	12	.3	Admitted
Level 2	45	1.1	Admitted
Level 3	120	2.9	Admitted
Missing	3	.1	
Total	**4207**	**100.0**	

Table 18. Frequency distribution of recoded NNU admission within 12 hrs of birth

Admitted to NNU within 12 hrs recode	Frequency	Percent
Not admitted to NNU	4027	95.7
Admitted to NNU	177	4.3
Missing	3	.1
Total	**4207**	**100.0**

Recoding of independent variables:

Binary logistic regression can interpret continuous exposure (independent) variables. However, in this research the exposure (independent) variables are categorical and the research hypotheses require the exposure (independent) variables also be configured into a binary or dichotomous format:

1. ***Place Presenting in Labour***

Originally "Place Presenting in Labour" had eight categories: Middlemore Hospital; Papakura Maternity Unit; Pukekohe Maternity Unit; Botany Downs Maternity Unit and being born before arrival (BBA) to each of these four sites (Table 19). These options were assigned primary or tertiary status as shown in Table 20 below:

Table 19. Frequency distribution and recoding of Place Presenting in Labour

Place Presenting in Labour	Frequency	Percent	Recode
Middlemore Hospital	3039	73.5	Tertiary
Papakura Maternity Unit	374	8.4	Primary
Pukekohe Maternity Unit	336	7.4	Primary
Botany Downs Maternity Unit	394	8.8	Primary
Born Before Arrival MMH	54	1.3	Tertiary
Born Before Arrival Papakura	10	.4	Primary
Born Before Arrival Pukekohe	6	.1	Primary
Born Before Arrival Botany	8	.1	Primary
Total	4207	100.0	

Table 20. Frequency distribution of recoded Place Presenting in Labour

Place Presenting in Labour primary/tertiary	Frequency	Percent
Primary	1114	26.5
Tertiary	3093	73.5
Total	4207	100.0

2. Model of Care

"Model of Care" originally had six categories (Table 21). Private Midwife and Team midwifery care were recoded as Continuity of Care while Closed Unit and Shared Care were recoded as Fragmented care (Table 22). The private obstetrician/GP model was experienced by 24 women (0.6%). These GP's/obstetricians invariably use midwifery services so these 24 women were included in the fragmented model.

Table 21. Frequency distribution and recoding of Model of Care

Model of Care	Frequency	Percent	Recode
Private Midwife	2489	59.1	Continuity of Midwifery Care
Closed Unit	952	22.6	Fragmented Midwifery Care
Shared Care	593	14.1	Fragmented Midwifery Care
Private Obstetrician/GP	24	.6	Fragmented Midwifery Care
Team midwifery care	149	3.5	Continuity of Midwifery Care
Total	4207	100.0	

Table 22. Frequency distribution of recoded Model of Care

Model of Care recode	Frequency	Percent
Continuity of Midwifery Care	2633	62.6
Fragmented Midwifery Care	1574	37.4
Total	4207	100.0

4.2 Inferential Statistics

The inferential statistical analysis was conducted using IBM SPSS version 22.0 using the protocols described by Field (2013) and Pallant (2013). Frequencies were used to describe the characteristics of the low risk cohort. Proportions and Pearson's chi-squared tests were used to explore the associations at $p < .05$ between cross-tabulated variables. Binary logistic regression was then used to test four hypotheses (H1, H2, H3, and H4) using the variables listed in Table 23 and 24.

Table 23. Hypotheses H1 and H3 concerning Maternal Outcomes with Outcome, Controlling, and Exposure Variables

Hypothesis	**Outcome Variables**	**Potential Confounding Variables**	**Exposure Variables**
H1: Low risk women presenting in labour at a primary unit are less likely than low risk women presenting in labour at a tertiary unit to: (a) experience a Caesarean section (b) experience a blood loss greater than 500 ml; (c) be admitted to HDU/ICU/Theatre	Birth Method: Vaginal = 0 Caesarean = 1 Blood loss: < 500 ml = 0 ≥ 500 ml = 1 Admission: None = 0 HDU/ICU/Theatre = 1	Age (Years) BMI (kg/m^2) NZ Deprivation Decile (0 to 10) Prioritized ethnicity: *NZ European, NZ Maori, Pacific Islander, Asian, Other Smoking Status: Non Smoker = 0 Smoker = 1 Parity: Nulliparous = 0 Multiparous = 1	Birth Site: Primary Unit = 1 Tertiary Unit = 0
H3: Low risk women cared for by self-employed or team midwives are less likely than low risk women in shared or closed unit care to (a) experience a Caesarean section (b) experience a blood loss greater than 500 ml (c) be admitted to HDU, ICU and theatre.			Model of Care: Continuity = 1 Fragmented = 0

* NZ European was the reference category for ethnicity.

Table 24. Hypotheses H2 and H4 concerning Neonatal Outcomes with Outcome, Confounding, and Exposure Variables

Hypothesis		**Outcome Variables**	**Potential Confounding Variables**	**Exposure Variables**
H2	Babies of low risk women presenting in labour at a primary unit are less likely than babies of low risk women presenting in labour at a tertiary hospital to (a) have a five minute Apgar of less than 7 (b) be admitted to a NNU within 12 hours of birth.	Five minute Apgar: < 7 = 0 ≥ 7 = 1 Neonatal Unit admission: NNU = 0 None = 1	Age (Years) BMI (kg/m2) NZ Deprivation Decile (0 to 10) Prioritized ethnicity: NZ European,* NZ Maori, Pacific Islander, Asian, Other Smoking Status: Non Smoker = 0 Smoker = 1 Parity: Nulliparous = 0 Multiparous = 1	Birth Site: Primary Unit = 1 Tertiary Unit = 0
H4	Babies of low risk women cared for by a self-employed or team midwife are less likely than babies of low risk women in shared or closed unit care. to: (a) have a five minute Apgar of less than 7; (b) be admitted to a NNU within 12 hours of birth.			Model of Care: Continuity = 1 Fragmented= 0

* NZ European was the reference category for ethnicity.

4.3 Conditions and assumptions

4.3.1 Measurement levels of the variables:

In the previous section, as is required to satisfy the primary assumptions of logistic regression, the outcome (dependent) variables were each transformed into dichotomous or binary groupings with mutually exclusive categories. In order to test the hypotheses as stated the exposure (independent) variables were also transformed into binary categories.

The next step in logistic regression is to systematically code each of the variables, and report how they were coded. The next section presents the codes for each variable. Without this information clearly outlined the interpretation of the Logistic Regression output is not possible (Bagley, White, & Golomb, 2001).

4.3.2 Coding the Outcome (dependent) variables:

The above section created five dichotomous outcome (dependent) variables (a) birth method; (b) maternal blood loss; (c) maternal admission to theatre/ High Dependency Unit (HDU)/ Intensive Care Unit (ICU) (d) neonatal admission to Neonatal Unit (NNU); and (e) Apgar scores at five minutes consisting of two nominal categories. Because logistic regression is concerned with predicting a specified event coded by a high number relative to a reference event coded by a lower number, the five outcome (dependent) variables were coded by 1 for the specified events (non-optimal outcomes) and 0 for the reference events (preferred outcomes).

The specified and reference events for HI and H3 were: Women experiencing a Caesarean birth = 1, relative to women experiencing a vaginal birth = 0; women experiencing a blood loss ≥ 500ml = 1, relative to women experiencing a blood loss < 500ml =0; women being admitted to theatre/HDU/ICU = 1, relative to women not being admitted to Theatre/HDU/ICU = 0. The specified and reference events for H2 and H4 were: Babies experiencing Apgars < 7 = 1, relative to babies experiencing Apgars ≥ 7 = 0; babies admitted to NNU within 12 hrs of birth = 1, relative to babies not admitted to NNU = 0.

4.3.3 Coding the Exposure (Independent) Variables

In the previous section the configuration of the exposure variables was outlined

The two nominal exposure variables for H1 and H2 (coded dichotomously by 1 or 0) was Place Presenting in Labour (tertiary unit = 0; primary unit =1). The two nominal exposure variables for H3 and H4 (also coded dichotomously by 1 or 0) was Model of Care (fragmented = 0; continuity=1).

4.3.4 Coding Potential confounding (independent) variables

The potential confounding (independent) variables, hypothesized to have causal effects on the relationships between the exposure (independent) variables and the outcome (dependent) variables, were the socio-demographic and personal characteristics of the mothers measured at the interval and categorical (ordinal or nominal) level.

The two interval level covariates were Age, measured in years, and BMI measured in kg/m^2. The ordinal level factor was NZ Deprivation Decile, ranked from 1 to 10, with 1 indicating that people are living in the least deprived 10 percent (Decile) of New Zealand and a score of 10 indicating that people are living in the most deprived 10 percent of New Zealand. Ethnicity was a nominal level factor, consisting of five qualitative categories, NZ European was set as the reference category for ethnicity, SPSS then sets up dummy variables (coded dichotomously by 1 = Yes or 0 = No). Each variable defined the mother's ethnicity either as NZ Maori, Pacific Islander, Asian or Other category and estimated the effect of the exposure relative to NZ European. The two other nominal factors were Smoking Status (coded by Non Smoker = 0; Smoker = 1); and Parity (coded by Nulliparous = 0; Multiparous = 1).

4.3.5 Sample Size

The results of logistic regression are sensitive to the sample size (Hosmer, Lemeshow, & Sturdivant, 2013). If the sample size is too small, then the analysis is underpowered, and the statistical inferences are compromised, and may be meaningless. In many studies reported in the medical research literature, the sample sizes were small, calling into question the accuracy of the logistic regression models and the statistical inferences(Strasak, Zaman, Pfeiffer, Göbel, & Ulmer, 2007). Simulation experiments have indicated that, to obtain meaningful results using logistic regression, the number of participants in the less common of the two possible events in the dependent variable divided by the number of exposure (independent) variables should be at least 10, and preferably much greater (Peduzzi, Concato, Kemper, Holford, & Feinstein, 1996). The lowest event per variable in this study is 51 (Apgar score less than 7 at 5 minutes) / 2

(exposure variables) =25.5. The events per variable in this study were always > 10; consequently, a low sample size was not a problematic issue in this study.

4.3.6 Explanation of Logistic regression

The goal of a Logistic regression analysis is to find the best fitting model to describe the outcome (dependent) variable and a set of independent (exposure and potential confounding) variables. The following section will outline the workings involved in the process of logistic regression in the hope that the final models presented in chapter 5 will be more accessible.

Rationale for reporting adjusted and unadjusted results

As is convention, two sets of analyses will be performed on each of the hypotheses, adjusted and unadjusted. The unadjusted analysis will predict the probability that a woman will experience one of the two categories of the outcome (dependent) variable based on her exposure to each of the exposure (independent) variables. The adjusted analysis will take into the equation the potential confounding variables.

The theory of Logistic regression analysis

The following section will use H1a as an example to work through the theory of logistic regression analysis starting with setting forth the basic hypotheses and null hypotheses for the model with confounders and the model without confounders. Crosstabulation is then used to explain how the odds ratio (OR) and the coefficient (β) is calculated for the model without confounders. This is followed by a brief explanation of the general logistic regression equation and then a calculation of the p value and the meaning of confidence interval (CI). The potential confounders are then added and backward elimination is demonstrated, step by step, to show how the final logistic regression model is generated. It is then explained what the OR indicates for each exposure potential confounding variable.

Example of the null and alternative hypotheses for H1a with and without confounders

Model with confounders:

P1: The **odds** of women birthing in a primary setting experiencing a caesarean section after controlling for age, ethnicity, parity, Decile and smoking status.

P2: The **odds** of women birthing in a tertiary setting experiencing a caesarean section after controlling for age, ethnicity, parity, Decile and smoking status.

H0 (Null hypothesis): P1=P2

Low risk women birthing in a primary setting have the same odds of experiencing a caesarean section as woman birthing in the tertiary environment after controlling for age, ethnicity, parity, Decile and smoking status.

H1 (Alternative hypothesis): P1<P2

Odds of low risk women birthing in a primary setting experiencing a caesarean section is less than that of woman birthing in the tertiary environment after controlling for age, ethnicity, parity, Decile and smoking status.

Model without confounders:

P1': The **odds** of women birthing in a primary setting experiencing a caesarean section

P2': The **odds** of women birthing in a tertiary setting experiencing a caesarean section

H0 (Null hypothesis): P1'=P2'

Low risk women birthing in a primary setting have the same odds of experiencing a caesarean section as woman birthing in the tertiary environment.

H1 (Alternative hypothesis): P1'<P2'

Odds of low risk women birthing in a primary setting experiencing a caesarean section is less than that of woman birthing in the tertiary environment.

Table 25. Crosstabulation of Birth Method by Place Presenting in Labour

		Place Presenting in Labour		**Total**
		Tertiary	**Primary**	
Birth Method	Vaginal	2860	1094	3948
	CS	233	20	253
Total		**3093**	**1114**	**4207**

Table 25 is a two-way frequency table (crosstabulation) which explains how the coefficient (β) -1.494 is generated for the logistic regression model without confounders.

The odds of low risk women birthing at a primary unit having an emergency caesarean section (CS) = Proportion of CS's (primary) /Proportion of Vaginal Births (VB's) (primary) = 20/1094 = 0.0183

The odds of low risk women birthing at a tertiary unit having an emergency CS= Proportion of CS's (tertiary) /Proportion of VB's (tertiary) = 233/2860 = 0.0815

From these two figures we can calculate the "odds ratio (OR)" or the ratio of odds for Caesarean section in a primary unit (Table 26).

OR = Odds (CS primary)/odds (CS tertiary) = (20/1094)/(233/2860) = 0.224.

With this result we can relate the odds for CS (primary) then calculate the log(odds)

log(odds) = Log (0.224)

=-1.494 this is known as the coefficient (β) for Place Presenting in Labour

Table 26. Ratio of odds for Caesarean section in a primary unit

	β	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Place Presenting in Labour	-1.494	40.194	.000	.224	.116	.435
Constant	-2.508	1354.682	.000	.081		

General logistic regression equation:

log(p/1-p) = b0 + b1*x1 + b2*x2 + b3*x3 + b3*x3+b4*x4

Where log(p/1-p) is the log odds of the dependent variable (i.e., the predicted likelihood that a specified event will occur, relative to a reference event); p is the probability that the specified event will occur; b0 is a constant or baseline value; and b1, b2..... bk are the logistic regression coefficients (B) for k independent variables (Hosmer et al., 2013).

In this case:

log(probability of women having caesarean section/probability of women having vaginal birth) = -2.508 – 1.494 * Place Presenting in Labour (coded as 0 for tertiary and 1 for primary).

H0 (**Null** hypothesis): P1'=P2'

Low risk women birthing in a primary setting have the same odds of experiencing a caesarean section as woman birthing in the tertiary environment.

H1 (**Alternative** hypothesis): P1'<P2'

Odds of women birthing in a primary setting experiencing a caesarean section is less than that of woman birthing in the tertiary environment.

The p-value is 0.000<0.05, we have strong evidence **against the null hypothesis and in favour of the alternative hypothesis.**

It shows that the odds of low risk women presenting to birth at a primary unit experiencing a caesarean section are less than for low risk women presenting to birth at the tertiary unit.

Confidence Interval

A confidence interval (CI) is a type of interval estimate of a population parameter. In this case, CI is (0.116, 0.435) which doesn't include 1. It indicates that the odds of a woman presenting in labour to a primary unit experiencing a caesarean section is less than that of a woman presenting in labour to the tertiary hospital.

So, without consideration of confounders, we reject the null hypothesis and odds of women birthing in a primary setting experiencing a caesarean section is less than that of women birthing in the tertiary environment.

We can now add further independent variables into the equation in the form of potential confounding factors (age, BMI, Decile, ethnicity, smoking status and parity,) and look at the model that results. Adding all the potential confounders at once generates the output presented in Table 27:

Table 27. Binary Logistic Regression Model for Hypothesis H1a with Confounders. Outcome = Birth Method; Exposure = Place Presenting in Labour

	β	Wald	Sig.	OR	99.5% C.I.	
					Lower	Upper
Age	.039	8.674	.003	1.040	1.013	1.068
BMI	.044	11.419	.001	1.045	1.019	1.073
Decile	-.005	.035	.852	.995	.940	1.053
NZ Maori	.188	.343	.558	1.206	.644	2.261
NZ European	.445	2.140	.143	1.560	.860	2.832
Pacific Island	.569	3.429	.064	1.767	.967	3.228
Asian	.059	.040	.842	1.061	.592	1.902
Smoking	.404	3.055	.080	1.498	.952	2.357
Parity	1.571	93.753	.000	4.812	3.501	6.614
Place Presenting in Labour	-1.437	34.841	.000	.238	.148	.383

This table holds a lot of information about the effect of the potential confounders (collectively) on the independent variable (Place Presenting in Labour) and how this effects the dependent variable (birth method). But not all of the confounders have a significant impact indicated by p values greater than 0.05. The next section will explain a process called backward elimination which will remove all the non-significant confounders.

Backward Elimination

Backward elimination is a stepwise procedure intended to select the “best” subset of confounders. We want to explain the data in the simplest way — redundant confounders should be removed. Unnecessary confounders will add noise to the estimation of the other quantities that we are interested in. The aim is to construct a model that predicts well or explains the relationships in the data. The process of backward elimination for H1 is demonstrated in Tables a-f below:

The process of backward elimination:

1. Start with all the potential confounders in the model
2. Remove the potential confounder with highest p-value greater than αcrit (αcrit is sometimes called the "p-to-remove", in this case it is at 0.05).
3. Refit the model (every time a confounder is removed it changes the relationship of the remaining variables to each other) and repeat step 2.
4. Stop when all p-values are less than αcrit.

Table a:

	B	**Wald**	**p**	**OR**	**99.5% C.I.**	
					Lower	**Upper**
Age	.039	8.674	.003	1.040	1.013	1.068
BMI	.044	11.419	.001	1.045	1.019	1.073
Decile	-.005	.035	.852	.995	.940	1.053
NZ Maori	.188	.343	.558	1.206	.644	2.261
NZ European	.445	2.140	.143	1.560	.860	2.832
Pacific Island	.569	3.429	.064	1.767	.967	3.228
Asian	.059	.040	.842	1.061	.592	1.902
Smoking	.404	3.055	.080	1.498	.952	2.357
Parity	1.571	93.753	.000	4.812	3.501	6.614
Place Presenting in Labour	-1.437	34.841	.000	.238	.148	.383

Initially the potential confounding variable "Decile" has the biggest p-value at .852 providing strong evidence that Decile has no effect on the birth method in relation to Place Presenting in Labour (Table a). In order to improve the model this variable is removed and the regression analysis is run again.

Table b:

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Age	.040	9.118	.003	1.040	1.014	1.068
BMI	.044	11.385	.001	1.045	1.019	1.072
NZ Maori	.445	2.143	.143	1.561	.860	2.833
NZ European	.584	3.871	.049	1.793	1.002	3.209
Pacific Island	.065	.049	.825	1.068	.598	1.906
Asian	.407	3.113	.078	1.503	.956	2.362
Smoking	1.575	95.737	.000	4.831	3.524	6.623
Parity	-1.433	34.867	.000	.238	.148	.384
Place Presenting in Labour	-1.437	34.841	.000	.238	.148	.383

After running the logistic regression again the Pacific Island ethnicity has a p value of .825 providing strong evidence that being from the Pacific does not significantly affect birth method in relation to Place Presenting in Labour therefore Pacific Island ethnicity can be removed as a potential confounding variable (Table b).

Table c:

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Age	.040	9.158	.002	1.041	1.014	1.068
BMI	.045	11.697	.001	1.046	1.019	1.073
NZ Maori	.396	3.617	.505	1.486	.988	2.234
NZ European	.535	7.146	.008	1.708	1.154	2.529
Asian	1.576	95.793	.000	4.834	3.526	6.627
Smoking	-1.430	34.851	.000	.239	.149	.385
Parity	-1.433	34.867	.000	.238	.148	.384
Place Presenting in Labour	-1.437	34.841	.000	.238	.148	.383

After running the logistic regression a third time the Maori ethnicity has a p value of .505 providing strong evidence that being Maori does not significantly affect birth method in relation to Place Presenting in Labour therefore Maori can be removed as a potential confounding variable (Table c).

Table d:

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Age	.043	11.903	.001	1.044	1.019	1.069
BMI	.042	11.380	.001	1.043	1.018	1.069
NZ European	.337	3.166	.075	1.401	.966	2.030
Smoking	.443	3.895	.048	1.557	1.003	2.418
Parity	1.594	100.928	.000	4.925	3.608	6.722
Place Presenting in Labour	-1.442	35.624	.000	.237	.147	.380

After running the logistic regression a fourth time the NZ European ethnicity has a p value of .075 providing evidence that being NZ European does not significantly affect birth method in relation to Place Presenting in Labour therefore NZ European can be removed as a potential confounding variable (Table d).

Table e:

	B	Wald	Sig.	OR	99.5% C.I.	
					Lower	Upper
Age	.040	10.658	.001	1.041	1.016	1.066
BMI	.041	10.764	.001	1.042	1.017	1.067
Smoking	.424	3.588	.058	1.529	.985	2.371
Parity	1.574	99.420	.000	4.828	3.543	6.579
Place Presenting in Labour	-1.490	38.482	.000	.225	.141	.361

After running the logistic regression a fifth time the smoking variable has a p value of .058 providing evidence that being a smoker does not significantly affect birth method in relation to Place Presenting in Labour therefore smoking can be removed as a potential confounding variable (Table e).

Table f:

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Age	.044	13.479	.000	1.045	1.021	1.070
BMI	.038	9.324	.002	1.038	1.014	1.064
Parity	1.613	105.381	.000	5.017	3.687	6.826
Place Presenting in Labour	-1.504	39.213	.000	.222	.139	.356

Above is the final model. All variables in this model exert a significant influence on birth method evidenced by p-values smaller than 0.05. Now we can interpret the findings (Table f).

Odds ratio

The odds ratio (OR = e^{β}) indicates the effect size of each of the exposure and potential confounding (independent) variables. For an interval or ordinal level independent variable, the OR indicates the likelihood of the dependent variable changing from 1 (specified event) to 0 (reference event) for each successive one unit increase in the independent variable. For a nominal level independent variable the OR predicts the likelihood of the dependent variable changing from 1 (specified event) to 0 (reference event) for the category coded with the highest number (1) relative to the category coded with the lowest number (0).

The interpretation of the odds ratios was as follows: If OR = 1.0, then the independent variable had no effect on the dependent variable. If the 95% confidence interval (CI) for the OR did not include 1.0 then the OR was significantly different from 1.0 at $p \leq .05$. If OR > 1.0 then independent variable increased the likelihood of a change in the dependent variable. If OR < 1.0 then the independent variable decreased the likelihood of a change in the dependent variable.

For example, In relation to Hypothesis H1a with Confounders:

For every one year increase in Age, we expect a 0.045 (4.5%) increase in the log-odds of having CS, holding all other independent variables constant.

For every one unit increase in BMI, we expect a 0.038 (3.8%) increase in the log-odds of having CS, holding all other independent variables constant.

The odds of having an emergency CS for nulliparous women is exp (1.613) 5.02 times higher than that for multiparous women, holding all other independent variables at a fixed value. Reference group which is coded as 0 for variable “parity” is nulliparous women.

We always set the reference group as the denominator. That is to say,

$$\frac{\frac{Prob\ (\text{having an emergency CS for a multiparous woman})}{Prob\ (\text{having a vaginal birth for a multiparous woman})}}{\frac{Prob\ (\text{having an emergency CS for a nulliparous woman})}{Prob\ (\text{having a vaginal birth for a nulliparous woman})}} = 5.02$$

Finally the odds of having an emergency CS for women presenting in a primary unit over the odds of having an emergency CS for women presenting at a tertiary unit is exp(-1.508) = 0.222, holding all other independent variables at a fixed level.

In other words we can **reject** the null hypothesis and **accept** the **alternative hypothesis;**

Odds of women birthing in a primary setting experiencing a caesarean section (OR 0.22, 95% C.I: 0.14 – 0.36) is less than that of women birthing in the tertiary environment after controlling for age, ethnicity, parity, Decile and smoking status.

Another way of writing this is to say that the odds of emergency caesarean section for women presenting in labour to the tertiary environment was 4.50 (95% CI: 2.81–7.19) times that of women presenting in labour to a primary unit.

The Hosmer & Lemeshow test

The Hosmer & Lemeshow test for the overall fit of the binary logistic regression model to the data was recorded. This test was chosen because it is more robust than the other goodness of fit tests in SPSS (Hosmer et al., 2013). A finding of non-significance ($p > .05$) corresponded to the researcher concluding the logistic model adequately fitted the data.

Nagelkerke R2

Nagelkerke R^2 was recorded to indicate the strength of the association between the dependent and independent variables on a scale from 0 (very weak) to 1 (very strong).

Nagelkerke R^2 is a modification of Cox & Snell R^2, the latter of which cannot achieve a value of 1. For this reason, it is preferable to report the Nagelkerke R^2 value(Pallant, 2013).

Wald statistics

Wald statistics were used to test the significance of the regression coefficients (β) for each exposure (independent) variable. The decision rule was to conclude a β coefficient significantly different from zero if $p \leq .05$ for the Wald statistic. Negative coefficients

indicated that the specified event in the dependent variable was less likely, and positive coefficients indicated that the specified event was more likely.

4.4 Summary

The above chapter has outlined the methodology of Phase 2, Binary Logistic Regression. The chapter started an explanation of the treatment of missing variables using Hot Deck Imputation. This was followed by an explanation of the descriptive statistics used to present the data in Chapter 5. The way the variables were collapsed into binary categories was then discussed and described for both the dependent (outcome) and independent (exposure) variables. The inferential statistics used to create the findings in Chapter 6 were then stated and the conditions and assumptions for Binary Logistic Regression outlined. The last section of the chapter (4.3.6) was a more in depth look at the theory of Logistic Regression. The intention of this final section was to explore the statistical methodology that led to the Models presented in Chapter 6.

Chapter 5 Maternal and neonatal outcomes

5.1 Characteristics of the Cohort

The frequency distributions of the socio-demographic and other contextual characteristics of the cohort of *N* = 4207 women with low risk births included in this study are summarized in Table 34. The women were aged between 15 and 45 years (*Mdn* = 28.0, *M* = 27.9, *SD* = 5.9). The most frequent age-group was 18-24 (*n* = 1405, 33.4%). New Zealand Maori outnumbered New Zealand Europeans (*n* = 999, 23.7% NZ Maori, *n* = 878, 20.9% NZ European). Pacific Islanders represented over one third of the cohort (n = 1492, 35.5%) whilst the remainder were Asian (n= 622, 14.8%) or members of other ethnic groups (n=200, 4.8%).

The majority of the women (*n* = 2628, 62.4%) were classified in NZ Deprivation Decile 8, 9, or 10, implying that they were among the most deprived 30 percent of people in New Zealand. Relatively few of the women (n = 506, 12.0%) were classified in NZ Deprivation Decile 1, 2, or 3, implying that they were among the least deprived 30 percent of people in New Zealand.

The Body Mass Index (BMI) of the women ranged from 15 to 40 kg/m^2 (*Mdn* = 26.0, *M* = 27.2, *SD* = 5.7). About one quarter of the women (n = 1115, 26.5%) were overweight (BMI = 25-29 kg/m^2) and about one third (*n* = 1305, 31.0%) were obese (BMI $\geq$ 30 kg/m^2).

Almost two thirds of the women were multiparous (n = 2636, 62.7%). About three quarters of the women (n = 3100, 73.7%) reported that they did not smoke.

Table 28. Socio-demographic and Contextual Characteristics of the low risk Cohort (N = 4207)

Characteristic	Category	Frequency	Percent
Age group	15-24	1403	33.3
	25-34	2174	51.7
	35-45	630	15.0
Ethnicity	NZ Maori	1001	23.7
	NZ European	882	20.9
	Pacific Islander	1498	35.9
	Asian	625	14.8
	Other	201	4.8
NZ Deprivation	1	153	3.6
Decile	2	196	4.7
	3	186	4.4
	4	177	4.2
	5	184	4.6
	6	257	6.1
	7	258	6.1
	8	512	12.2
	9	914	21.7
	10	1360	32.3
Booking BMI (kg/m^2)	< 18	126	3.0
	18-24	1445	34.3
	25-29	11210	28.8
	30-34	855	20.3
	35-40	571	13.6
Parity	Nulliparous	1571	37.3
	1-4	2427	57.7
	5-10	202	4.8
	10-13	7	0.2
	Multiparous	2636	62.7
Smoking	Non-smoker	3514	83.5
	Smoker	693	16.5

5.2 Distribution of births by Place Presenting in Labour and Model of Midwifery Care:

The flow chart in Figure 5 shows how N = 4207 women who satisfied the inclusion criteria for low risk births were distributed according to where they presented in labour to either a primary or a tertiary birthing unit. The locations referred to in Figure 5 are illustrated in the map in Figure 2. The flow chart in Figure 6 shows the distribution of the low risk cohort between Model of Care.

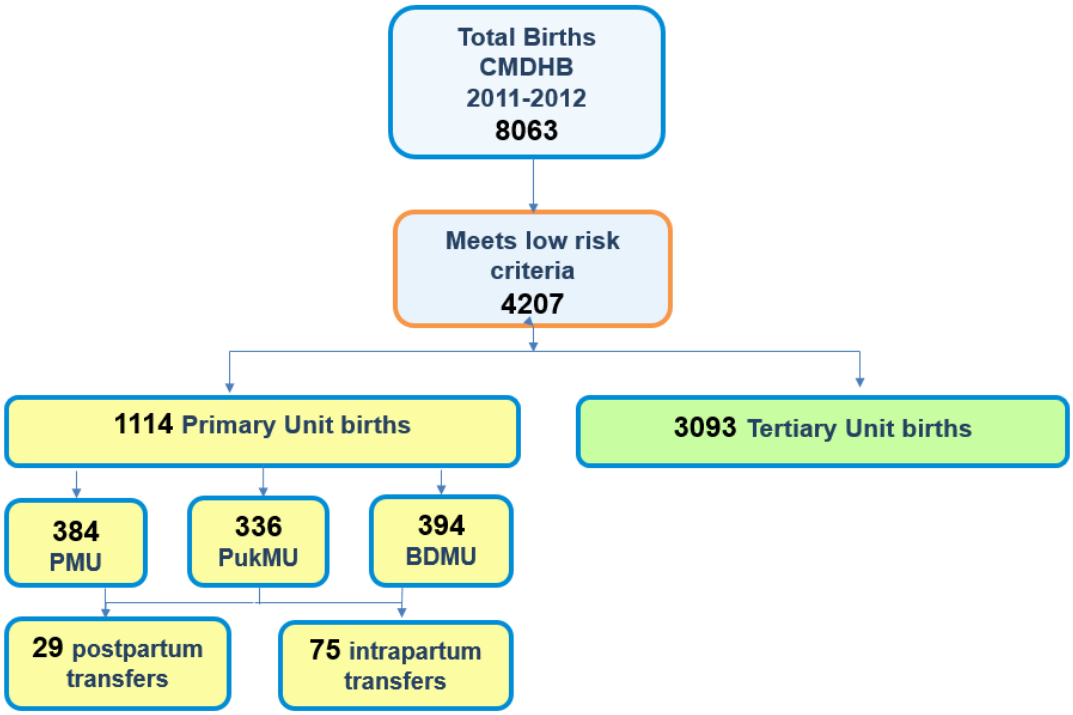

Figure 5. Distribution of the low risk cohort between Primary and Tertiary Hospital including post-partum and intrapartum transfers. Papakura Maternity Unit (PMU), Pukekohe Maternity Unit (PukMU) Botany Downs Maternity Unit (BDMU)

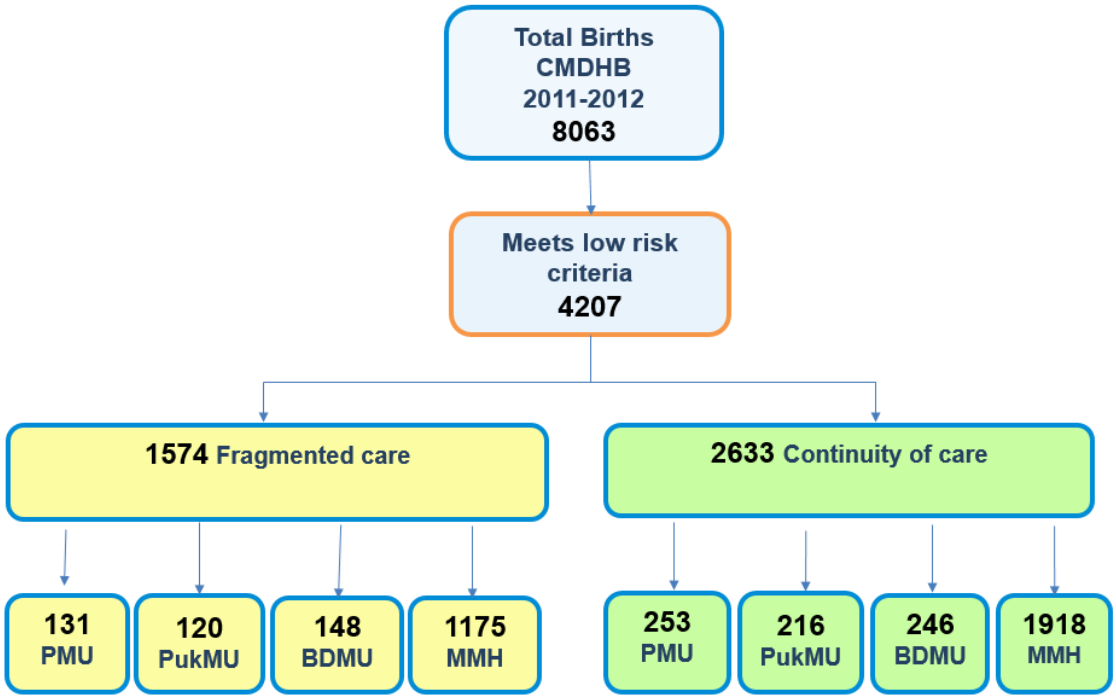

Figure 6. Distribution of the low risk cohort between Fragmented and Continuity of Midwifery Care. Middlemore Hospital (MMH)

5.3 Frequency Distributions of Characteristics of Cohort According to Place Presenting in Labour

The frequency distributions of the characteristics of the low risk women were cross-tabulated against the frequencies of low risk women presenting in labour to the two birth sites (Primary or Tertiary unit). Pearson's Chi Square tests were conducted, to determine if there were significant associations between the frequencies in the rows and columns of the cross-tabulations. The results are presented in Table 29 (age); Table 30 (ethnicity); Table 31 (deprivation decile); Table 32 (BMI); Table 33 (parity); and Table 34 (smoking status). Statistically significant associations were identified between the Place Presenting in Labour and the characteristics of the cohort, indicated by $p < .05$ for Pearson's Chi Square. These results indicate that women presenting to the primary unit are more likely to be NZ Maori and NZ European. Women presenting in labour to the tertiary hospital are more likely to be Pacific or Asian. Women presenting to tertiary are also more likely to be highly deprived, nulliparous and have a BMI over 35. Therefore including these confounders in the logistic regression model is justified.

Table 29. Crosstabulation of Age vs. Place Presenting in Labour

		Place Presenting in Labour		Total
		Tertiary	Primary	
Age (Years)	15-25	1090	313	1403
	25-35	1565	609	2174
	35-45	438	192	630
Total		**3093**	**1114**	**4207**

Note: Pearson's Chi-Square (2) = 20.328, p < .001

Table 30. Crosstabulation of Ethnicity vs. Place Presenting in Labour

		Place Presenting in Labour		Total
		Tertiary	Primary	
Ethnicity	NZ Maori	641	360	1001
	NZ European	459	423	882
	Pacific Islander	1352	146	1498
	Asian	509	116	625
	Other	132	69	201
Total		3093	1114	4207

Note: Pearson's Chi-Square (4) = 502.423, p < .001

Table 31. Crosstabulation of Deprivation Decile vs. Place Presenting in Labour

		Place Presenting in Labour		Total
		Tertiary	Primary	
Deprivation Decile	1	84	69	153
	2	99	97	196
	3	106	80	186
	4	111	66	177
	5	110	84	194
	6	161	96	257
	7	197	61	258
	8	392	129	512
	9	731	183	914
	10	1102	258	1360
Total		3093	1114	4207

Note: Pearson's Chi-Square (9) = 223.550, $p < .001$

Table 32. Crosstabulation of BMI vs. Place Presenting in Labour

		Place Presenting in Labour		Total
		Tertiary	Primary	
BMI (kg/m^2)	<18	95	31	126
	18-24	1014	431	1445
	25-29	854	356	1210
	30-34	649	206	855
	35-40	481	90	571
Total		3093	1114	4207

Note: Pearson's Chi-Square (4) = 50.116, $p < .001$

Table 33. Crosstabulation of Parity vs. Place Presenting in Labour

		Place Presenting in Labour		Total
		Tertiary	Primary	
Parity	Nulliparous	1210	361	1571
	Multiparous	1883	753	2636
Total		3093	1114	4207

Note: Pearson's Chi-Square (1) = 15.783, $p < .001$

Table 34. Crosstabulation of Smoking Status vs. Place Presenting in Labour

		Place Presenting in Labour		Total
		Tertiary	Primary	
Smoking Status	Non-smoker	2607	907	3514
	Smoker	486	207	693
Total		3093	1114	4207

Note: Pearson's Chi-Square (1) = 4.899, $p = .027$

5.4 **Frequency Distributions of Characteristics of Cohort According to Model of Care**

The frequency distributions of the characteristics of the low risk women were cross-tabulated against the frequencies of low risk women experiencing different models of care (Fragmented or Continuity). Pearson's Chi Square tests were conducted, to

determine if there were significant associations between the frequencies in the rows and columns of the cross-tabulations. The results are presented in Table 35 (age); Table 36 (ethnicity); Table 37 (deprivation Decile); Table 38 (BMI); Table 39 (parity); and Table 40 (smoking status). No statistically significant associations were identified between the Model of Care and the characteristics of the cohort, indicated by $p > .05$ for Pearson's Chi Square. Consequently, there is no evidence to suggest that a woman/s characteristics determines the Model of Midwifery Care she received.

Table 35. Crosstabulation of Age vs. Model of Care

		Model of Care		Total
		Fragmented	Continuity	
Age (Years)	15-25	525	878	1403
	25-35	803	1371	2174
	35-45	246	384	630
Total		1574	2633	4207

Note: Pearson's Chi-Square (2) = 0.930, p = .628

Table 36. Crosstabulation of Ethnicity vs. Model of Care

		Model of Care		Total
		Fragmented	Continuity	
Ethnicity	NZ Maori	360	641	1001
	NZ European	318	564	882
	Pacific Islander	583	915	1498
	Asian	237	388	625
	Other	76	125	201
Total		1574	2633	4207

Note: Pearson's Chi-Square (4) = 3.450, p=.486

Table 37. Crosstabulation of Deprivation Decile vs. Model of Care

		Model of Care		Total
		Fragmented	Continuity	
Deprivation Decile	1	61	92	153
	2	83	113	196
	3	57	129	186
	4	76	101	177
	5	71	123	194
	6	95	162	257
	7	95	163	258
	8	182	330	512
	9	347	567	914
	10	507	853	1360
Total		1574	2633	4207

Note: Pearson's Chi-Square (9) = 9.384, p = .403

Table 38. Crosstabulation of BMI vs. Model of Care

		Model of Care		Total
		Fragmented	Continuity	
BMI (kg/m^2)	<18	54	72	126
	18-24	526	919	1445
	25-29	449	761	1201
	30-34	310	545	855
	35-40	235	336	571
Total		1574	2633	4207

Note: Pearson's Chi-Square (4) = 6.178, p =.186

Table 39. Crosstabulation of Parity vs. Model of Care

		Model of Care		Total
		Fragmented	Continuity	
Parity	Nulliparous	587	984	1571

Multiparous	987	1649	2636
Total	1574	2633	4207

Note: Pearson's Chi-Square (1) = .003, p =.959

Table 40. Crosstabulation of Smoking Status vs. Model of Care

		Model of Care		Total
		Fragmented	Continuity	
Smoking Status	Non-smoker	1315	2199	3514
	Smoker	259	434	693
Total		1574	2633	4207

Note: Pearson's Chi-Square (1) =.001, p = .981

5.5 Frequency Distributions of Outcomes According to Place Presenting in Labour and Model of Care

Ideally the exposure (Independent) variables will be strongly related to the outcome (dependent) variables but not strongly related to each other (Pallant 2010). In order to examine the strength of the relationship between the exposure variables the frequency distributions of the two models of care were cross-tabulated against the frequencies of women presenting in labour to the two birth sites. Pearson's Chi Square test indicated a non-significant association at p = .179 between the frequencies in the rows and columns of the cross-tabulation. Consequently, Model of Care and Place Presenting in Labour are not associated (Table 41). Women experiencing Continuity of Midwifery Care are not more likely to use a primary unit than women experiencing Fragmented Midwifery Care. It is therefore justified to treat the exposures as separate analyses.

Table 41. Cross-tabulation of Model of Care vs. Place Presenting in Labour

		Place Presenting in Labour		Total
		Tertiary	Primary	
Model of Care	Fragmented Midwifery Care	1175	399	1574
	Continuity of Midwifery Care	1918	715	2633
Total		3093	1114	4207

Note: Pearson's Chi-Square (1) = 1.810, p = .179

Figures 7-16 below depict the rates of each outcome; Caesarean section, Blood loss greater than 500ml, maternal admission to theatre/HDU/ICU, five minute Apgar score below 7 and neonatal admission to neonatal unit by Place Presenting in Labour and Model of Midwifery Care expressed as a percentage of the total births. These bar graphs are intended to help the reader visualise the raw data before the logistic regression analysis is applied. The percentage rate of each outcome is decreased in the primary environment but the next section will explore whether this is significant after controlling for the potential confounders.

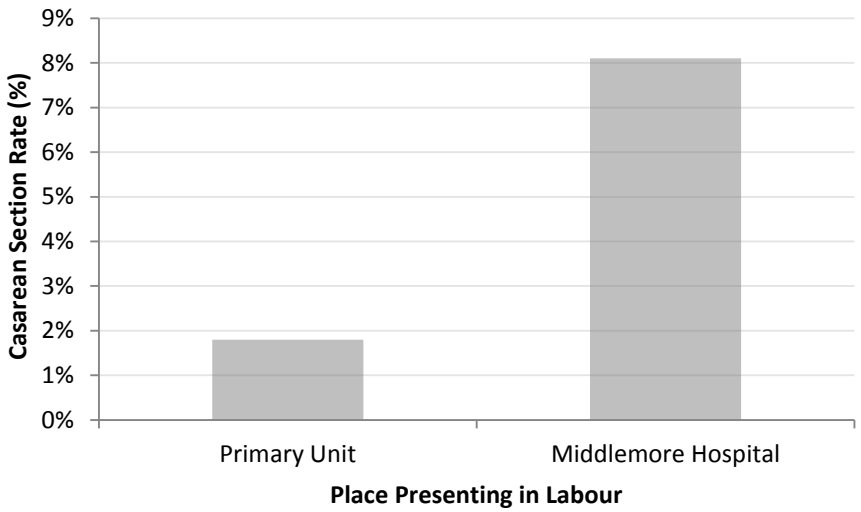

Figure 7*:* Rate of caesarean section by Place Presenting in Labour expressed as a percentage of the total. Total (n) births represented are 1114 and 3093 for Primary Unit and Middlemore respectively.

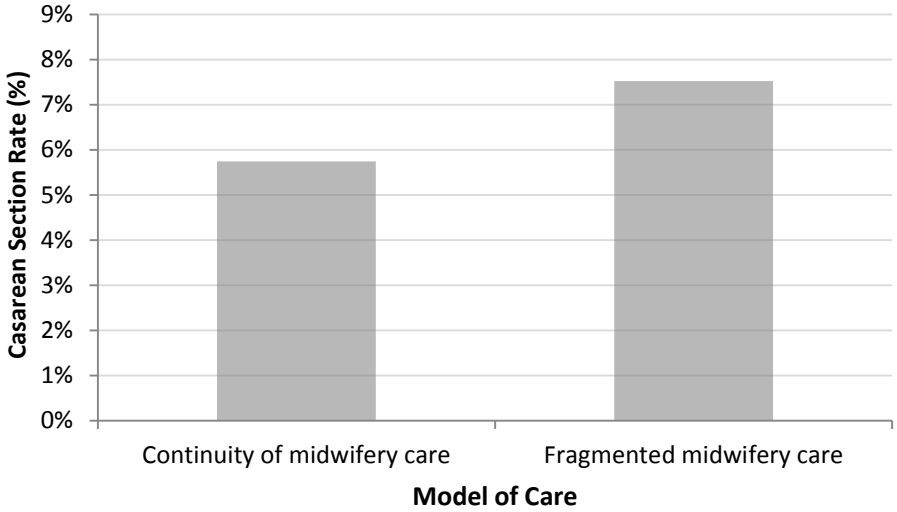

Figure 8. Rate of caesarean section by Model of Care expressed as a percentage of the total. Total (n) births represented are 2633 and 1574 for Continuity of Midwifery Care and Fragmented Midwifery Care respectively.

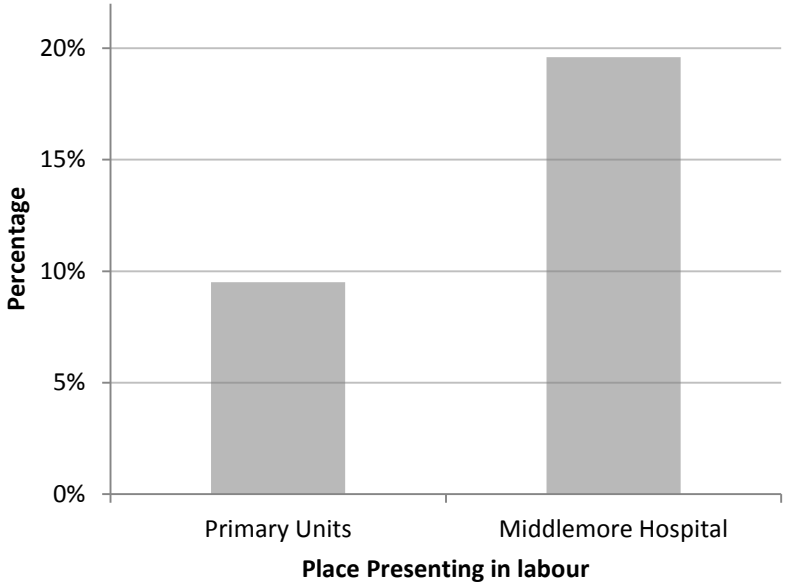

Figure 9. Blood loss 500mls or greater by Place Presenting in Labour expressed as a percentage of the total. Total (n) births represented are 1114 and 3093 for Primary Unit and Middlemore respectively.

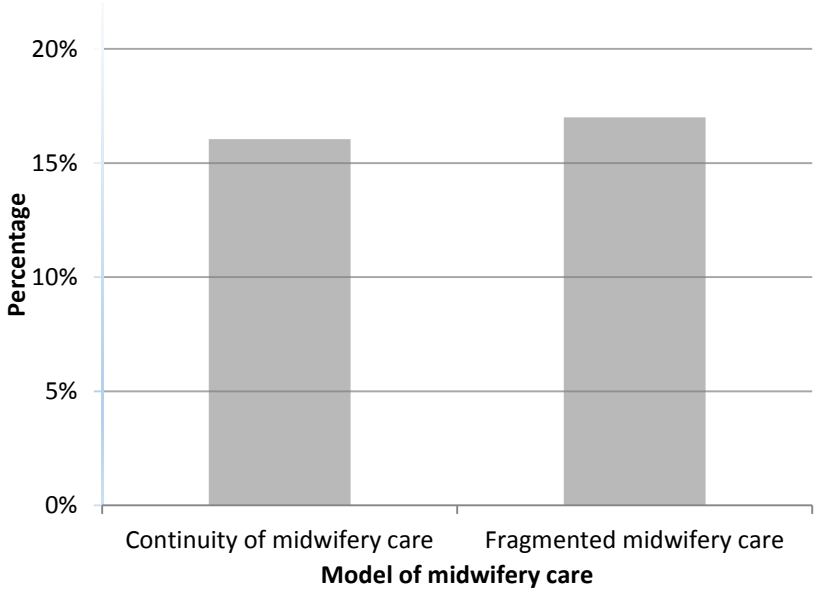

Figure 10. Blood loss 500mls or greater by Model of Care expressed as a percentage of the total. Total (n) births represented are 2633 and 1574 for Continuity of Midwifery Care and Fragmented Midwifery Care respectively.

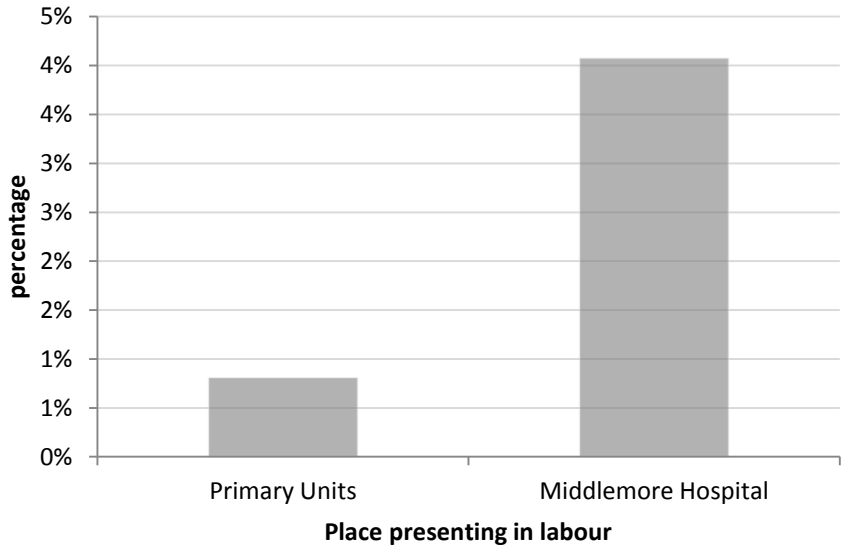

Figure 11. Admission to HDU/ICU/Theatre by Place Presenting in Labour expressed as a percentage of the total. Total (n) births represented are 1114 and 3093 for Primary Unit and Middlemore respectively.

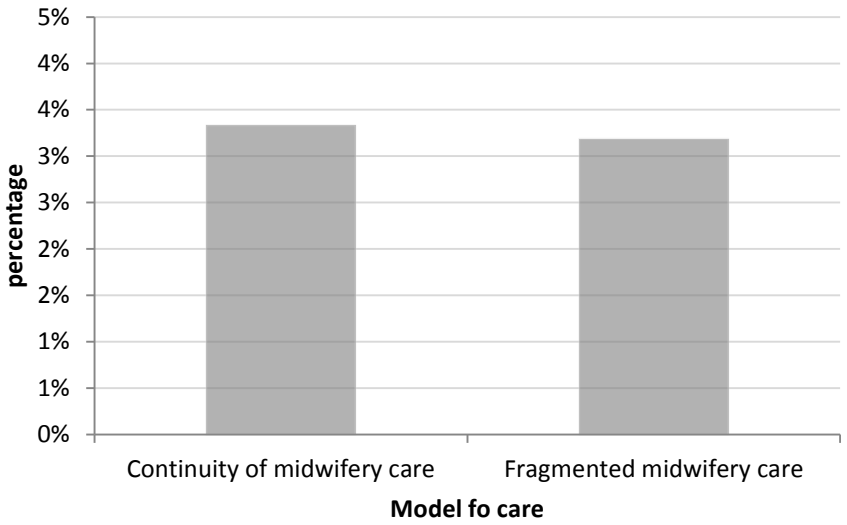

Figure 12 Admission to HDU/ICU/Theatre by Model of Care expressed as a percentage of the total. Total (n) births represented are 2633 and 1574 for Continuity of Midwifery Care and Fragmented Midwifery Care respectively.

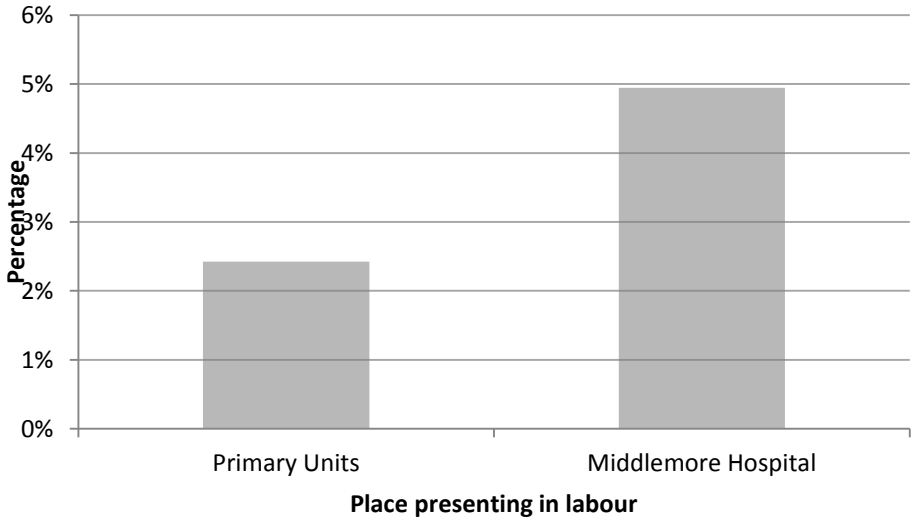

Figure 13. Rate of admission to NNU by Place Presenting in Labour expressed as a percentage of the total. Total (n) births represented are 1114 and 3093 for Primary Unit and Middlemore respectively.

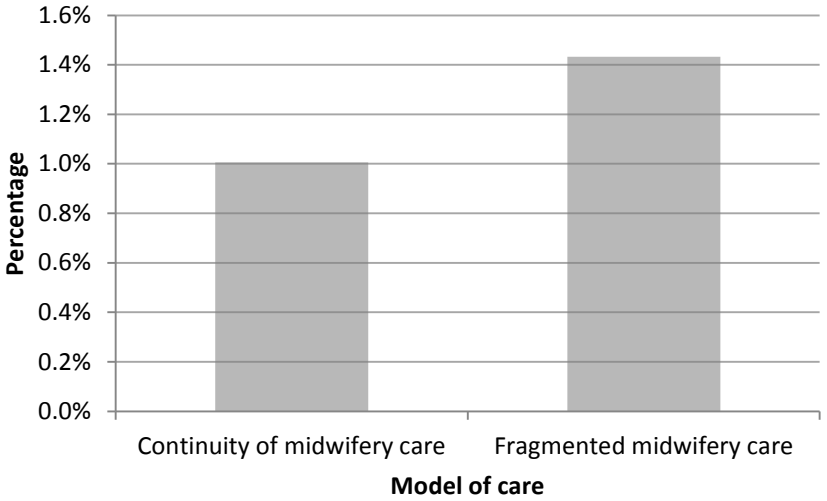

Figure 14. Rate of admission to NNU by Model of Care expressed as a percentage of the total. Total (n) births represented are 2633 and 1574 for Continuity of Midwifery Care and Fragmented Midwifery Care respectively.

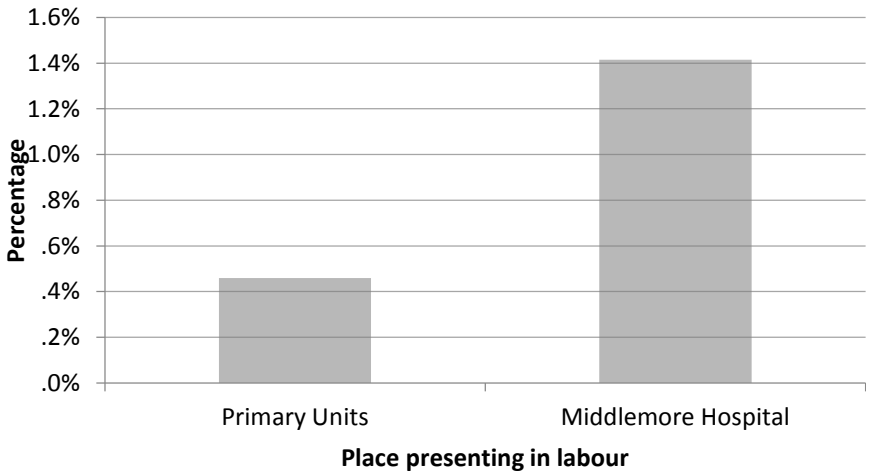

Figure 15. Five minute Apgar <7 by Place Presenting in Labour expressed as a percentage of the total. Total (n) births represented are 1114 and 3093 for Primary Unit and Middlemore respectively.

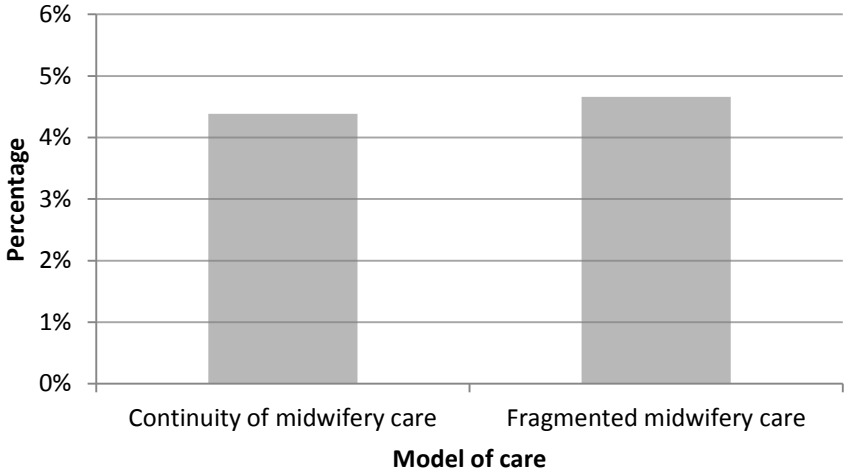

Figure 16. Five minute Apgar <7 by Place Model of Care expressed as a percentage of the total. Total (n) births represented are 2633 and 1574 for Continuity of Midwifery Care and Fragmented Midwifery Care respectively.

Chapter 6 Logistic Regression Analysis

6.1 Place Presenting in Labour

A logistic regression was performed to ascertain the effects of age, BMI, ethnicity, Decile, parity and Place Presenting in Labour on the likelihood that participants or their babies have a caesarean section, experience a blood loss greater than 500ml, are admitted to Theatre HDU/ICU, have a five minute Apgar of less than 7 or are admitted to the neonatal unit. As explained in the methods chapter a process of backwards selection was applied to remove all the non-significant confounders in the models.

Nagelkerke R2 values provide an indication of the amount of variation in the dependent variable explained by the model. In this model the values are low nevertheless, Hosmer & Lemeshow tests were not significant at the 0.05 level and therefore model selection and interpretation proceeded.

Table 42. Hosmer & Lemeshow Test and Nagelkerke R^2

Hypothesis	Exposure		Outcome	Hosmer & Lemeshow goodness of fit test		Nagelkerke R2	
				No confounders p	With confounders p	No confounders	With confounders
H1	a	Place Presenting in Labour	Birth method	1.000	.795	.038	.132
	b		Blood loss	1.000	.948	.018	.049
	c		Admission	1.000	.546	.035	.069
H2	a	Model of Care	Birth method	1.000	.553	.003	.100
	b		Blood loss	1.000	.886	.000	.042
	c		Admission	1.000	.617	.000	.045
H3	a	Place Presenting in Labour	5 minute Apgar	1.000	.580	.017	.046
	b		Neonatal Unit	1.000	.252	.011	.028
H4	a	Model of Care	5 minute Apgar	1.000	.715	.003	.037
	b		Neonatal Unit	1.000	.505	.000	.022

6.1.1 Hypothesis H1a Birth method by Place Presenting in Labour

The non-significant confounders for hypothesis H1a were removed in the following order; Decile, Pacific ethnicity, smoking, Maori ethnicity, other ethnicity. The confounders that had a significant effect on birth method were age, BMI, Asian ethnicity and parity. Table 43 shows the contribution of each of these independent variables to the model and their statistical significance.

Table 43. Binary Logistic Regression Model for Hypothesis H1a with Confounders. Outcome = Birth Method; Exposure = Place Presenting in Labour

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Age	.043	12.355	.000	1.044	1.019	1.070
BMI	.038	9.018	.003	1.038	1.013	1.064
Asian	.352	3.846	.050	1.423	1.000	2.023
Parity	-1.615	104.501	.000	.199	.146	.271
Place Presenting in Labour	-1.386	33.653	.000	.250	.157	.399
Constant	-4.056	71.703	.000	.017		

Note: * Significant at α = .05

For every one year increase in Age, there was a 0.043 (4.3%) increase in the log-odds of having a Caesarean section, holding all other independent variables constant.

For every one unit increase in BMI, there was a 0.038 (3.8%) increase in the log-odds of having Caesarean section, holding all other independent variables constant.

The odds of having an emergency caesarean section for an Asian woman was 1.423 (95%CI: 1.000 -2.023) times higher than for a woman of European ethnicity, holding all other independent variables at a fixed value.

The odds of a multiparous woman having an emergency CS is lower (OR 0.199 95%CI 0.146-0.271) than for a nulliparous women, holding all other independent variables at a fixed value.

Odds of experiencing a caesarean section for women presenting in labour to a primary unit are less (OR 0.25 95%C.I: 0.157 – 0.339) than for woman presenting in labour the tertiary hospital after controlling for age, ethnicity, parity, Decile and smoking status

6.1.2 Hypothesis H1b Blood loss by Place Presenting in Labour

The non-significant confounders were removed in the following order; age, Decile, Asian ethnicity, other ethnicity, Maori ethnicity, Pacific ethnicity. Table 44 shows the confounders that had a significant effect on birth method were; BMI, smoking and parity.

Table 44. Binary Logistic Regression Model for Hypothesis H1b with Confounders. Outcome = Blood loss; Exposure = Place Presenting in Labour

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
BMI	.039	24.198	.000	1.040	1.024	1.056
Smoking	.377	7.964	.005	1.46	1.89	1.12
Parity	-.574	38.656	.000	.563	.470	.675
Place Presenting in Labour	-.623	27.840	.000	.536	.425	.676
Constant	-2.336	112.535	.000	.097		

Note: * Significant at α = .05

For every one unit increase in BMI, there was a 0.039 (3.9%) increase in the log-odds of having a blood loss greater than 500ml, holding all other independent variables constant. The odds of having blood loss>500 for women who smoke is 1.46 times that of women who are non-smokers holding all other independent variables at a fixed value.

The odds of a multiparous woman having a blood loss greater than 500ml is lower (OR 0.563 95%CI 0.470-0.675) than for a nulliparous woman, holding all other independent variables at a fixed value.

Odds of women presenting in labour to a primary unit experiencing a PPH are less (OR 0.536 95%C.I: 0.424 – 0.676) than for women presenting in labour to the tertiary hospital after controlling for age, ethnicity, parity, Decile and smoking status.

These results may have been skewed due to the rate of emergency caesarean section being so much higher in the tertiary setting. For this reason the logistic regression analysis was rerun having excluded the 253 women whose labour resulted in an emergency caesarean section (Table 45).

Table 45. Binary Logistic Regression Model for Hypothesis H1b with Confounders (excluding caesarean sections). Outcome = Blood loss; Exposure = Place Presenting in Labour

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Decile	.058	6.663	.010	1.060	1.014	1.108
BMI	.022	5.088	.024	1.022	1.003	1.041
Pacific Island	.231	3.878	.049	1.260	1.001	1.585
Smoking	.351	5.539	.019	1.420	1.060	1.902
Parity	-.342	10.423	.001	.710	.577	.874
Place Presenting in Labour	-.368	7.665	.006	.692	.534	.898
Constant	-2.832	95.547	.000	.059		

Note: * Significant at α = .05

After excluding the 253 women whose labour resulted in caesarean section and the non-significant confounders in the following order Age, Asian ethnicity, Maori ethnicity, other ethnicity the logistic regression analysis suggests that:

For every one unit increase in BMI, there was a 0.022 (2.2%) increase in the log-odds of having a blood loss greater than 500ml, holding all other independent variables constant. The odds of having a blood loss >/= 500ml for women who smoke is 1.42 times that of women who are non-smokers holding all other independent variables at a fixed value.

It would appear that Pacific women are at a slightly higher risk of experiencing a PPH compared to European women. However this result only just reaches significance so should be interpreted with caution.

The odds of a multiparous woman having a blood loss >/= 500ml is lower (OR 0.710 95%CI 0.577-0.874) than for a nulliparous woman, holding all other independent variables at a fixed value.

Odds of women presenting in labour to a primary unit experiencing a PPH are less (OR 0.692 95%C.I: 0.534 – 0.898) than for women presenting in labour to the tertiary hospital after removing the 253 women whose labour ended in an emergency caesarean section and controlling for, ethnicity, parity, Decile and smoking status.

6.1.3 Hypothesis H1c Maternal admission to HDU/ICU/theatre by Place Presenting in Labour

The non-significant confounders were removed in the following order; smoking, BMI, Maori ethnicity, Decile, Age, Asian ethnicity, Pacific ethnicity, other ethnicity. Only one confounder had a significant effect on maternal admission; parity (Table 46).

Table 46. Binary Logistic Regression Model for Hypothesis H1c with Confounders. Outcome = Admission; Exposure = Place Presenting in Labour

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Parity	-.745	17.680	.000	.475	.335	.672
Place Presenting in Labour	-1.603	21.303	.000	.201	.102	.398
Constant	-2.768	531.743	.000	.063		

Note: * Significant at α = .05

The odds of a multiparous woman being admitted to HDU/ICU/theatre is lower (OR 0.475 95%CI 0.335-0.672) than for a nulliparous women, holding all other independent variables at a fixed value.

Odds of women presenting in labour to a primary unit being admitted to HDU/ICU/Theatre are less (OR 0.201 95%C.I: 0.102 – 0.398) than for woman presenting in labour to the tertiary hospital after controlling for age, ethnicity, parity, Decile and smoking status.

6.1.4 Hypothesis H3a Five minute Apgar by Place Presenting in Labour

The non-significant confounders were removed in the following order; Asian ethnicity, Decile, other ethnicity, BMI, Pacific ethnicity, age, Maori ethnicity, smoking. Again, only one confounder had a significant effect on five minute Apgar; parity (Table 47).

Table 47. Binary Logistic Regression Model for Hypothesis H3a with Confounders. Outcome = 5 minute Apgar; Exposure = Place Presenting in Labour

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Parity	-.678	5.705	.017	.508	.291	.886
Place Presenting in Labour	-1.161	6.035	.014	.313	.124	.791
Constant	-3.835	385.488	.000	.022		

Note: * Significant at α = .05

The odds of the babies of a multiparous women having an Apgar lower than 7 at 5 minutes is lower (OR 0.508 95%CI 0.291-0.886) than for babies of nulliparous women, holding all other independent variables at a fixed value.

Odds of babies of women presenting in labour to a primary unit having an Apgar score of less than 7 @ 5 mins are less (OR 0.313 95%C.I: 0.124 – 0.791) than for babies of women presenting in labour to the tertiary hospital after controlling for age, ethnicity, parity, Decile and smoking status.

6.1.5 Hypothesis H3b Admission to Neonatal unit by Place Presenting in Labour

The non-significant confounders were removed in the following order; Maori ethnicity, BMI, Pacific ethnicity, Asian ethnicity. Age, smoking and parity had a significant effect on five minute Apgar (Table 48).

Table 48. Binary Logistic Regression Model for Hypothesis H3b with Confounders. Outcome = Neonatal Unit; Exposure = Place Presenting in Labour.

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Age	.030	4.834	.028	1.031	1.003	1.059
Smoking	.655	5.628	.018	1.526	3.311	1.121
Parity	-.628	14.570	.000	.534	.387	.737
Place Presenting in Labour	-.709	11.089	.001	.492	.324	.747
Constant	-3.375	80.126	.000	.034		

Note: * Significant at $\alpha = .05$

For every one year increase in maternal age, there was a 0.03 (3.0%) increase in the log-odds of neonatal admission to the NNU, holding all other independent variables constant. The odds of a baby being admitted to NNU for women who smoke over the odds of a baby being admitted to NNU for women who don't smoke is exp(0.655) = 1.526, holding all other independent variables at a fixed value. This means women who smoke are more likely to have a baby in NNU.

Odds of babies of women presenting in labour to a primary unit being admitted to NNU are less (OR 0.492 95%C.I: 0.324 – 0.747) than for babies of women presenting in labour to the tertiary hospital after controlling for age, ethnicity, parity, Decile and smoking status.

6.2 Model of Care

6.2.1 Hypothesis H2a Birth method by Model of Care

Table 49. Binary Logistic Regression Model for Hypothesis H2a with Confounders. Outcome = Birth Method; Exposure = Model of Care

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
BMI	.027	4.837	.028	1.027	1.003	1.052
Others	.616	5.446	.020	1.852	1.104	3.108
Asian	.719	16.754	.000	2.053	1.455	2.897
Smoking	-.498	5.175	.023	.608	.396	.933
Model of Care	-.264	4.025	.045	.768	.594	.994
Constant	-3.435	84.503	.000	.032		

Note: * Significant at α = .05

Table 49 shows that after removing all the non-significant confounders (Decile, Maori ethnicity, Pacific ethnicity and age) from the model the P-value of Model of Care is 0.045(<0.05) which indicates that **the odds of a caesarean section for women experiencing Continuity of Midwifery Care is less (OR: 0.768, 95%CI: 0.594-0.994), than for women experiencing Fragmented Midwifery Care after controlling for BMI, other ethnicity, Asian ethnicity, and smoking status.**

6.2.2 Hypothesis H2b Blood loss by Model of Care

Table 50. Binary Logistic Regression Model for Hypothesis H2b with Confounders. Outcome = Blood loss; Exposure = Model of Care

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
BMI	.037	17.862	.000	1.038	1.020	1.056
NZ Maori	.402	7.113	.008	1.494	1.112	2.008
Others	.508	5.091	.024	1.662	1.069	2.584
Pacific	.531	14.882	.000	1.700	1.298	2.226
Asian	.428	6.829	.009	1.534	1.113	2.115
Smoking	-.402	8.336	.004	.669	.510	.879
Parity	-.615	44.378	.000	.541	.451	.648
Model of Care	-.052	.317	.573	.950	.794	1.136
Constant	-2.751	112.520	.000	.064		

Note: * Significant at α = .05

Table 50 shows that after removing all the non-significant confounders (age and Decile) from the model the P-value of Model of Care is 0.573(>0.05) (OR: 0.950, 95%CI:

0.794-1.136), which indicates that **there is no difference between the odds of Blood loss>500ml for women experiencing Continuity of Midwifery Care and that of women experiencing Fragmented Midwifery Care, when taking account of the effect of BMI, Maori, Others, Pacific, Asian, Smoking and Parity.**

6.2.3 Hypothesis H2c Maternal admission to HDU/ICU/theatre by Model of Care

Table 51. Binary Logistic Regression Model for Hypothesis H2c with Confounders. Outcome = Admission; Exposure = Model of Care

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Pacific	.432	5.880	.015	1.540	1.086	2.183
Parity	-.838	22.265	.000	.433	.306	.613
Model of Care	.025	.019	.891	1.025	.718	1.464
Constant	-3.144	307.605	.000	.043		

Note: * Significant at α = .05

Table 51 shows that after removing all the non-significant confounders from the model (Decile, smoking, BMI, age, other ethnicity, Asian ethnicity) P-value of Model of Care is 0.891(>0.05) (OR:1.025, 95%CI: 0.78-1.464), indicating **that there is no difference between the odds of maternal admission to HDU/ICU/theatre for women experiencing Continuity of Midwifery Care when compared with women experiencing Fragmented Midwifery Care, when taking account of the effect of Pacific ethnicity, and parity.**

6.2.4 Hypothesis H4a Five minute Apgar by place Model of Care

Table 52. Binary Logistic Regression Model for Hypothesis H4a with Confounders. Outcome = 5 minute Apgar; Exposure = Model of Care

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Parity	-.724	6.531	.011	.485	.278	.845
Model of Care	-.323	1.298	.255	.724	.415	1.262
Constant	-3.819	239.907	.000	.022		

Note: * Significant at α = .05

Table 52 shows that after removing all the non-significant confounders from the model (Asian ethnicity, other ethnicity, Decile, BMI, smoking, age, Pacific ethnicity, Maori ethnicity) P-value of Model of Care is 0.255 (>0.05) (OR:0.724, 95%CI: 0.415-1.262), which indicates **that there is no difference between the odds of neonatal Apgar's**

less than 7 @ 5 min for babies of women experiencing Continuity of Midwifery Care when compared with babies of women experiencing Fragmented Midwifery Care, when taking account of the effect of parity.

6.2.5 Hypothesis H4b Neonatal admission to NNU by Model of Care

Table 53. Binary Logistic Regression Model for Hypothesis H4b with Confounders. Outcome = Neonatal Unit Admission Exposure = Model of Care

	B	Wald	p	OR	99.5% C.I.	
					Lower	Upper
Age	.027	3.946	.047	1.028	1.000	1.056
Smoking	-.689	6.260	.012	.502	.292	.861
Parity	-.651	15.736	.000	.522	.378	.720
Model of Care	-.059	.143	.705	.942	.693	1.282
Constant	-3.386	74.654	.000	.034		

Note: * Significant at α = .05

Table 53 shows that after removing all the non-significant confounders from the model (BMI, NZ Maori ethnicity, Pacific ethnicity, Asian ethnicity, other ethnicity and Decile) the P-value of Model of Care is 0.705 (>0.05) (OR:.942, 95%CI: 0.693-1.282), which indicates that **there is no difference between the odds of neonatal admission to NNU for babies of women experiencing Continuity of Midwifery Care when compared with babies of women experiencing Fragmented Midwifery Care, when taking account of the effect of age, smoking status and parity.**

6.3 Summary tables:

Table 54. Comparison of Place Presenting in Labour (primary vs tertiary) for birth method, blood loss, maternal postnatal admission to tertiary services, and admission to NNU

	Descriptive statistics for Place Presenting in Labour (n,%)				**Unadjusted**			**Adjusted a**		
Outcome variable	**Primary**		**Tertiary**		**OR (95%CI)**		**p**	**Odds ratio (95%CI)**		**p**
Birth method					.224	(.141– .356)	<.001*	.250	(.157 – .339)	<.001*
Vaginal	1094	(98.2%)	2860	(92.5%)						
CS	20	(1.8%)	233	(7.5%)						
Blood Loss					.489	(.389– .615)	<.001*	.536	(.424 – .676)	<.001*
<500-mls	1017	(91.3%)	2588	(83.7%)						
>/=500mls	97	(8.7%)	505	(16.3%)						
Maternal admission to tertiary service					.192	(.097-.378)	<.001*	.201	(.102 - .398)	<.001*
Yes	9	(0.8%)	126	(4.1%)						
No	1105	(99.2%)	2967	(95.9%)						
Five minute Apgar					.298	(.118 - .752)	.010*	.313	(0.124 - 0.791)	.014*
<7	1109	(99.5%)	3047	(98.5%)						
>/= 7	5	(0.5%)	46	(1.5%)						
Admission to NNU					.477	(.315-.723)	<.001*	.492 (.324 - .747)		.001*
Yes	27	(2.4%)	153	(4.9%)						
No	1087	(97.6%)	2940	(95.1%)						

Note: [a] Adjusted for deprivation index, BMI, mother's age, parity, ethnicity, smoking status Note: * Significant at $\alpha = .05$

Table 55. Comparison of Model of Care (Continuity of Midwifery Care vs Fragmented Midwifery Care) for birth method, blood loss, maternal postnatal admission to tertiary services, and admission to NNU

	Descriptive statistics for Model of Care (n,%)				**Unadjusted**			**Adjusted a**		
Outcome variable	**Continuity of care**		**Fragmented care**		**OR (99.5% CI)**		**p**	**Odds ratio (95% CI)**		**p**
Birth method					.763	(.590 - .986)	.039*	.768	(.594 - .994)	.045*
Vaginal	2490	(94.6%)	1464	(93.0%)						
CS	143	(5.4%)	110	(7.0 %)						
Blood Loss					.497	(.787- 1.123)	.497	.950	(.794 - 1.136)	.573
<500-mls	2264	(86%)	1341	(85.2%)						
>/=500mls	369	(14%)	233	(14.8%)						
Maternal PN admission to tertiary service					1.015	(.712 - 1.448)	.934	1.025	(.718 - 1.464)	.891
Yes	85	(3.2%)	50	(3.2%)						
No	2548	(96.8%)	1524	(96.8%)						
Five minute Apgar					.722	(.414 - 1.258)	.250	.724	(.415 - 1.262)	.255
<7	28	(1%)	23	(1.5%)						
>/= 7	2605	(99%)	1551	(98.5%)						
Admission to NNU					.705	(.392- 1.266)	.705	.942	(.693 - 1.282)	.705
Yes	110	(4.2%)	70	(4.5%)						
No	2523	(95.8%)	1504	(95.5%)						

Note: [a] Adjusted for deprivation index, BMI, mother's age, parity, ethnicity, smoking status Note: * Significant at $\alpha = .05$

6.4 Summary of findings:

After controlling for age, ethnicity, parity, BMI, Decile and smoking status low risk women experiencing continuity of midwifery care are:

- less likely to experience an emergency caesarean section (OR 0.768 95%C.I: 0.594 - 0.994)
- No more or less likely to experience a PPH **(**OR 0.950 95%C.I: 0.794 - 1.136)
- No more or less likely to be admitted to HDU/ICU/Theatre (OR 0. 934 95%C.I: 0.718 - 1.464)

Than women experiencing fragmented midwifery care.

After controlling for age, ethnicity, parity, BMI, Decile and smoking status babies of low risk women experiencing continuity of midwifery care are:

- No more or less likely to have an Apgar below 7 at 5 minutes (OR 0. 250 95%C.I: 0.415 - 1.262).
- No more or less likely to be admitted to the neonatal unit (OR 0.705 95%C.I: 0.693 - 1.282).

Than babies of women presenting in labour to the tertiary hospital.

After controlling for age, ethnicity, parity, BMI, Decile and smoking status low risk women presenting in labour to the primary unit are:

- Four times less likely to experience an emergency caesarean section (OR 0.25 95%C.I: 0.157-0.339)
- Almost one and a half times less likely to experience a PPH **(**OR 0.692 95%C.I: 0.534 – 0.898)
- Five times less likely to be admitted to HDU/ICU/Theatre (OR 0.201 95%C.I: 0.102- 0.398)

Than women presenting in labour to the tertiary hospital.

After controlling for age, ethnicity, parity, BMI, Decile and smoking status babies of low risk women presenting in labour to the primary units are:

- Three times less likely to have an Apgar below 7 at 5 minutes (OR 0.313 95%C.I: 0.124 -0.791).

- Half as likely to be admitted to the neonatal unit (OR 0.492 95%C.I: 0.324-0.747).

Than babies of women presenting in labour to the tertiary hospital.

After controlling for age, ethnicity, parity, BMI, Decile and smoking status low-risk women who received Continuity of Midwifery Care are less likely to experience a caesarean section (OR: 0.768, 95%CI: 0.594-0.994), than low-risk women who received fragmented midwifery.

6.4.1 Family wise error

However, considering there are 10 hypotheses (without confounders) tested simultaneously, control of the family wise error rate at 0.05 would require each hypothesis to be tested at 0.05/10 = 0.005 and we should report 99.5% (1-0.005) CI (Dunn, 1959, 1961).If this rule is adhered to then the finding that the five minute Apgar </=7 being less likely in the primary setting does not reach significance and neither does the reduction in rate of caesarean section found to be occurring with Continuity of Midwifery Care. The other findings remain significant.

Chapter 7 Discussion

7.1 Introduction

This research suggests that midwifery care, whether it be modular or continuous, is effective in providing a health service that ensures comparable national and international outcomes for low risk women in Counties Manukau. While different models of midwifery care did not have a significant impact on outcomes, this research shows that the place where midwives care for women has the potential to significantly improve the five measured outcomes. The following discussion will consider the rates of treatments/interventions in primary and tertiary settings (see table 8, Chapter 3.6) that may account for how much more effective midwives and women are (regardless of Model of Care) at protecting and achieving physiological birth in a primary environment. How can 'a place' make it four times more likely that a low-risk woman will have a caesarean section, one and a half times more likely that she will experience a PPH and five times more likely that she will be admitted to theatre, high dependency unit or intensive care? Furthermore how can 'a place' expose her baby to a threefold risk of a low Apgar and a twofold risk of admission to the neonatal unit?

7.2 Limitations of Logistic Regression analysis in this Research

The logistic regression analysis included five dichotomous outcome variables (mode of birth, blood loss, admission to theatre/HDU/ICU, five minute Apgar and neonatal admission to neonatal unit) and two dichotomous exposure variables (Model of Midwifery Care; Fragmented /Continuity and Place Presenting in Labour; Primary unit/Tertiary hospital). Further dichotomous exposure variables could have been included e.g., admission CTG/no admission CTG, Continuous Electronic Fetal Monitoring/Intermittent Auscultation, Epidural analgesia/No Epidural analgesia, Upright posture at birth posture/Supine posture at birth. Equally, other dichotomous outcome variables could have been included e.g. instrumental birth/normal vaginal birth. All of these variables were captured and most of them were found to be accurate in Phase 1 but including them in the logistic regression analysis would have taken this research outside the parameters of a master's thesis (each exposure variable adds 10 extra logistic regression models to the thesis). However it was possible to run simple cross tabulations and chi squared analyses in Phase 1 to compare the rates of certain treatments/ interventions. The Chi square analyses (Appendix J) indicate significant differences between the treatments/interventions occurring in primary units compared

with tertiary hospital but non-significant differences in the treatments/interventions occurring in the cohort of women receiving Continuity of Midwifery Care compared with the cohort of women receiving Fragmented Midwifery Care. The rates of various treatments/interventions occurring at the primary unit compared to the rates of various treatments/interventions occurring at the tertiary hospital will be included in the discussion to identify, albeit in a limited way, the possible reasons why 'Place Presenting in Labour' makes such a significant difference to outcomes.

7.3 Place Presenting in Labour, Model of Midwifery Care and birth method

This research shows that after controlling for age, ethnicity, Decile, BMI, smoking status and parity the odds of a woman presenting in labour to the tertiary unit experiencing an emergency caesarean section are four times the odds of a woman presenting in labour to the primary unit (OR 0.25, 95% CI: 0.157-0.339). The odds of a woman receiving continuity of midwifery care experiencing an emergency caesarean section are also less (OR: 0.768, 95% CI: 0.594-0.994) than for a woman experiencing Fragmented Midwifery Care but by nowhere near the same degree.

If the odds of emergency caesarean section among women presenting in labour to the tertiary unit could be brought in line with the odds of women presenting in labour to the primary units over 157 women and their babies in this cohort would have avoided a major surgical procedure. At the time of the surgery the women faced a significantly increased risk of mortality (Gregory, Jackson, Korst, & Fridman, 2011), infection, anaesthetic and surgical complications (Thorpe, 2009). In the longer term these 157 women may have more difficulty in becoming pregnant again and if they do they will experience an increased likelihood of ectopic pregnancy and/or miscarriage (Gregory et al., 2011) preterm birth, low birthweight, small for gestational age (Kennare, Tucker, Heard, & Chan, 2007) and stillbirth (Smith, Pell, & Bobbie, 2003). Later in their pregnancy they will be at increased risk of uterine rupture, recurrent emergency caesarean delivery, abnormal placentation due to uterine scar (previa/accreta/abruption) (Gregory et al., 2011), malpresentation and prolonged labour (Kennare et al., 2007). At the time of surgery 157 babies faced an immediate risk of asphyxia, scalpel lacerations, neonatal respiratory morbidity (Thorpe, 2009) and following birth they probably experienced delayed initiation of breastfeeding (Hyde 2011), and altered physiological adaptation that may have long-term immunologic and metabolic implications (Biasucci et al., 2010; Bouhanick et al., 2014; Gronlund, Arvilommi, Kero, Lehtonen, & Isolauri,

2000; Huurre et al., 2008; Laubereau et al., 2004). They also face an increased rate of asthma, food allergy/sensitivity, and atopy (Bager, Wohlfahrt, & Westergaard, 2008; Giacomo, Belinda, Lorenzo, Elena, & Günther, 2008; Hyde, Mostyn, Modi, & Kemp, 2012; Neu & Rushing, 2011).

This research shows that 'Place Presenting in Labour' has a significant impact on caesarean section rates without improving outcomes. It is clear that this surgery may lead to numerous health issues for women and babies. The risks of emergency caesarean sections far outweigh the risks of physiological birth for both mother and baby (Gregory et al., 2011). Protecting physiological birth is increasingly becoming a public health issue which requires an urgent response from the Ministry of Health down to the individual practitioner.

7.4 Adjusting for Confounding variables

Each logistic regression model describes the effect of each of the confounding variables on each of the outcome variables and these findings are reported in Chapter 5. The intention of including the potential confounding variables was simply to control for them and thus provide adjusted and unadjusted results for each of the hypotheses. As it turns out, adjusting for the confounding variables did not markedly alter the p values for any of the five outcome variables (mode of birth, blood loss, admission to theatre/HDU/ICU, five minute Apgar, neonatal admission to neonatal unit) in relation to either of the two exposure variables (Model of Midwifery Care and Place Presenting in Labour). Therefore the logistic regression findings for the confounding variables are stated for each hypothesis in the results but will not be explored further in the discussion. It is perhaps of interest to note that parity was by far the most commonly significant confounding variable (significant in 9 out of 10 of the logistic regression models) followed by BMI and smoking status which were significant 4 and 5 times respectively. Age was significant in 3 of the models as was being of Asian ethnicity. Being of Pacific ethnicity was significant in 2 of the models Being Maori was significant in only 1 model and Decile was not significant in any model, probably owing to the majority of women living in areas of high deprivation.

7.5 Place Presenting in Labour and Fetal Monitoring

A certain number of admission CTG's (even in low risk women) possibly reflects best practice especially in a primary unit where even subtle clinical indications/deviations are investigated thoroughly as midwives are vigilant about identifying the need to

transfer early. While this would account for a small number of the admission CTG's performed on low-risk women in the tertiary hospital the majority were more likely performed as part of a routine admission procedure. Midwives have reported that a 'normal' 20 minute CTG trace taken during admission is a kind of protection in a retrospective assessment of their care should a poor outcome take place (Hindley & Thomson, 2007). This thinking is however unjustifiable in the face of the evidence which shows that the admission CTG is a poor predictor of adverse fetal outcomes, has a high rate of error and falsely identifies 'fetal distress' in low-risk women (Blix, 2013). Furthermore, systematic reviews have shown that, when compared to Intermittent Auscultation (IA), admission CTG increases interventions such as epidural analgesia, continuous CTG monitoring, fetal blood sampling, caesarean section and instrumental delivery without improving neonatal outcomes in any way. (Blix, 2013; Blix, Reinar, Klovning, & Øian, 2005; Gourounti & Sandall, 2007; Rossignol, Chaillet, Boughrassa, & Moutquin, 2014).

In this research only 14% (n= 160) of women presenting in labour to a primary unit received an admission CTG compared with 75% (n=1110) in the tertiary hospital (Chapter 3.6, Table 8). It was also found that Intermittent Auscultation (IA) was used in 89% (n=995) of the labours occurring in the primary units compared with 52% (n=1636) of the labours occurring in the tertiary hospital (Chapter 3.6, Table 8). In low-risk labours the use of Intermittent Auscultation (IA), as is more commonly used in the primary units has been recommended by the international midwifery and obstetric community (Maude, Skinner, & Foureur, 2014). Close attention from a supportive midwife using IA, as occurs in the primary unit leads to less intervention, less pain relief, and a better maternal experience while not compromising the safety and wellbeing of mother and baby (Hodnett, Gates, Hofmeyr G J, & Sakala C, 2013; Sandall, Soltani, Gates, Shennan, & Devane, 2013). This type of close attention is threatened when the midwife:labouring women ratio increases beyond 1:1 as frequently occurs in the tertiary hospital where the number of birthing women often outnumber the midwives in the labour ward. In this environment midwives are more likely to use EFM (Hindley 2006).

In the tertiary hospital 39% (n=1200) of women were subject to continuous EFM compared 5.5% (n=62) of women in the primary units (Chapter 3.6, Table 8). This reflects the higher rates of epidural and/or augmentation in the tertiary hospital. We know from randomised controlled trials that continuous EFM in low-risk labours has

raised both operative and instrumental delivery rates whilst making no difference to rates of neonatal mortality and morbidity (Alfirevic & Gyte, 2013; Ananth, Chauhan, Chen, D'Alton, & Vintzileos, 2013; Dyson, Austin, & Lees, 2011; Lowe, 2011; Resnik, 2013; Sartwelle, 2012; Sartwelle & Johnston, 2014; Stout & Cahill, 2011). While CTG's are available at the primary units it is unlikely that a midwife would use *continuous* EFM in a primary unit. If there was any indication for continuous EFM the labour is no longer termed "low-risk" prompting the midwife to arrange for transfer (unless birth is imminent). Therefore, the use of continuous EFM monitoring on women who presented in labour to the primary units most likely corresponds to the women who transferred in labour to the tertiary hospital however this cannot be determined from the available data.

Any intervention that increases the rate of caesarean section must be used with extreme caution. The results from the cross tabulations suggest that the rate of admission CTG's and continuous EFM may be too high in the tertiary hospital amongst low-risk women in labour. There is an urgent need to review this culture as it would appear to be one of the most significant factors increasing the rate of caesarean section in the tertiary setting.

7.6 Place Presenting in Labour and Epidural

The rate of epidural, spinal, and pudendal analgesia in labour is just 3% (n=34) in the women who presented to the primary units compared with 18% (n=554) in tertiary hospital (Chapter 3.6, Table 8) where epidural analgesia is provided on request to low-risk women with uncomplicated pregnancies. Epidurals are an intervention which are not without risk and women are often not adequately informed (Mahomed, Chin, & Drew, 2015) of these risks; maternal hypotension, fever, dural puncture, prolonged second stage, immobility, episiotomy, instrumental and operative deliveries, oxytocin augmentation and interference with breastfeeding(L. L. Albers, Migliaccio, Bedrick, Teaf, & Peralta, 2007). Few women do not request relief in labour (physiological or otherwise) but it is at this point that having a physical distance from the pharmaceutical forms of this relief may be beneficial. Women who need to transfer from primary units to the tertiary hospital for the placement of an epidural do so, in the majority of cases, because labour is no longer progressing physiologically. In contrast, women who reach the point of intense active and physiological labour in the tertiary setting are sometimes not given the full range of options. Whereas, at the primary units non pharmacological options (e.g. a pool of warm water, massage and close support from their support

people) are not only the most appropriate options but the only options. Often women at the end of what they believe they can endure in the tertiary setting are, as their first choice, given the option of an epidural. This increased readiness to site an epidural has multiple implications such as augmentation and continuous fetal monitoring with CTG.

Unfortunately the rate of augmentation was not captured in this research and thus the rate of augmentation by Place Presenting in Labour is unknown. However, considering the fact that the need for augmentation increases after the placement of an epidural (Rahm, Hallgren, Hogberg, Hurtig, & Odlind, 2002) and, as we have seen in the previous section, the rate of epidural is six times higher in the tertiary hospital it seems fair to presume that the rate of augmentation among women presenting in labour to the tertiary hospital would also be higher. Therefore it will be considered as a possible reason for the different outcomes found in each setting.

It is believed augmentation is required after siting an epidural due to a decrease in the level of circulating oxytocin (Rahm et al., 2002) and diminished oxytocin receptor binding in myometrial cells, which has been shown to desensitize the oxytocin receptors in the uterus (Robinson, Schumann, Zhang, & Young, 2003). These factors decrease the strength and co-ordination of the uterine contraction thus synthetic oxytocin is used in order to "augment" labour (Anim-Somuah, Smyth, & Jones, 2011; Mayberry, Clemmens, & De, 2002).

Augmentation is another intervention that is in greater readiness in a tertiary hospital than in the primary unit where augmentation by synthetic means is not an option. In the primary units midwives use physiological measures e.g. calming the environment (lowering lights, minimizing the amount of people, discussion and disturbance), mobilization and nipple stimulation to strengthen waning contractions. While the evidence to support or refute these techniques is still developing, they are known to 'do no harm' and if nothing else they provide a distraction and some time for labour to strengthen. On the other hand, administering intravenous syntocinon can cause hyper-stimulation (Wei, Luo, Qi, Xu, & Fraser, 2010), fetal hypoxia and distress (Simpson, 2008). This association necessitates continuous electronic fetal monitoring which as discussed increases the risk of emergency caesarean section. This series of cause and effect that results from intervention in labour was termed the "cascade of intervention" (Inch, 1989) over thirty years ago. The findings of multiple meta-analyses have since proven that epidural on request and electronic fetal monitoring at admission increase the

rate of operative interventions in low-risk births without improving maternal or fetal outcomes (Rossignol et al., 2014).

7.7 Place Presenting in Labour and instrumental births

Chapter 3.6 Table 8 shows the rate of instrumental births are 2.7% (n=30) for primary units which is half the rate of 6.7% (n=204) for the tertiary hospital. This higher rate of instrumental births may also reflect the higher rate of epidural analgesia at the tertiary hospital (Anim-Somuah et al., 2011; Eriksen, Nohr, & Kjærgaard, 2011; Eriksson, Olausson, & Olofsson, 2006; National Institute for Health and Clinical Excellence (NICE), 2014; Nguyen et al., 2010) which has been shown to increase the risk of fetal malposition particularly the Occipito Posterior (OP) position (Lieberman, Davidson, Lee-Parritz, & Shearer, 2005) possibly due to the epidural analgesia blocking maternal bearing down efforts and reducing the peak level of oxytocin during the second stage, as well as relaxing pelvic floor muscles, reducing the resistance against the presenting part as it descends and thus interfering with fetal rotation (Simkin, Ancheta, & Myers, 2005). OP position often necessitates an instrumental birth and this in turn results in an increased rate of episiotomy and severe perineal trauma (Dahlen 2007).

7.8 Place Presenting in Labour, postpartum haemorrhage and maternal admission to ICU/HDU/theatre admission

The increased rate of blood loss over 500ml OR 1.45 (95% CI 1.11 – 1.87) found to be occurring in this research in the low-risk cohort presenting in labour to the tertiary hospital (after removal of those labours ending in emergency caesarean section) is related to the higher rate of maternal admission to ICU/HDU/theatre (OR 0.201 95%C.I: 0.102- 0.398).

The higher rate of caesarean as already mentioned results in an increased risk of significant morbidity (Gregory et al., 2011), infection, anaesthetic and surgical complications (Thorpe, 2009). It also possibly reflects the combined outcome of epidural, episiotomy and forceps (Fitzgerald et al., 2007) which is more likely to result in third and fourth degree tears. Unfortunately the accuracy assessment of the "third stage procedures" did not reach the 90% accuracy criterion and therefore the rate of episiotomy was not able to be compared between birth sites.

7.9 Place Presenting in Labour, Apgar scores and admission to NNU

The logistic regression analysis in this research shows that after controlling for age, ethnicity, Decile, BMI, smoking status and parity the odds of babies of low-risk women presenting in labour to the tertiary hospital are:

Three times more likely (OR 0.313 95%C.I: 0.124 – 0.791) to have an Apgar score of less than 7 at 5 minutes and twice as likely (OR 0.201 95%C.I: 0.102 – 0.398) to be admitted to NNU than babies of women presenting in labour to the primary units.

Very recently the incidence of Apgar score below 7 at 5 minute has been found to be associated with epidural analgesia (Törnell et al., 2015). However a less recent Cochrane review reported an odds ratio of 0.70 (0.44–1.10, 95% CI) for an Apgar score of less than 7 at 5 minutes after epidural analgesia(Anim-Somuah et al., 2011).

Neonatal morbidity is associated with instrumental birth (Langeron et al., 2012; Sánchez Andrés, Gómez Tébar, Vento Torres, & Colomer Revuelta, 2007) and, as previously mentioned, emergency caesarean carries the risk of birth asphyxia, and neonatal respiratory morbidity (Thorpe, 2009).

The rate of maternal fever may also contribute to the higher rate of admission to NNU. The absolute risk of intrapartum temperature greater than 38ºC in nulliparous women using epidural analgesia has been reported to range from 14.5% to 33%(Goetzl et al., 2007). The exact cause is unknown but intrapartum fever could partly account for the higher rate of neonatal admission to the neonatal unit for evaluation for and treatment of suspected sepsis.

The higher rate of admission to the neonatal unit and the lower Apgar scores for babies of women presenting in labour to the tertiary unit is possibly indirectly associated with the higher rate of epidural, and directly associated with the higher rate of instrumental birth and caesarean section.

7.10 Place Presenting in Labour and non-pharmacological pain relief

In Chapter 3.6, Table 8 the use of hydrotherapy was shown to be far more prevalent in the primary units 16% (182) than the tertiary hospital 1.5% (47) even though waterbirth in the primary units was noted to be significantly under reported on Healthware. It is likely that the other options in this field are also under reported. This indicates a level of invisibility of the skills being used in the primary units. Leap and Anderson (2008)

introduced the paradigm of committing to working with pain versus calling for pain relief to illustrate the different approaches to pain management Midwives assisting women to give birth in primary units by necessity have experience with multiple non-pharmacological methods for working with pain. A challenging labour (especially for a primigravid woman) will require the measured use of the varied methods if physiological birth is to be achieved and transfer for pharmacological methods avoided. Knowing how and when to use each of the various methods is a specialist skill that is practiced and passed on to newer practitioners in the primary units where the environment is more conducive to the successful practice of these methods and the spatial and physical arrangements make them more accessible. During labour, pain plays an important role in the production of natural pain relief hormones, such as endogenous oxytocin and endorphins, which also contribute to regulate uterine contractions (Buckley, 2003; Leap, Dodwell, & Newburn, 2010). In the primary unit environment, midwives use practice wisdom to moderate the sensations of labour allowing women to feel the sensations without becoming overwhelmed. Because the mother is present to her sensations she is able to maintain a coordinated and dynamic interaction with her unborn baby through free and intuitive movement. When the laboring woman becomes overwhelmed the midwife uses not only biomechanical methods but also psychosocial understandings and sometimes spiritual ways of relating to bring the woman 'back to herself'. She is thus able to continue to trust the sensations as they increase in their intensity. It is in order to maintain this dynamic maternal/fetal interaction that non-pharmacological methods of pain relief should be used in every low-risk labour with the addition of pharmacological pain relief only when non-pharmacological options have been exhausted (Chaillet et al., 2014).

The vast majority of women who indicate antenatally that they do not wish to use intrapartum pharmacological pain relief do not in fact use it (Klomp, de Jonge, Hutton, & Lagro-Janssen, 2013). This finding implies that the education of women around the benefits of the non-pharmacological alternatives will strengthen their resolve to birth physiologically and that a significant amount of time should be spent antenatally communicating and discussing the risks of pharmacological forms of pain relief as well as describing, preparing for, and providing non-pharmacological alternatives. This requires that all midwives feel confident in each of the three endogenous mechanisms (Chaillet & Dumont, 2007) of pain management. Midwives need to be confident about how and when to apply each form to ensure that the woman feels their efficacy. In this

way her confidence in her ability to cope builds with the increasing intensity of her labour. Like any skill, if these methods are not regularly practiced, as can become the case in the tertiary hospital, midwives may lose their confidence and skill and turn to pharmacological methods sooner than their primary unit counterparts. Midwives also need to be confident in the skill of water immersion and water birth as one of their core tools. Water is perhaps the most effective physiological medium in reducing the overwhelming sensations of labour while seemingly providing the woman with buoyancy and a sense of her own privacy both of which may improve her experience significantly and beyond the basic physical sensation of pain. Water is an element that women are often familiar with in relieving pain. It is a valuable tool in assisting relaxation and facilitating the physiological cascade of endogenous hormones as has already been discussed.

It is acknowledged by systematic reviews that various methods of non-pharmacological pain relief "may work" and that the standard methods on offer do no harm to mothers or babies (Jones et al., 2012). There have also been randomised controlled trials specifically investigating the effect of immersion in water on labour and birth (Cluett & Burns, 2009; Dahlen, Dowling, Tracy, Schmied, & Tracy, 2013) and while further research is necessary they report significant benefits and no evidence of increased adverse effects to the fetus/neonate or woman. With these findings it would seem clear that midwives have a responsibility to become proficient in the many non-pharmacological methods of "working with" the sensations of labour.

7.11 Place Presenting in Labour and maternal birth position

The rate of an upright posture for birth for women presenting in labour to the primary unit was 55% (n=610) compared with 23% (n=724) for women presenting in labour to the tertiary hospital (Chapter 3.6, Table 8). Physiological birth is essentially a coordinated series of movements between the mother and her baby. It appears that freedom of movement is not innate, instinctive and intuitive to all birthing women. This is perhaps a cultural phenomenon. The recumbent positions favoured by a medical model and now common place in tertiary hospitals has been implemented without supporting scientific evidence (Gupta & Nikodem, 2000). In fact science describes multiple benefits of mobilisation and upright positioning during the intrapartum period, including gravity's assistance with fetal descent and uterine contractions, minimization of the weight of the pregnant uterus on the inferior vena cava to allow adequate oxygenation of the fetus (Gupta & Nikodem, 2000; Lawrence, Lewis, Hofmeyr,

Dowswell, & Styles, 2009) an increased pelvic diameter (Gupta & Nikodem, 2000; Michel et al., 2002) a shorter first stage of labour, a lower rate of epidural use (Lawrence et al., 2009) and assistance with fetal rotation (Leah L. Albers, 2007; Mayberry et al., 2002; Romano & Lothian, 2008).

Midwives in primary units have been shown to protect and promote women's freedom of movement in a physiological labour (Priddis, Dahlen, & Schmied, 2011) which in turn supports *"constructions of the maternal body as competent and the childbearing process as one that involves the childbearing woman as an active participant"* (Davis et al., 2011, p. 135). Swaying, lunging, stepping and other naturally adopted positions can bring women effectively to the next stage of labour by improving application of the presenting part (Balaskas, 1991) thus promoting optimal hormonal feedback which in turn increases the power of each contraction while optimizing the level of endorphins (natural pain relief hormones) that can protect a woman and her baby from feeling the full intensity of each contraction (Buckley, 2003).

7.12 The environment

Several qualitative studies in New Zealand have demonstrated that midwifery practice is influenced by place (Davis & Hunter, 2015; M. Foureur, 2002; Hammond, Foureur, Homer, & Davis, 2013; Hammond, Homer, & Foureur, 2014; Hunter, 2003; D. Walsh & Downe, 2004; T. Walsh, 2009). Midwives struggle to facilitate physiological birth in tertiary settings. This research suggests that midwifery practice wisdom is perhaps overshadowed in the tertiary hospital where "dominance of bio-medical constructs and power relations" (Davis & Hunter, 2015, p. 136) prevail. Midwives either change their approach to care as suggested byMiller and Skinner (2012) or don't have the skills/support/motivation or perhaps incentive to maintain the physiological environment in the tertiary setting.

A recent Guardian article summarizes the findings of the NICE guidelines (2014) thus; " The risks of needing unnecessary intervention are increased in a highly-medical setting, and the majority of women do best at home or in a home-from-home environment, where stress levels stay down and the natural process of birth functions best" (Moorhead, 2014, p. para 7) These findings are described as "reversing a generation of misconception about birth" (Moorhead, 2014, para. 7) during which time women have been sold a myth that birthing in hospital with technology would improve safety for themselves and their babies.

However, now it is understood that a low-risk woman is safest when she is in control of her environment, physically and socially, to exercise freedom of movement, and interact naturally and positively with her surroundings. If she feels cast or constrained, which is often the result of a highly technological setting, it will create an unnatural stasis which will increase her pain and fear and therefore the probability of other obstetric interventions such as epidural, instrumental delivery, augmentation and caesarean section (D Davis & K Walker, 2010).

It has also been suggested that a floor plan that does not centralise the bed, as can occur in the primary units, acts as a facilitator for physiological birth positions (Priddis et al., 2011). The availability of space in the primary units allows women to comfortably adopt various upright positons at appointed stations around the birthplace. These various positions are achieved using support people, furniture and other props e.g., bean bag, Swiss ball or birth stool. Free access to large open private outdoor spaces make mobilising more pleasant and therapeutic than the public corridors and stairwells of the tertiary hospital.

A metanalysis showed improved outcomes in a range of patient groups who are in an environment that can offer privacy, promote social support, allow freedom and control, are calming, and include scenes of nature and other visual and auditory stimuli that elicit positive emotional responses (Hodnett, Stremler, Weston, & McKeever, 2009). Multiple pieces of qualitative research have explored the importance of the design and surroundings of the birthing environment, and its physiological and psychological impact on birthing (Fahy & Parratt, 2006; M. Foureur & Hunter, 2010; Lepori, 2008; Wagner, 1996).

In humans there are four hormonal systems (oxytocin, beta-endorphins, epinephrine/norepinephrine and prolactin) involved in achieving physiological labour and birth (Buckley 2015). The optimal interaction of these hormones is open to environmental influences. A place perceived as calm, warm, friendly and supportive facilitates the release of oxytocin (responsible for contracting the uterine myometrium in powerful rhythmic waves which cause it to change shape and at the same time exert the necessary force to facilitate birth). Whereas a place experienced as stressful, threatening or demanding triggers release of catecholamines which are also required during labour but at levels that are too high they prepare the body for “fight or flight” which during labour will interrupt contractions; an evolutionary adaptation that allowed

the woman to flee the apparent danger (Hammond et al., 2013). Primary units have the capacity to promote feelings of safety and support more so than tertiary hospitals (de Labrusse & Kiger, 2013). This is perhaps due to the physical as well as the cultural environment.

Davis and Hunter (2015) explain that in the midwifery-led culture of the primary units midwives use "embodied knowledge" rather than technology to assess a woman and her baby. This allows labour to "be" by protecting women from unnecessary intervention. The conscious reduction in interference is perhaps one of the most powerful protectors of the cascade of physiological hormones required to achieve a physiological birth. When birth remains physiological a different relationship with time can occur which is more focused on progress as it occurs for a particular woman rather than absolute clock time. This physiological focus has led to suggestions (mostly by the media) that midwives practicing in primary units are overly focused on physiological birth and thus delay recognition of complications. The findings of this research would refute this suggestion and assert that midwives in primary units are competent and experienced midwives equipped to detect and manage complications promptly with an astute awareness of normal labour and that these midwives distinguish physiological variation from damaging pathological variations appropriately as evidenced by the low transfer rate of around 10% and the improved rate of every outcome for women presenting in labour to primary units as compared to women presenting in labour to the tertiary hospital.

7.13 Place Presenting in Labour and maternal choice

The notion of informed choice is one of the guiding principles of the midwifery-women partnership in New Zealand (New Zealand College of Midwives (NZCOM), 2008b). Informed choice is the ideal that through discussion, education and the sharing of ideas a woman is able to come to a decision that best serves her needs. McAra-Couper, Jones, and Smythe (2012) have argued that the notion of "informed choice" has little meaning in an environment that is so skewed by the anxiety and fear that have come to surround the process of birth in the popular imagination. This fear is prevalent especially among primigravid women (Toohill, Fenwick, Gamble, & Creedy, 2014) and is increasing as the rate of operative birth increases (Hastie & Fahy, 2011). If there is any chance of stabilizing let alone reducing the predominance of childbirth fear this research clearly

demonstrates that the option of presenting in labour to a primary unit needs to be actively promoted to women and their support people. A midwife who does not offer birth in a primary setting is not providing informed choice. The limiting of her low-risk clients "Place of Birth" options is placing them at greater risk of morbidity and is therefore in direct contrast to the midwifery frameworks for practice and her duty to 'do no harm'. It is known that in NZ the vast majority of women birth in the place they originally planned to birth (Hunter et al., 2011) but how they came to decide their birth place is far less well understood. This research has shown, as has Pilkington, Blondel, Drewniak, and Zeitlin (2012), significant difference in the demographic characteristics of women birthing in the primary units compared to the tertiary hospital. In Counties Manukau women presenting to the primary units are more likely to be NZ Maori and NZ European. Women presenting in labour to the tertiary hospital are more likely to be Pacific or Asian. These findings are in agreement with the findings of the Ministry of Health Report on Maternity 2010 (Ministry of Health, 2012b). Women presenting to the tertiary hospital in this research are also more likely to be from areas of high deprivation, nulliparous and have a BMI over 35. (Pilkington et al., 2012) also found that about one-third of women chose their maternity units based on proximity

Women of CMDHB are currently well provided with options for primary birthing. No-one lives further than 30-40 minutes from a primary birthing facility. However, it would seem that many women of Mangere and Otahuhu present in labour to the tertiary hospital because it is in their neighborhood not because they need and possibly not because they particularly want tertiary services considering the rate of epidural amongst these women is only 18% (Table J3). This is still significantly lower than the national epidural rate which was at 25% in 2010 (Ministry of Health, 2012b). These women deserve to be informed, by way of a directed promotion, encouraging them away from the tertiary hospital and into an environment that will properly support their efforts to birth physiologically.

There is a definite need for more understanding of the perceptions of risk and decision-making by pregnant women in CMDHB in relation to deciding on a Place of Birth and the reasons midwives don't utilize the primary units more often. Understanding the barriers will help create the resources necessary to turn the tide of tertiary birthing in CMDHB. With so much to gain women need better information to make good decisions about the birthplace most likely to result in a "successful" birth i.e. one that leaves both

mother and baby healthy and happy, in the optimum physical and mental condition, particularly when they fear labour.

Place of Birth remains a difficult area as there is a potential conflict between the midwife's duty to her client and the client's right to self-determination. Midwives respect a mother's autonomy as the highest priority, if a woman is afraid, she will not birth well. But it is also of the highest priority to 'do no harm'. A competent woman, who is able to weigh information to make a decision, must be given risks and benefits of the Place of Birth for herself and her baby before she can make a truly informed decision. With the now readily available statistics and multiple sources of robust scientific information it would seem all health professionals have an obligation to vigorously promote primary birthing by way of informing women about the outcomes in relation to Place of Birth in a real way with accessible figures. If a woman remains too afraid to birth in the primary setting after this discussion this decision point should be documented and justified in full consciousness. It should also be revisited at a later stage in the pregnancy, as all big decisions are, and midwives need to be open to a woman changing her mind in labour by seeing her at home in early labour and being ready to support her wherever she feels most comfortable being at that time.

7.14 **Strengths**

A strength of this study was the large cohort and the accuracy assessment performed to ensure only high quality data was used to generate the findings. Another strength was the fact that logistic regression was used to control for confounding variables which has not been achieved before in research of CMDHB birthing women. The findings of this research are congruent with a large body of previously collected data across a range of jurisdictions. This work reinforces the findings that low risk women birthing in primary settings have improved outcomes and that indeed harm is caused to low risk women who present for care in tertiary environments.

7.15 **Representativeness**

It is difficult to comment on the representativeness of the women included in this study because no national data are available on a low-risk cohort of women. The median age for all women giving birth in New Zealand in 2010 was 29 years compared with 28 years in the low-risk cohort in this research. The proportion of nulliparous women giving birth nationally was 35.2 percent compared with 37.2 percent in this study and 29.9% in the MMPO, and the proportion of women giving birth who identified as Maori

were 23.7% in this study 25% nationally, 21.1% in the MMPO database, the proportion of women identifying themselves as European was 20.9% in this study, 50.1% nationally and 62.2% in the MMPO database. The proportion of women identifying themselves as Pacific 35.5% in this study, 11.7% nationally and 6.2% in the MMPO database and Asian 14.8% in this study 10.8% nationally and 6.3% in the MMPO database. The median BMI in this study was 26 which is classed as “overweight”, no national or MMPO figures could be found for BMI. Smoking status 16.5% in this study 16.2% nationally and 18.4% in the MMPO database. This information is depicted in Table 56 below.

Table 56. Comparison of the national and MMPO data with data from the current study

	Current research	**National data (NZ maternity report 2010)**	**MMPO Midwives 2010 Annual Report on Care Activities and Outcomes**
Median age (years)	28	29	29
Smoking status (%)	16.5	16.2	18.4
Maori ethnicity (%)	23.7	25	21.1
Pacific ethnicity (%)	35.5	11.7	6.2
European ethnicity (%)	20.9	50.1	62.2
Asian ethnicity (%)	14.8	10.8	6.3
Proportion of Nulliparous women in cohort (%)	37.2	35.2	29.9
BMI	26	-	-
% in decile 8,9,10	66	-	27.8
Primary unit birth (%)	26.5	10.8	12.7
Secondary/Tertiary birth (%)	73.5	85.4	82.2

7.16 Limitations

The use of an existing database Healthware™ presented some limitations as discussed in chapter three. These limitations were largely overcome by careful application of diagnostic coding to isolate the low-risk cohort and the utilization of a second database PiMS™ to extract the fields that were not available in the Healthware™ database.

A further limitation of this study is the fact that it is not possible to control for the particular psychology that causes some women to consciously choose the primary environment and therefore this cannot be overlooked as a possible contributing factor to the differences in outcomes found in this cohort. Although the sample is low-risk women, those choosing to give birth in a primary unit will have different motivations to those planning to give birth in the tertiary hospital. This factor has undoubtedly influenced some outcomes reported here. Another limitation of this study was the fact that the rate of augmentation of labour, artificial rupture of membranes, and episiotomy were not captured in this research and would have added to the discussion.

The logistic regression models were not a good fit to the data which implies that the variables chosen as potential confounders were possibly not as significant as other confounders may have been.

7.17 Recommendations for future research and practice

This research implies that there is something intriguing occurring in free standing midwifery led primary units of CMDHB that is worth further investigation. This would involve the exploration of midwifery practice wisdom and the embodied knowledge of both the midwives and the woman who present in labour to primary units. It would seem clear that having a fuller understanding of these skills and values (as far as it is possible to quantify them) would perhaps increase their value and allow for their universal acceptance as the gold standard of care rather than an optional practice style.

It is also necessary to explore the barriers to women accessing free standing midwifery led primary units. There is a plethora of research around what supports or undermines a woman's decision and ability to breastfeed. This has been due in large part to the establishment of the highly impactful Baby Friendly Hospital Initiative (BFHI). The "Place of Birth" needs to make this same impact perhaps by the establishment of a Primary Birth Initiative (PBI) that is supported by Ministry Of Health, practitioners (both doctors and midwives) and consumers. A backlash from certain consumer groups claiming that woman's choice is being eroded is already happening in response to the NICE guidelines (2014). In an article in The Guardian entitled "The cult of natural childbirth has gone too far" the author claims that "being bullied or cajoled into having a natural birth because of trumped-up risks to "baby" is not what I call feminism"(Glaser, 2015, para. 13). Such resistance is inevitable and important, however if the true message around the "risks to baby" in the tertiary setting are to emerge in a way that doesn't threaten a woman's right to choose, it will require a bold and collective approach.

Women need to feel safe in order to birth physiologically, and in many cases, this sense of safety is dependent on their partner supporting their "Place of Birth" decision. Birth is a pinnacle and challenging event for most women and they therefore need to be reassured from every angle. If obstetricians undermine the midwifery led free standing primary unit option for a low-risk woman, it is unlikely that there will be a significant change in public behaviour. Obstetricians who respect science can no longer deny the evidence around primary birthing. If they are committed to protecting vaginal birth they will support the drive to invest in free standing midwifery led primary units. An anesthetist recently wrote in the Sunday Star Times about a recent and tragic death that

occurred after transfer from a midwifery led primary unit. He acknowledged in this article that the quality of ongoing maternity care in this country necessitates investment in primary birthing facilities where “dedicated, passionate, caring” midwives can continue their “very difficult job in very difficult circumstances”(O'Donnell, 2015, para. 38).

It would seem the tide is turning and yet there is a sense that it will not turn quickly in this country where private obstetricians benefit financially (and from public funds) every time there is a “social” reason to order an elective caesarean section for a low-risk client. The women accessing this type of private obstetric care are well resourced and this alliance continues to reinforce the private obstetric model. A valuable area of further research would be to compare outcomes for low-risk women and babies cared for by obstetrician LMC’s using core midwifery services with low-risk women and their babies cared for by midwife LMC’s with access to public obstetric services.

Further research is also needed to determine the barriers to midwives providing the midwifery led free standing primary unit birthing option? They are perhaps responding to women’s overwhelming preference to be where they can access an epidural. Perhaps they are tired of attending to the often emotionally tumultuous and physically demanding process of physiological birthing. Perhaps they don’t feel confident to identify deviations from the physiological into the pathological and prefer to be where they can access medical staff by pushing a button. Perhaps they are reluctant to embrace the potential of transfer to a tertiary facility should the women require pharmacological pain relief. Perhaps there are financial reasons; they can book more clients if they only offer care at one tertiary facility. Perhaps it is habitual and they are comfortable in their local tertiary facility that they know and where they are known. Without understanding the barriers, it will be difficult to change behaviour.

7.18 Implications for education

Education of women, midwives, obstetricians and the public in general is necessary to make birthing in the primary units a logical option for all low-risk women. With so much to gain from physiological birthing a public health campaign “Primary Birth Initiative” could combine all the proven benefits of physiological birth into an easily

accessible resource and thus public opinion about primary birthing will evolve. It will be an accepted fact that low-risk women are better served in primary settings and this will become a normal and socially sanctioned choice that is preferable to hospital.

The education of undergraduate midwives includes evidence based information about 'Place of Birth' and skills focused on supporting physiological birth are acknowledged as a real and valued aspect of their competence. It would be interesting to investigate whether obstetricians are encouraged to explore research around the optimal birthing environment and the interaction of physiology and psychology during pregnancy and birth as part of their education. Obstetricians are not generally privileged to observe birth in the primary environment and therefore their understanding of the way a woman's body behaves during birth is limited to the biomedical context. Unfortunately, inviting obstetricians into the primary environment to observe physiological birthing is likely to defeat the purpose. This is something, however, which is not unreasonable to expect obstetricians to be aware, i.e. their point of view can be detrimental to physiological birthing. Indeed most obstetricians in CMH perceive their role as crucial to women who need intervention. There are very few obstetricians in CMH who practice privately. Only 24 out of the 4207 births in this cohort were cared for by a private obstetrician.

Counties Manukau Obstetricians are, for the most part, very well aware and quietly supportive of the role of the primary birth facilities in keeping well women away from the hospital. There is a growing awareness among obstetricians, as well as women and midwives, in other DHB's that have no primary birth facility that their basic birthing needs are not being met. There is a strong drive to create a public private partnerships to provide primary birthing spaces. The findings of this research have already been shared at a number of public forums with this intention. Counties Manukau Health is seen as a progressive model where women are well served in terms of birthing options.

The establishment of a primary service coordinator at Counties Manukau Health is a positive step in promoting primary birthing. A project is currently underway to produce a virtual tour of the primary units available on the Counties Manukau Health website. The findings of this research will be included in this educational resource. Practitioners can refer women here when discussing Place of Birth options.

Another positive step are the “drop in clinics” Counties Manukau Health has established throughout the suburbs of South Auckland where late booking is a major issue. These are in addition to the primary birthing units where woman know they can go to access all they need for their pregnancy and birth. These informal and highly accessible portals to maternity care and education is crucial to this population. Conversations about “Place of Birth” (among many other conversations about pregnancy and primary health) can happen and, over time, women and whanau become aware of their options with risks of all choices properly outlined. This needs to be a requirement of the birth plan as an aspect of informed consent in a woman-centered profession.

7.19 Conclusion

After controlling for age, ethnicity, parity, BMI, Decile and smoking status low-risk women who receive Continuity of Midwifery Care are less likely to experience a caesarean section (OR: 0.768, 95%CI: 0.594-0.994), than low-risk woman who receive Fragmented Midwifery Care. Experiencing Continuity of Midwifery Care does not significantly improve the other four outcomes measured in this research when compared to Fragmented Midwifery Care.

After controlling for age, ethnicity, parity, BMI, Decile and smoking status low-risk women who present in labour to a free standing midwifery led primary unit are at a decreased risk of all three of the measured outcomes; emergency caesarean section, postpartum haemorrhage and admission to theatre/HDU/ICU. Babies of low-risk women presenting to give birth in the free standing midwifery led primary unit have a decreased risk of both of the measured outcomes; admission to neonatal intensive care (NNU) and Apgar scores of less than 7.

Increased rates of caesarean in the tertiary hospital may be associated with the prevalence of continuous electronic fetal monitoring and low-risk women being exposed to the dangerous practice of providing an admission CTG still occurring in the hospital environment. Increased rate of PPH may be associated with the combined impact of epidural and episiotomy associated with the increased rates of instrumental births. It may also be associated with augmentation of labour with syntocinon (however rates of augmentation are unknown in this research). The increased rates of admission to the neonatal intensive care and the lower 5 minute Apgar may be associated with

increased rates of labour interventions and operative and assisted modes of birth in the tertiary hospital.

Low-risk women of Counties Manukau are significantly more likely to have a normal vaginal birth and a healthy baby if they present in labour to a free standing midwifery led primary unit. This research has echoed the findings of many other national and international studies. It is time that this public health message is taken seriously. Continuing to increase the rates of intervention in low-risk births has long term and significant consequences for the health and wellbeing of mothers and babies and subsequently the whole of society.

Glossary

To aid the reader meanings have been explained for some of the more complex terms used in this study.

Apgar score: A scale from 1-10 developed by Dr Virginia Apgar in 1975 to assess a newborn for the need for medical assistance.

Antenatal: Occurring before birth, during pregnancy.

Direct maternal mortality ratio: the number of maternal related deaths per 100,000 maternities resulting from obstetric complications of the pregnant state (pregnancy, labour or puerperium), from interventions, omissions, incorrect treatment or from a chain of events resulting from the above (PMMRC,2015,p.108).

Intrapartum: Occurring during labour and childbirth.

Lead Maternity Carer (LMC): A Midwife, General Medical Practitioner (GP) or Obstetrician who provides continuity of primary maternity care to a woman and her infant (New Zealand Health Information Service, 2007) (Ministry of Health, 2007). For the purposes of the study different midwife roles have been included:

Low-risk: For the purposes of this research the term low risk describes the women who became full term (37 weeks) without developing any illness that required admission to hospital for secondary care. The women needed to have been booked for at least two full weeks to allow for adequate screening and to have gone into labour spontaneously with a cephalic, singleton pregnancy. She needed to have a BMI less than 40 and be no older than 40 if she is nulliparous and no older than 45 if she is multiparous.

Models of midwifery care:

1. **Self-employed Lead Maternity Carer (LMC) Model:**

A Midwife, General Medical Practitioner (GP) or Obstetrician who provides continuity of primary maternity care to a woman and her infant (Ministry of Health, 2007). Only midwife LMC's have been included in this research. Their care is fully funded by the government and no fee can be charged for their services.

2. **Maternity models offered by CMDHB at the time of data collection:**

- **Team**

"Team midwives" also known as "Case loading midwives" are LMC's employed by the DHB who work as a team to provide a model of maternity care similar to that provided by self-employed LMCs in the community providing continuity of midwifery care.

- **Shared Care**

Shared care provides fragmented midwifery care. In response to the high birth rate in the region and an ongoing shortage of self-employed LMCs and team midwives (both offering a degree of continuity) CMDHB developed a "Shared Care" model that is unique to the Counties region. The Shared Care model is intended to provide a type of

LMC service to women, and care is delivered through the co-ordination of various practitioners who "share" care. Under the Shared Care model, antenatal care up to 31 weeks' gestation is provided by a GP or GPs who have entered into a Shared Care arrangement with the DHB. Women are also offered up to three antenatal visits and about 4 postnatal visits by CMDHB employed community midwives. The Shared Care model within CMDHB operates only with GPs, and does not extend to self-employed midwives.

- **Closed Unit**

Closed unit care in Fragmented Midwifery Care. Under the "closed unit" model, all maternity care, antenatal, labour and postnatal care is provided by a DHB employed midwife. Clinics are held at Middlemore, Manukau, Botany Superclinic, or in the community. Although attempts are made to provide continuity of care where possible, this Model of Care often results in women receiving care from a variety of different care providers throughout different stages of their antenatal care and during labour. Approximately 3,500 women per year receive closed unit care. Some women receive closed unit care because they require obstetric Senior Medical Officer input into their care because of medical conditions (these women have been excluded from this study); others receive closed unit primary maternity care because they are unable or unwilling to access a self-employed LMC or Team (Caseloading) DHB midwife.

Multigravida: A woman having her second or subsequent pregnancy

Multiparous: A woman who has had two or more babies over 24 weeks gestation

Nulliparous: A woman who has never before given birth; **nulliparae** (pl).

NHI National Health Index, a unique number given to every person at birth or at first contact with a health service if not born in New Zealand. All health events and health data are stored using this unique number.

Perinatal related mortality rate: Fetal deaths and early and late neonatal deaths per 1000 total babies born at 20 weeks gestation or beyond or weighing at least 400g if gestation is unknown (PMMRC, 2015,p.4)

Postnatal: Occurring after birth, usually up to a period of six weeks.

Postpartum Haemorrhage: Excessive bleeding from the genital tract, in excess of 500mls, (for this research, within 12 hours of giving birth).

Primary Maternity Unit:

Currently there are 52 primary maternity units within New Zealand/Aotearoa; both rural and urban. Primary maternity units (PMU's) are standalone, community birthing environments in which midwives take primary professional responsibility. PMU's provide "access for women assessed as being at low risk of complications for labour and birth care. They do not provide epidural analgesia or operative birth services" (Ministry of Health, 2011, p. 31). During labour and birth diagnostic and medical services including obstetricians, paediatricians and anaesthetists are available offsite.

There are three PMU's in CMDHB:

1. Papakura Maternity Unit: serves a suburban population
2. Botany Downs Maternity Unit: serves an urban population
3. Pukekohe Maternity Unit: serves a rural population

Midwives (experts in physiological birthing) access these units through a national maternity access agreement and transfer with women to the tertiary hospital (Middlemore Hospital) by ambulance if the aforementioned services are required

Primigravida: A woman having her first pregnancy

Primiparous: A woman who has only one pregnancy progressing beyond 24 weeks gestation, whether it is live or stillborn, singleton or multiple infants.

Tertiary Hospital:

A tertiary hospital offers the full range of hospital services; diagnostic, treatment and medical services including obstetric, neonatal and anaesthetic care 24 hours a day/ 7 days a week. The CMDHB tertiary hospital is Middlemore Hospital (MMH); very low risk through to very high risk women birth at MMH.

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Appendices

Appendix A

CMDHB Research Office ethics approval

COUNTIES MANUKAU DISTRICT HEALTH BOARD
A Community Partnership

Middlemore Hospital
Private Bag 93311, Otahuhu
Manukau 1640
Auckland, New Zealand
Telephone 64-9-276-0000

CMDHB Research Office
Ground Floor, Room 56
Clinical Support Building
Middlemore Hospital

23-Apr-12

Dear Judith McAra Couper

Thank you for the information you supplied to the Research Committee regarding your research proposal:

Ethics reference Number: NTX/12/EXP/078
Research Registration Number: 1215

Research Project Title: Maternal and Neonatal Outcomes for low risk women labouring in a primary unit or teritary hospital. A cohort Study

I am pleased to inform you that the Counties Manukau District Health Board Research Committee has approved this research with you as CMDHB investigator.

We wish you well in your project and require an update on how it is progressing. A copy of the progress report that is required by the Ethics Committee is sufficient, and should be submitted to the **Research Officer by** 23 Apr 13

Please note failure to submit the progress report may result in the withdrawal of ethical approval.

Yours Sincerely,

Alison Robertson
Research Officer
Counties Manukau District Health Board
DDI: 09 276 0279 Ext: 8279
MB: 021 943 784
Email: amroberts@middlemore.co.nz
CC: Debra Fenton

Appendix B

Northern X Regional Ethics Committee approval

Health and Disability Ethics Committees

Northern X Regional Ethics Committee
c/- Ministry of Health
650 Great South Rd
Penrose
Auckland
Phone: (09) 580 9105
Email: northernx_ethicscommittee@moh.govt.nz

17 November 2011

Ms Judith McAra-Couper
Auckland University of Technology
Midwifery Department
Akoranga Drive
Northcote
Auckland

Dear Judith

Re:		
	Ethics ref:	**NTX/11/EXP/284** (please quote in all correspondence)
	Study title:	Maternal and neonatal outcomes for low risk women labouring in a primary maternity unit or tertiary hospital. A cohort study
	Investigators:	Ms Judith McAra-Couper (Principal), Ms Tomasina Stacey, Ms Debra Fenton, Dr David John Bailey

Thank you for your application received on 14 November 2011. This study was given ethical approval by the Chairperson of the Northern X Regional Ethics Committee on 17 November 2011.

Approved Documents

- Protocol [undated, received 14/11/11]
- Questionnaire [undated, received 14/11/11]

This approval is valid until 1 June 2014, provided that Annual Progress Reports are submitted (see below).

Amendments and Protocol Deviations

All significant amendments to this proposal must receive prior approval from the Committee. Significant amendments include (but are not limited to) changes to:

- the researcher responsible for the conduct of the study at a study site
- the addition of an extra study site
- the design or duration of the study
- the method of recruitment
- information sheets and informed consent procedures.

Significant deviations from the approved protocol must be reported to the Committee as soon as possible.

Annual Progress Reports and Final Reports

The first Annual Progress Report for this study is due to the Committee by **17 November 2012**. The Annual Report Form that should be used is available at www.ethicscommittees.health.govt.nz. Please note that if you do not provide a progress report by this date, ethical approval may be withdrawn.

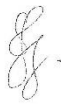
A Final Report is also required at the conclusion of the study. The Final Report Form is also available at www.ethicscommittees.health.govt.nz.

Statement of compliance
The committee is constituted in accordance with its Terms of Reference. It complies with the *Operational Standard for Ethics Committees* and the principles of international good clinical practice.

The committee is approved by the Health Research Council's Ethics Committee for the purposes of section 25(1)(c) of the Health Research Council Act 1990.

We wish you all the best with your study.

Yours sincerely



Sabrina Young
Temp Administrator
Northern X Regional Ethics Committee

Appendix C

AUTEC Approval

AUTEC
SECRETARIAT

11 July 2013

Judith McAra Couper
Faculty of Health and Environmental Sciences

Dear Judith

Re Ethics Application: **13/176 Maternal and neonatal outcomes for low risk women labouring in a primary unit or tertiary hospital. A cohort study.**

Thank you for submitting your application for ethical review. I am pleased to confirm that the Auckland University of Technology Ethics Committee (AUTEC) has approved your ethics application for three years until 8 July 2016.

AUTEC advises that it is a requirement that health data be stored for a minimum of 10 years.

As part of the ethics approval process, you are required to submit the following to AUTEC:

- A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/researchethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 8 July 2016;
- A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/researchethics. This report is to be submitted either when the approval expires on 8 July 2016 or on completion of the project;

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this. If your research is undertaken within a jurisdiction outside New Zealand, you will need to make the arrangements necessary to meet the legal and ethical requirements that apply within their.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

All the very best with your research,

Kate O'Connor
Executive Secretary
Auckland University of Technology Ethics Committee

Cc: Annabel Farry annabel.farry@aut.ac.nz

Appendix D

Sample Confidentiality Agreement

Confidentiality Agreement

Project title: ***Maternal and Neonatal Outcomes for low risk women labouring in a primary unit or teritary hospital. A cohort Study***

Project Supervisor: ***Judith McAra-Couper, Tomasina Stacey and Mark Wheldon***

Researcher: ***Annabel Farry***

- I understand that all the material I will be asked to record is confidential.
- I understand that the contents of the Healthware database and the women's clinical notes can only be discussed with the researchers.
- **I will not keep any copies of the information nor allow third parties access to them.**

Intermediary's signature: .....

Intermediary's name: .....

Intermediary's Contact Details (if appropriate):

.....

.....

.....

.....

Date:

Project Supervisor's Contact Details (if appropriate):

.....

.....

.....

Approved by the Auckland University of Technology Ethics Committee on type the date on which the final approval was granted AUTEC Reference number type the AUTEC reference number

Note: The Intermediary should retain a copy of this form.

Appendix E

Confidentiality Deed between researcher and CMDHB

CONFIDENTIALITY DEED

1. **The Parties**

This Deed is between Counties Manukau District Health Board (**CMDHB**) and Annabel Farry.

AGREEMENT

2. You are undertaking a research project which may require access to personal and clinical information held by CMDHB regarding patients of CMDHB. You confirm that the proposal for this research project has received ethics approval where required from the appropriate New Zealand Health and Disability Ethics Committee.

3. You agree that any and all information observed or obtained by you while performing research at CMDHB is confidential information (**Confidential Information**) and may only be used in accordance with your research proposal. Identifiable information may only be disclosed with patient or staff consent. Confidential Information includes, but is not limited to, information and health information relating to CMDHB or to past, present or future patients, clients or staff.

3. You agree to abide by the following conditions:

   - You will only use Confidential Information in accordance with your research proposal, as approved by the relevant Ethics Committee.
   - You will, at all times, manage Confidential Information in accordance with requirements of the Health Information Privacy Code 1994, the Privacy Act 1993, and CMDHB policies and procedures.
   - Except in accordance with legislation and your research proposal, you will not disclose or duplicate Confidential Information to or for any person, corporate entity, firm or organisation, unless you have prior authorisation from CMDHB. Identifiable information will only be disclosed with patient consent.
   - If you believe that Confidential Information needs to be disclosed without patient authorisation, you must notify the CMDHB Research Officer. You are aware that the CMDHB Research Officer must be consulted before any disclosure occurs.
   - You will ensure that printed copies of Confidential Information are destroyed through confidential waste disposal.
   - You will notify the CMDHB Research Officer if you have or intend to have electronic access to clinical information, and have or intend to obtain a log-on for the CMDHB clinical information systems. You will ensure that you log-off when you have finished electronically accessing information, and you will not leave a computer unattended while you are logged-in.
   - You acknowledge that security of passwords and other identifiers are the responsibility of individuals. You will not share your log-in password with any other person.

4. You agree that:
   - 4.1 These obligations of confidentiality will survive the terms of your research project; and
   - 4.2 The obligations of confidentiality imposed by this deed are in addition to obligations of confidentiality imposed by law, and you are expected to have an understanding of obligations imposed by the Privacy Act 1993 and the Health Information Privacy Code 1994.
   - 4.3 You understand that your use of Confidential Information and electronic systems will be monitored and audited and that any inappropriate access to, or use of, information may be reported to your employer, your registering body, the Privacy Commissioner and other agencies.

EXECUTION

You have read, understood and agreed to be bound by the above provisions of this Confidentiality Deed.

(Signature)	21-06-13 (Date)
WITNESSED BY:	
(Signature)	124B Sunset Rd (Address)
Jane Townsend (Full Name)	21.06.13 (Date)

Appendix F

Diagnostic codes used to determine low risk cohort

Description of diagnosis	Secondary care prior to labour
Abnormal results of liver function studies	Secondary
Abnormality of forces of labour, unspecified	
Abnormality of white blood cells, not elsewhere classified	Secondary
Abrasion of lower leg	
Abscess of Bartholin's gland	Secondary
Abscess of breast associated with childbirth, without mention of attachment	
Abscess of vulva	Secondary
Accidental poisoning by and exposure to other and unspecified drugs,	Secondary
Accidental puncture and laceration during a procedure, not elsewhere c	Secondary
Acquired deformity of pelvis	Secondary
Acute nasopharyngitis [common cold]	
Acute pancreatitis	Secondary
Acute pharyngitis, unspecified	
Acute posthaemorrhagic anaemia	
Acute upper respiratory infection, unspecified	
Acute vaginitis	Secondary
Agalactia, with mention of attachment difficulty	
Agalactia, without mention of attachment difficulty	
Allergic contact dermatitis due to adhesives	
Allergic purpura	Secondary
Alpha thalassaemia	Secondary
Anaemia complicating pregnancy, childbirth and the puerperium	Secondary
Anaemia, unspecified	
Anaesthesiology devices associated with misadventures, prosthetic and other implants	Secondary
Anaphylactic shock due to adverse effect of correct drug or medicament	Secondary
Anogenital (venereal) warts	Secondary
Antenatal screening, unspecified	
Antepartum haemorrhage, unspecified	Secondary
Antiallergic and antiemetic drugs causing adverse effects in therapeutic use	Secondary
Anticoagulants causing adverse effects in therapeutic use	Secondary
Anxiety disorder, unspecified	
Aortic (valve) stenosis	Secondary
Aplastic anaemia, unspecified	Secondary
Arthritis, unspecified, other	Secondary
Arthritis, unspecified, pelvic region and thigh	Secondary
Ascites	Secondary
Asthma, unspecified	
Atrial fibrillation and flutter	Secondary
Attention to surgical dressings and sutures	
Bacterial infection, unspecified	
Bell's palsy	Secondary
Benign neoplasm of ovary	Secondary
Beta thalassaemia	Secondary
Bicornate uterus	Secondary
Bipolar affective disorder, unspecified	Secondary

Bizarre personal appearance	
Blister of lower limb, level unspecified	
Bradycardia, unspecified	Secondary
Bronchiectasis	Secondary
Bronchitis, not specified as acute or chronic	Secondary
Calculus of gallbladder without cholecystitis, without mention of obstruction	Secondary
Calculus of kidney	Secondary
Candidiasis of vulva and vagina (N77.1*)	
Cardiac arrhythmia, unspecified	Secondary
Cardiac murmur, unspecified	Secondary
Care and examination of lactating mother	
Carpal tunnel syndrome	
Carpal tunnel syndrome in pregnancy	
Carrier of other specified bacterial diseases	
Carrier of viral hepatitis B	
Carrier of viral hepatitis C	
Cellulitis of lower limb	Secondary
Cellulitis of trunk	Secondary
Cellulitis of upper limb	Secondary
Cerebral infarction due to embolism of cerebral arteries	Secondary
Cervicalgia	Secondary
Chest pain, unspecified	Secondary
Chlamydial infection of genitourinary tract, unspecified	Secondary
Chlamydial infection of lower genitourinary tract	Secondary
Chlamydial infection of pelviperitoneum and other genitourinary organs	Secondary
Chlamydial infection, unspecified	Secondary
Chorioretinal inflammation in infectious and parasitic diseases	Secondary
Chronic hepatitis, unspecified	
Chronic renal impairment	Secondary
Chronic viral hepatitis B without delta-agent	
Coeliac disease	
Combined disorders of mitral, aortic and tricuspid valves	Secondary
Complication of labour and delivery, unspecified	
Complication of the puerperium, unspecified	
Congenital absence and hypoplasia of umbilical artery	Secondary
Congestive heart failure	Secondary
Conjunctival haemorrhage	
Conjunctivitis, unspecified	
Constipation	
Contact with and exposure to other communicable diseases	
Cough	
Cracked nipple associated with childbirth, with mention of attachment	
Cracked nipple associated with childbirth, without mention of attachment	
Cramp and spasm	
Cutaneous abscess, furuncle and carbuncle of buttock	Secondary
Cutaneous abscess, furuncle and carbuncle of trunk	Secondary
Cyanosis	Secondary
Decubitus ulcer	Secondary
Deep phlebothrombosis in pregnancy	Secondary
Deep phlebothrombosis in the puerperium	
Delayed and secondary postpartum haemorrhage	
Delayed delivery after spontaneous or unspecified rupture of membranes	Secondary
Depressive episode, unspecified, arising in the postnatal period	

Dermatitis, unspecified	
Diabetes mellitus arising in pregnancy, insulin-requiring	Secondary
Diabetes mellitus arising in pregnancy, non-insulin-requiring	Secondary
Diabetes mellitus in pregnancy, unspecified onset, insulin treated	Secondary
Discoid lupus erythematosus	Secondary
Diseases of the circulatory system complicating pregnancy, childbirth	Secondary
Diseases of the digestive system complicating pregnancy, childbirth an	Secondary
Diseases of the respiratory system complicating pregnancy, childbirth	Secondary
Diseases of the skin and subcutaneous tissue complicating pregnancy, c	Secondary
Disorder of breast, unspecified	
Disorder of pituitary gland, unspecified	Secondary
Disorders of calcium metabolism	Secondary
Disruption of caesarean section wound	
Disruption of operation wound, not elsewhere classified	
Disruption of perineal obstetric wound	
Dizziness and giddiness	
Drug or medicament, unspecified causing adverse effects in therapeutic use	
Drug use	
Drug-induced autoimmune haemolytic anaemia	Secondary
Duration of pregnancy 14-19 completed weeks	Secondary
Duration of pregnancy 20-25 completed weeks	Secondary
Duration of pregnancy 26-33 completed weeks	Secondary
Duration of pregnancy 34-36 completed weeks	Secondary
Dyspnoea	Secondary
Dysuria	
Eclampsia in labour	Secondary
Eclampsia in pregnancy	Secondary
Eclampsia in the puerperium	Secondary
Effusion of joint, ankle and foot	
Elevated blood glucose level	Secondary
Elevated blood-pressure reading, without diagnosis of hypertension	
Embolism and thrombosis of arteries of upper extremities	Secondary
Embryonic cyst of fallopian tube	Secondary
Emotionally unstable personality disorder, borderline type	Secondary
Endocarditis, valve unspecified	Secondary
Endocrine, nutritional and metabolic diseases complicating pregnancy,	Secondary
Epilepsy, unspecified, without mention of intractable epilepsy	Secondary
Epistaxis	Secondary
Escherichia coli [E. coli] as the cause of diseases classified to other	
Essential (haemorrhagic) thrombocythaemia	Secondary
Essential (primary) hypertension	Secondary
Excessive weight gain in pregnancy	
External haemorrhoids with other complications	Secondary
External haemorrhoids without complication	
Faecal incontinence	
Failed application of vacuum extractor and forceps, unspecified	
Failed induction of labour, unspecified	Secondary
Failed instrumental induction of labour	Secondary
Failed medical induction of labour	Secondary
Failed trial of labour, unspecified	Secondary
Fall involving bed	
False labour at or after 37 completed weeks of gestation	
False labour before 37 completed weeks of gestation	Secondary

Family history of deafness and hearing loss	
Fatty (change of) liver, not elsewhere classified	Secondary
Female chlamydial pelvic inflammatory disease (A56.1+)	Secondary
Female pelvic inflammatory disease, unspecified	Secondary
Female pelvic peritoneal adhesions	Secondary
Fever, unspecified	
First degree perineal laceration during delivery	
Flatulence and related conditions	
Fluid overload	
Fourth degree perineal laceration during delivery	
Gastritis, unspecified	Secondary
Gastrointestinal haemorrhage, unspecified	Secondary
Genital varices in pregnancy	Secondary
Gestational [pregnancy-induced] hypertension without significant protein	Secondary
Gestational oedema	
Gestational oedema with proteinuria	Secondary
Gestational proteinuria	Secondary
Glomerular disorders in blood diseases and disorders involving the immunity	Secondary
Glomerular disorders in systemic connective tissue disorders	Secondary
Gonococcal infection, unspecified	Secondary
Gonorrhoea complicating pregnancy, childbirth and the puerperium	Secondary
Grand mal seizures, unspecified (with or without petit mal), without mention of intractable epilepsy	Secondary
Haemangioma, intracranial structures	Secondary
Haemangioma, skin and subcutaneous tissue	Secondary
Haematoma of obstetric wound	
Haemorrhage and haematoma complicating a procedure, not elsewhere classified	
Haemorrhage in early pregnancy, unspecified	
Haemorrhagic disorder due to circulating anticoagulants	Secondary
Haemorrhoids in pregnancy	
Haemorrhoids in the puerperium	
Headache	
Health service area	
Healthy person accompanying sick person	
Heartburn	
Hemiplegia, unspecified	Secondary
Hepatitis A without hepatic coma	Secondary
Hereditary spherocytosis	Secondary
Herpesviral infection of genitalia and urogenital tract	Secondary
Herpesviral infection, unspecified	Secondary
Homelessness	
Hypertensive encephalopathy	Secondary
Hypertonic, incoordinate, and prolonged uterine contractions	
Hypoglycaemia, unspecified	Secondary
Hypokalaemia	Secondary
Hypotension due to drugs	
Hypotension, unspecified	Secondary
Hypothyroidism, unspecified	Secondary
Idiopathic thrombocytopenic purpura	Secondary
In vitro fertilization	
Inadequate housing	
Incomplete uterovaginal prolapse	Secondary
Infection and inflammatory reaction due to other cardiac and vascular	Secondary

Infection of amniotic sac and membranes	
Infection of obstetric surgical wound	
Infection with multidrug resistant Staphylococcus Aureus	Secondary
Infection with other drug-resistant microorganism	
Infections of kidney in pregnancy	Secondary
Infections of the genital tract in pregnancy	
Inflammatory disease of cervix uteri	Secondary
Inflammatory disease of uterus, unspecified	Secondary
Injury of uterus	Secondary
Insulin and oral hypoglycaemic [antidiabetic] drugs causing adverse effects in therapeutic use	Secondary
Insulin-dependent diabetes mellitus with ophthalmic complications	Secondary
Internal haemorrhoids with other complications	Secondary
Internal haemorrhoids without complication	
Intra-abdominal and pelvic swelling, mass and lump	Secondary
Intrapartum haemorrhage, unspecified	
Intravenous anaesthetics	Secondary
Iron deficiency	
Iron deficiency anaemia secondary to blood loss (chronic)	
Iron deficiency anaemia, unspecified	
Keloid scar	
Kidney transplant status	Secondary
Labour and delivery complicated by biochemical evidence of fetal stress	
Labour and delivery complicated by cord around neck, with compression	
Labour and delivery complicated by fetal heart rate anomaly	
Labour and delivery complicated by fetal heart rate anomaly with meconium	
Labour and delivery complicated by fetal stress, unspecified	
Labour and delivery complicated by meconium in amniotic fluid	
Labour and delivery complicated by other cord complications	
Labour and delivery complicated by other cord entanglement	
Labour and delivery complicated by other evidence of fetal stress	
Labour and delivery complicated by prolapse of cord	
Labour and delivery complicated by short cord	
Labour and delivery complicated by vasa praevia	Secondary
Labour and delivery complicated by vascular lesion of cord	Secondary
Late vomiting of pregnancy	Secondary
Left ventricular failure	Secondary
Leiomyoma of uterus, unspecified	Secondary
Lesion of sciatic nerve	Secondary
Liver disorders in pregnancy, childbirth and the puerperium	Secondary
Local anaesthetics causing adverse effects in therapeutic use	
Local antifungal, anti-infective and anti-inflammatory drugs,	
Local infection of skin and subcutaneous tissue, unspecified	
Localized oedema	
Long labour, unspecified	
Loss of consciousness of unspecified duration	Secondary
Low back pain	
Malaise and fatigue	
Malformation of placenta	Secondary
Maternal care due to uterine scar from previous surgery	Secondary
Maternal care for (suspected) central nervous system malformation in f	Secondary
Maternal care for (suspected) chromosomal abnormality in fetus	Secondary
Maternal care for (suspected) fetal abnormality and damage, unspecified	Secondary

Maternal care for abnormality of vagina	Secondary
Maternal care for abnormality of vulva and perineum	Secondary
Maternal care for breech presentation	Secondary
Maternal care for cervical incompetence	Secondary
Maternal care for congenital malformation of uterus	Secondary
Maternal care for disproportion due to generally contracted pelvis	Secondary
Maternal care for excessive fetal growth	Secondary
Maternal care for face, brow and chin presentation	
Maternal care for high head at term	Secondary
Maternal care for intrauterine death	Secondary
Maternal care for multiple gestation with malpresentation of one fetus	Secondary
Maternal care for other (suspected) fetal abnormality and damage	Secondary
Maternal care for other abnormalities of cervix	Secondary
Maternal care for other abnormalities of pelvic organs	Secondary
Maternal care for other isoimmunization	Secondary
Maternal care for other malpresentation of fetus	
Maternal care for other specified fetal problems	Secondary
Maternal care for poor fetal growth	Secondary
Maternal care for rhesus isoimmunization	Secondary
Maternal care for signs of fetal hypoxia	
Maternal care for transverse and oblique lie	Secondary
Maternal care for tumour of corpus uteri	Secondary
Maternal care for unstable lie	Secondary
Maternal distress during labour and delivery	
Maternal hypotension syndrome	Secondary
Mechanical complication of other specified internal prosthetic devices	Secondary
Medical abortion, complete or unspecified, without complication	Secondary
Melanocytic naevi of trunk	
Melanocytic naevi, unspecified	
Mental and behavioural disorders due to multiple drug use and use of p	Secondary
Mental and behavioural disorders due to use of cannabinoids, harmful u	
Mental and behavioural disorders due to use of other stimulants included	
Mental disorders and diseases of the nervous system complicating pregnancy	Secondary
Migraine, unspecified	
Mild mental and behavioural disorders associated with the puerperium,	
Mitral (valve) insufficiency	Secondary
Mitral (valve) prolapse	Secondary
Mitral stenosis	Secondary
Mixed anxiety and depressive disorder	Secondary
Moderate pre-eclampsia	Secondary
Morbidly adherent placenta	
Nausea and vomiting	
Neoplasm of uncertain or unknown behaviour of ovary	Secondary
Nephrotic syndrome, unspecified	Secondary
Neurofibromatosis (nonmalignant)	Secondary
Nonadministration of surgical and medical care	
Noninfective gastroenteritis and colitis, unspecified	Secondary
Non-insulin-dependent diabetes mellitus with ophthalmic complications,	Secondary
Nonpurulent mastitis associated with childbirth, with mention of attachment	
Nonpurulent mastitis associated with childbirth, without mention of at	
Nonspecific lymphadenitis, unspecified	Secondary
Nutritional anaemia, unspecified	

Obesity, unspecified	primary if bmi < 35
Obstetric blood-clot embolism	Secondary
Obstetric damage to pelvic joints and ligaments	Secondary
Obstetric haematoma of pelvis	Secondary
Obstetric high vaginal laceration alone	
Obstetric laceration of cervix	Secondary
Obstructed labour due to abnormality of maternal pelvic organs	Secondary
Obstructed labour due to breech presentation	
Obstructed labour due to brow presentation	
Obstructed labour due to compound presentation	
Obstructed labour due to face presentation	
Obstructed labour due to fetopelvic disproportion, unspecified	
Obstructed labour due to generally contracted pelvis	
Obstructed labour due to incomplete rotation of fetal head	
Obstructed labour due to malposition and malpresentation, unspecified	
Obstructed labour due to other malposition and malpresentation	
Obstructed labour due to shoulder dystocia	
Obstructed labour due to shoulder presentation	
Obstructed labour due to unusually large fetus	
Obstructed labour, unspecified	
Obstruction of bile duct	Secondary
Old myocardial infarction	Secondary
Oligohydramnios	Secondary
Oligomenorrhoea, unspecified	Secondary
Open wound (of any part of abdomen, lower back and pelvis)	
Opioids and related analgesics causing adverse effects in therapeutic use	
Orthostatic hypotension	Secondary
Other and unspecified abdominal pain	
Other and unspecified abnormalities of breathing	Secondary
Other and unspecified convulsions	Secondary
Other and unspecified disorders of breast associated with childbirth,	
Other and unspecified disorders of lactation, with mention of attachment	
Other and unspecified disorders of lactation, without mention of attachment	
Other and unspecified disturbances of skin sensation	
Other and unspecified ovarian cysts	Secondary
Other and unspecified symptoms and signs involving the nervous	Secondary
Other antenatal screening	
Other artificial openings of urinary tract status	Secondary
Other cardiomyopathies	Secondary
Other chest pain	Secondary
Other chronic osteomyelitis, pelvic region and thigh	Secondary
Other complications of cardiac and vascular prosthetic devices	Secondary
Other complications of obstetric surgery and procedures	Secondary
Other complications of procedures, not elsewhere classified	Secondary
Other complications of spinal and epidural anaesthesia during labour a	Secondary
Other complications of the puerperium, not elsewhere classified	
Other diseases of the blood and blood-forming organs	Secondary
Other disorders of nervous system, not elsewhere classified	Secondary
Other examinations for administrative purposes	
Other immediate postpartum haemorrhage	
Other infection during labour	
Other infection of genital tract following delivery	

Other infections with a predominantly sexual mode of transmission comp	Secondary
Other intrapartum haemorrhage	
Other iron deficiency anaemias	
Other maternal infectious and parasitic diseases complicating pregnancy	Secondary
Other medical procedures as the cause of abnormal reaction of the patient	Secondary
Other mental and behavioural disorders associated with the puerperium,	
Other noninflammatory disorders of ovary, fallopian tube and broad ligament	Secondary
Other obesity	
Other obstetric injury to pelvic organs	
Other phobic anxiety disorders	
Other placental disorders	
Other postprocedural disorders of circulatory system, not elsewhere cl	Secondary
Other postprocedural respiratory disorders	Secondary
Other problems related to housing and economic circumstances	
Other problems related to social environment	
Other prophylactic chemotherapy	Secondary
Other pruritus	
Other reaction to spinal and lumbar puncture	Secondary
Other secondary pulmonary hypertension	Secondary
Other shoulder lesions	Secondary
Other specific arthropathies, not elsewhere classified, pelvic region	Secondary
Other specified activity	
Other specified bacterial agents as the cause of diseases classified t	
Other specified cardiac arrhythmias	Secondary
Other specified coagulation defects	Secondary
Other specified complications of labour and delivery	
Other specified conditions associated with female genital organs and m	Secondary
Other specified congenital malformations of heart	Secondary
Other specified diabetes mellitus with hyperosmolarity, with coma	Secondary
Other specified diseases and conditions complicating pregnancy, childbirth	Secondary
Other specified disorders of amniotic fluid and membranes	Secondary
Other specified disorders of bladder	Secondary
Other specified disorders of eye and adnexa	Secondary
Other specified disorders of peritoneum	Secondary
Other specified disorders of teeth and supporting structures	
Other specified general symptoms and signs	
Other specified misadventures during surgical and medical care	
Other specified noninflammatory disorders of cervix uteri	Secondary
Other specified noninflammatory disorders of uterus	Secondary
Other specified noninflammatory disorders of vagina	
Other specified noninflammatory disorders of vulva and perineum	
Other specified obstetric trauma	
Other specified obstructed labour	
Other specified postsurgical states	
Other specified pregnancy-related conditions	Secondary
Other specified soft tissue disorders, ankle and foot	
Other specified soft tissue disorders, hand	
Other specified soft tissue disorders, lower leg	
Other specified soft tissue disorders, upper arm	
Other specified surgical follow-up care	
Other staphylococcus as the cause of diseases classified to other chap	
Other stressful life events affecting family and household	
Other superficial injuries of abdomen, lower back and pelvis, blister	

Other surgical procedures	
Other symptoms and signs involving emotional state	
Other thalassaemias	Secondary
Other uterine inertia	Secondary
Other venous complications in the puerperium	
Other viral diseases complicating pregnancy, childbirth and the puerperium	
Outcome of delivery, unspecified	
Oxytocic drugs causing adverse effects in therapeutic use	
Pain in a joint, pelvic region and thigh	
Pain in limb, lower leg	
Pain localized to other parts of lower abdomen	
Pain localized to upper abdomen	
Pain, unspecified	
Paraesthesia of skin	
Paranoid schizophrenia	Secondary
Parkinson's disease	Secondary
Pelvic and perineal pain	
Pemphigus, unspecified	
Penicillins causing adverse effects in therapeutic use	Secondary
Periapical abscess without sinus	Secondary
Perineal laceration during delivery, unspecified	
Peritoneal adhesions	Secondary
Personal history of allergy to analgesic agent	
Personal history of allergy to other antibiotic agents	
Personal history of allergy to other drugs, medicaments and biological	
Personal history of allergy to penicillin	
Personal history of complications of pregnancy, childbirth and the puerperium	Secondary
Personal history of diseases of the circulatory system	Secondary
Personal history of diseases of the nervous system and sense organs	Secondary
Personal history of drug use disorder	Secondary
Personal history of leukaemia	Secondary
Personal history of malignant neoplasm of genital organs	Secondary
Personal history of noncompliance with medical treatment and regimen	
Personal history of other mental and behavioural disorders	Secondary
Personal history of tobacco use disorder	
Petit mal, unspecified, without grand mal seizures, without mention of intractable epilepsy	Secondary
Phlebitis and thrombophlebitis of other sites	Secondary
Placenta praevia specified as without haemorrhage	Secondary
Placenta praevia with haemorrhage	Secondary
Placental transfusion syndromes	Secondary
Pleural effusion, not elsewhere classified	Secondary
Pneumonia due to Streptococcus pneumoniae	Secondary
Pneumonia, unspecified	Secondary
Polycystic ovarian syndrome	Secondary
Polyhydramnios	Secondary
Polyp of vulva	Secondary
Polyuria	
Postoperative intestinal obstruction	
Postpartum acute renal failure	
Postpartum care after hospital delivery	
Postpartum care after planned, out of hospital delivery	
Postpartum care after unplanned, out of hospital delivery	

Postpartum care and examination after delivery, unspecified	
Postpartum coagulation defects	
Postprocedural pelvic peritoneal adhesions	
Precipitate labour	
Pre-eclampsia, unspecified	Secondary
Pre-existing diabetes mellitus, insulin-dependent	Secondary
Pre-existing diabetes mellitus, Type 2, in pregnancy, insulin treated	Secondary
Pre-existing diabetes mellitus, Type 2, in pregnancy, non-insulin treated	Secondary
Pre-existing diabetes mellitus, unspecified, in pregnancy, non-insulin treated	Secondary
Pre-existing essential hypertension complicating pregnancy, childbirth	Secondary
Pre-existing hypertensive disorder with superimposed proteinuria	Secondary
Pre-existing hypertensive renal disease complicating pregnancy, childbirth	Secondary
Pregnancy care of habitual	Secondary
Premature rupture of membranes, onset of labour between 1-7 days later	Secondary
Premature rupture of membranes, onset of labour more than 7 days later	Secondary
Premature rupture of membranes, onset of labour within 24 hours	
Premature rupture of membranes, unspecified	
Premature separation of placenta, unspecified	
Preparatory care for dialysis	Secondary
Presence of aortocoronary bypass graft	Secondary
Presence of coronary angioplasty implant and graft	Secondary
Presence of other heart-valve replacement	Secondary
Presence of other orthopaedic joint implant	Secondary
Presence of other specified functional implants	Secondary
Presence of prosthetic heart valve	Secondary
Preterm delivery	Secondary
Primary biliary cirrhosis	Secondary
Primary inadequate contractions	
Primary ovarian failure	
Problems in relationship with spouse or partner	
Problems related to multiparity	
Problems related to other legal circumstances	
Prolonged first stage (of labour)	
Prolonged pregnancy	
Prolonged second stage (of labour)	
Prophylactic immunotherapy	Secondary
Proteus (mirabilis)(morganii) as the cause of diseases classified to o	Secondary
Pruritus, unspecified	
Pseudomonas (aeruginosa)(mallei)(pseudomallei) as the cause of disease	Secondary
Puerperal sepsis	
Pulmonary collapse	Secondary
Pulmonary oedema	Secondary
Pure hypercholesterolaemia	Secondary
Pyrexia during labour, not elsewhere classified	
Pyrexia of unknown origin following delivery	
Rash and other nonspecific skin eruption	
Rectal prolapse	Secondary
Renal disease, pregnancy-related	Secondary
Renal tubulo-interstitial disorders in systemic connective tissue disorder	Secondary
Retained placenta without haemorrhage	
Retained portions of placenta and membranes, without haemorrhage	
Retention of urine	
Retracted nipple associated with childbirth, with mention of attachment	

Retracted nipple associated with childbirth, without mention of attach	
Rheumatic fever without mention of heart involvement	Secondary
Rheumatic heart disease, unspecified	Secondary
Rheumatic mitral insufficiency	Secondary
Routine postpartum follow-up	
Rupture of uterus during labour	
Schizoaffective disorder, unspecified	Secondary
Schizophrenia, unspecified	Secondary
Sciatica	Secondary
Second degree perineal laceration during delivery	
Secondary uterine inertia	
Sensorineural hearing loss, unspecified	Secondary
Septicaemia due to streptococcus, group B	
Sequelae of cerebral infarction	Secondary
Sequelae of other nontraumatic intracranial haemorrhage	Secondary
Severe depressive episode without psychotic symptoms, not specified as arising in the postnatal period	Postpartum
Severe pre-eclampsia	Secondary
Sexually transmitted chlamydial infection of other sites	Secondary
Shock during or following labour and delivery	
Short stature, not elsewhere classified	Secondary
Sicca syndrome [Sjogren]	
Single delivery by caesarean section	
Single live birth	
Single spontaneous delivery	
Single stillbirth	
Spinal and epidural anaesthesia-induced headache during labour and del	
Spinal and epidural anaesthesia-induced headache during pregnancy	
Spinal and epidural anaesthesia-induced headache during the puerperium	
Staphylococcus aureus as the cause of diseases classified to other cha	
Sterilization	
Streptococcus, group A, as the cause of diseases classified to other c	
Streptococcus, group B, as the cause of diseases classified to other c	
Streptococcus, Group C	
Streptococcus, group D, as the cause of diseases classified to other c	
Streptococcus, Group G	
Streptococcus, other specified group	
Stress incontinence	
Striking against or struck by other objects	
Subserosal leiomyoma of uterus	Secondary
Superficial mycosis, unspecified	Secondary
Superficial thrombophlebitis in pregnancy	Secondary
Superficial thrombophlebitis in the puerperium	
Supervision of elderly primigravida	
Supervision of high-risk pregnancy due to social problems	Secondary
Supervision of other high-risk pregnancies	Secondary
Supervision of other normal pregnancy	
Supervision of pregnancy with grand multiparity	
Supervision of pregnancy with history of abortive outcome	Secondary
Supervision of pregnancy with history of insufficient antenatal care	
Supervision of pregnancy with other poor reproductive or obstetric his	Secondary
Supervision of very young primigravida	
Supraventricular tachycardia	Secondary

Syncope and collapse	Secondary
Systemic lupus erythematosus with organ or system involvement	Secondary
Tachycardia, unspecified	Secondary
Tetraplegia, unspecified, lumbar, incomplete	Secondary
Thalassaemia trait	Secondary
Thalassaemia, unspecified	Secondary
Third degree perineal laceration during delivery	
Third-stage haemorrhage	
Thrombocytopenia, unspecified	Secondary
Thyrotoxicosis with diffuse goitre	Secondary
Thyrotoxicosis, unspecified	Secondary
Tinnitus	
Tobacco use, current	
Toxoplasma oculopathy	Secondary
Tubulo-interstitial nephritis, not specified as acute or chronic	Secondary
Twin pregnancy	Secondary
Twins, both liveborn	Secondary
Twins, both stillborn	Secondary
Twins, one liveborn and one stillborn	Secondary
Type 1 diabetes mellitus with hypoglycaemia	Secondary
Type 2 diabetes mellitus with features of insulin resistance	Secondary
Type 2 diabetes mellitus with hypoglycaemia	Secondary
Type 2 diabetes mellitus with poor control	Secondary
Type 2 diabetes mellitus without complication	Secondary
Ulceration of vulva in infectious and parasitic diseases classified el	Secondary
Unintentional cut, puncture, perforation or haemorrhage during other surgical and medical care	
Unintentional cut, puncture, perforation or haemorrhage during surgical operation	
Unspecified activity	
Unspecified acute lower respiratory infection	Secondary
Unspecified dorsalgia, site unspecified	Secondary
Unspecified duration of pregnancy	
Unspecified haematuria	Secondary
Unspecified haemorrhoids without complication	
Unspecified infection of urinary tract in pregnancy	
Unspecified lump in breast	
Unspecified maternal hypertension	Secondary
Unspecified mood [affective] disorder	Secondary
Unspecified nephritic syndrome, other	Secondary
Unspecified nonorganic psychosis	Secondary
Unspecified osteomyelitis, pelvic region and thigh	Secondary
Unspecified pre-existing hypertension complicating pregnancy, childbirth	Secondary
Unspecified renal failure	Secondary
Unspecified urinary incontinence	Secondary
Urinary tract infection following delivery	
Urinary tract infection, site not specified	
Urogenital trichomoniasis	Secondary
Vaginal delivery following previous caesarean section	Secondary
Vaginitis, vulvitis and vulvovaginitis in infectious and parasitic dis	Secondary
Varicose veins of lower extremities without ulcer or inflammation	
Varicose veins of lower extremity in pregnancy	Secondary
Venous complication in pregnancy, unspecified	Secondary
Ventral hernia without obstruction or gangrene	Secondary

Ventricular septal defect	Secondary
Ventricular tachycardia	Secondary
Viral hepatitis complicating pregnancy, childbirth and the puerperium	
Viral warts	Secondary
Volume depletion	
Von Willebrand's disease	Secondary
Vulval varices	Secondary
Vulvar cyst	Secondary
Wheezing	Secondary
Wound infection following a procedure	

Appendix G

Registering and Birthing at a CMDHB Primary Birthing Unit

Guideline: Registering and Birthing at a CMDHB Primary Birthing Unit

Purpose

This guideline aims to:

- Identify women who are low risk and suitable for birth at a CMDHB Primary Birthing Unit or at home.
- Ensure the best possible outcomes for low risk women during labour and birth using risk assessment tools such as antenatal history and antenatal assessment of maternal and fetal wellbeing
- Encourage the majority use of Middlemore Hospital facilities as secondary care

Responsibility

This guideline applies to lead maternity carers (LMC) who may be a midwife, general practitioner (GP) or obstetrician and all CMDHB midwives and obstetricians.

Associated Documents

Other documents relevant to this guideline are listed below:

NZ Legislation	Maternity Services Notice of the NZ Health and Disability Act; Section 88 July, MOH 2007, Guidelines for Consultation with Obstetric and related Medical Services (Referral Guidelines) MOH 2011
CMDHB Clinical Board Policies	None
NZ Standards	None
Organisational Procedures or Policies	Guideline: Slow Progress in the First Stage of Labour Guideline: Slow Progress in the Second Stage of Labour Guideline: Pre-labour Rupture of Membranes at term
Other related documents	None

Guideline

This guideline is based on the philosophy that every woman's pregnancy is normal or low risk until a risk is identified.

The Woman and her unborn baby are screened during pregnancy through the antenatal booking history and antenatal assessment process to identify risks to maternal and fetal wellbeing.

Should this screening identify a deviation from anticipated normal progress or a risk during the pregnancy, birth or postnatal period, referral and a change in plan of care may be warranted.

The need for referral is guided by the Maternity Services Notice of the NZ Health and Disability Act; Section 88 July, MOH 2007 and Guidelines for Consultation with Obstetric and related Medical Services (Referral Guidelines) MOH 2011

Wherever possible the woman's choice will be respected and all referrals or transfers of clinical responsibility must be as a result of communication which includes the woman.

Step	Action
1	All women in low risk pregnancy will have the choice of birth locations explained to them, including homebirth. Women residing in Mangere, Otahuhu or Papatoetoe areas; Middlemore is their Primary Birthing Unit but they should be made aware of the option of birthing in a Primary Birthing Unit and the differences between the two
2	Women **without** co-morbidities or complications should be encouraged to birth at one of the Primary Birthing Units; Botany Downs, Papakura or Pukekohe.
3	Registration at a Primary Birthing Unit should be submitted after 15 weeks gestation using CMDHB forms OBST09 and OBST10
4	Primary Birthing Unit can be utilised for • LMC acute clinical consultations/examinations • Labour and birth • Emergency care as necessary until transfer to secondary services • Midwifery care for **urgent** antenatal assessment/care for woman with no LMC, unable to contact LMC/back up or is awaiting LMC/back up • Midwifery care in labour by CMDHB midwifery services **according to the woman's needs** until the LMC/back up arrives • Postnatal midwifery care
5	If a specialist consultation is warranted during pregnancy there should be a three way discussion between the woman, LMC and specialist regarding the suitability of the planned place of birth.
6	If a risk is identified but the woman still wishes to birth at a Primary Birthing Unit there should be discussion with the Charge Midwife Manager and/or Obstetric Consultant regarding individual suitability
7	Where risks are identified and planned place of birth changes, the booking status will be changed by CMDHB'S Maternity Administration Team.
8	In the situation where an identified risk is subsequently determined not to be of concern, the woman may request to change her booking to birth to a Primary Birthing Unit with the agreement of the Obstetric Consultant.

Parameters such as age and BMI; it is difficult to define absolute parameters and so individual decisions may need to be made (see point 6 & 8 above).

Registering and Birthing at a CMDHB Primary Birthing Units

Guide for birthing in a Primary Birthing Unit:

Criteria	Suitable	Not Suitable/requires discussion re place of birth
Maternal Age	Primiparous women under the age of 40 Women under the age of 17 are assessed individually for fetal and maternal wellbeing.	Primiparous women > 40 years
Parity	Primiparous Multiparous where previous births have been uncomplicated	History of complications at birth
Gestation	36.5 weeks to 42 weeks in **spontaneous** labour	Premature <36.5 weeks Prolonged pregnancy > 42 weeks
BMI	BMI <17 where maternal weight gain is good and fetal growth is proven BMI >35 if well grown fetus and IV access possible.	BMI < 17 – assessed individually for fetal and maternal wellbeing. Is there an identified factor in the low BMI? BMI > 35 – assessed individually. Can fetal growth by ascertained? Adiposity distribution may be relevant.
Hb	Over 100g/l @ 36/40	Anaemia < 100g/l @ 36/40
Infection	Known Group B Strep*	
Unbooked	Where no risk factors are identified following full assessment	Where risk factors are identified or full assessment is not possible
Mental health	Well controlled	Unstable/crisis
Previous obstetric history	Current pregnancy low risk	Recurrence of risk
Intrapartum - fetal	No fetal distress +/- Light meconium stained liquor only	Evidence of fetal distress +/- moderate to heavy meconium stained liquor
Neonatal	No risk factors known	Requires close supervision or elevated risk of resuscitation due to maternal or neonatal factors
Known risk factors	Cephalic presentation, singleton and well grown fetus	Women who have known indications for referral (consultation, transfer or emergency) and present in labour at a Primary Maternity Facility e.g. ROM ≥ 24 hours and not in established labour, raised BP
First stage of labour	Meets anticipated progress	Does not meet anticipated progress**
Second stage of labour	Meets anticipated progress	Does not meet anticipated progress**

*CMDHB Guideline; Group B Streptococcus – Prevention of early onset neonatal infection (2010)

**CMDHB Guideline; Slow progress in the first stage of labour & Guideline; slow progress in the second stage of labour (2010)

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Counties Manukau District Health Board			

This is not an exhaustive list.

*It is important that providers of intrapartum care in Primary Birthing Unit settings are aware of **changing circumstances and risk**. Transfer to the tertiary facility of Middlemore Hospital may be warranted.*

Definitions

Terms and abbreviations used in this document are described below:

Term/Abbreviation	Description
CMDHB	Counties Manukau District Health Board
GP	General Practitioner
LMC	Lead Maternity Carer
SMO	Senior Medical Officer - Consultant

Appendix H

Maternity Registration Forms

COUNTIES MANUKAU DISTRICT HEALTH BOARD
A Community Partnership

Affix patient's identification label here or NHI number

NHI No.

MATERNITY REGISTRATION FORM – Section 1 – Patient Information

Office Use Only:	**Old Records Requested:** ☐
Date received:	**1st Appointment:**
Place of Antenatal Care:	**PiMS Referral logged** ☐ **Healthware Booked** ☐
Comment:	

Lead Maternity Carer's Name:

Self-employed LMC	**CMDHB Options of Care**	
Midwife ☐	Closed Unit ☐	Community Midwife Name:
Obstetrician ☐	Caseloading Midwife ☐	Name:
GP ☐	Shared Care ☐	GP only (ineligible for care) ☐

Intended Place of Delivery

Family Details:	Family Doctor's Name:
Title:	Family Doctor's Address:
Last Name:	
Given Names:	**First Contact Details:**
Previous Last Name:	Name:
Any other names:	Relationship:
Date of Birth:	Address:
Address:	
	Home Phone No:
	Work Phone No:
Home Phone No:	Mobile Phone No:
Work Phone No:	**Second Contact Details:**
Mobile Phone No:	Name:
Marital Status:	Relationship:
Country of Birth:	Address:
Spoken Language:	
Interpreter required YES ☐ NO ☐	Home Phone No:
Resident ☐ Non-Resident ☐	Work Phone No:
Date of entry to NZ	Mobile Phone No:

Father of Baby:	**Mother's Ethnicity:** What ethnic group does the baby's mother belong to?		**Baby's Ethnicity:** What ethnic group will the baby belong to?	
Last Name:	New Zealand European	☐	New Zealand European	☐
First Name:	Maori	☐	Maori	☐
Given Names:	Samoan	☐	Samoan	☐
Address:	Cook Island Maori	☐	Cook Island Maori	☐
	Tongan	☐	Tongan	☐
	Niuean	☐	Niuean	☐
Country of Birth	Chinese	☐	Chinese	☐
Resident ☐ Non-Resident ☐	Indian	☐	Indian	☐
Date of entry to NZ	Fijian	☐	Fijian	☐
Additional Comments:	Other	☐	Other	☐
	Patient does not know	☐	Patient does not know	☐
	Patient refused to answer	☐	Patient refused to answer	☐
	Question not asked	☐	Question not asked	☐
	Response unidentifiable	☐	Response unidentifiable	☐

Completed by:

Name:	Designation:
Signature:	Date:

Re-Order No. OBST9 Revised October 2009

MATERNITY REGISTRATION FORM – Section 1 – Patient Information

COUNTIES MANUKAU DISTRICT HEALTH BOARD
A Community Partnership

Affix patient's identification label here or NHI number

MATERNITY REGISTRATION FORM – Section 2 – Clinical Information

Family Details:	
Last Name:	Given Names:
Address:	Date of Birth:

Menstrual Cycle:	LMP:	Gravida:	Height:
Regular: ☐	EDD by date:	Parity:	Weight:
Irregular: ☐	EDD by scan:	Blood Group:	Amnio Required: **Yes / No**

Previous Pregnancies:

Date	Place of Delivery	Duration (wks)	Complications Antenatal, postnatal, Intrapartum	Delivery Type	Length of Labour	Induced Yes/No	Sex & name of baby	Weight	No months BF	Alive NND SB
/ /										
/ /										
/ /										
/ /										
/ /										
/ /										
/ /										
/ /										
/ /										
/ /										

Woman's Medical History:

Medical History				Significant Gynae History	Family History	Sexual Health/HIV
Rheumatic Fever	☐			Ectopic pregnancy ☐	Adopted ☐	HIV screening offered Yes ☐ No ☐
Cardiac Disease	☐			Molar Pregnancy ☐	Hypertension ☐	HIV screeening completed Yes ☐ No ☐
Hypertension	☐			Laparotomy ☐	Multi-pregnancy ☐	STI _____
Epilepsy	☐	Asthma	☐	Myomectomy ☐	Deafness ☐	_____
Diabetes	☐	Coagulation	☐	Tubal ligation ☐	Diabetes ☐	Treatment _____
Thyroid	☐	UTI/Renal	☐		TB ☐	_____
Hepatitis B	☐	Mental Health	☐	**Smear History:**	Asthma ☐	Date _____
Hepatitis C	☐	Autoimmune	☐	Date of last smear:	Other – state:	**Contraceptive History:**
Other/Surgery – state:				Previous abnormal smears ☐		
				Date:		
				Treatment:		
				Cone biopsy:		

Alcohol	Smoking Status	Other Substances	Drug/Med Allergies	Blood Transfusion	Current Medication
Yes ☐	Never smoked ☐	Yes ☐	Yes ☐	Yes ☐	Yes ☐
Amount	Current smoker ☐	No ☐	No ☐	State when:	State:
No ☐	Past smoker ☐	IV User ☐	Not known ☐		
	Less than 12 months ago ☐	Not known ☐	State:	No ☐	No ☐
	More than 12 months ago ☐	State:			Not known ☐
	Smokefree environment Yes ☐ No ☐				

Completed by:

Name:	Designation:
Signature:	Date:

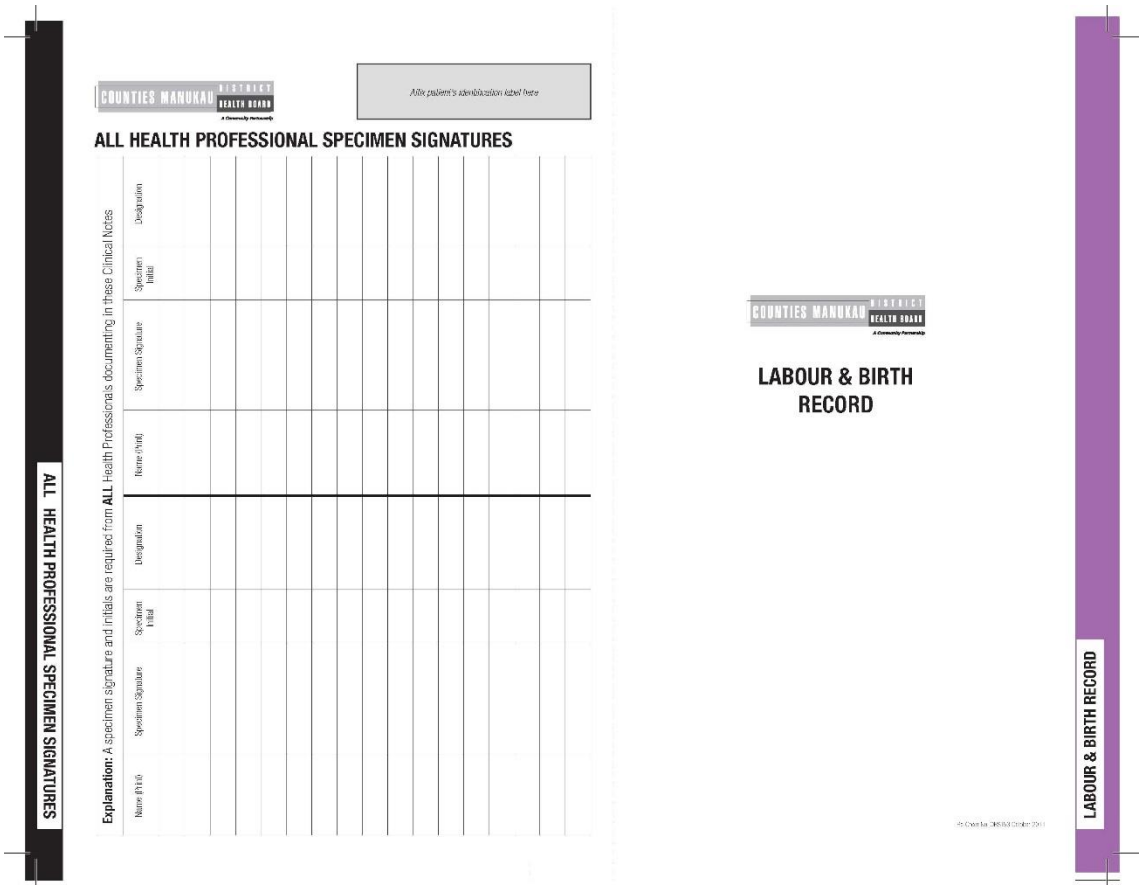
I certify that the Information Sections 1 and 2 are true and correct. I understand that I can change my Maternity Carer at any time.

Birth Mother or Caregiver Signature: _____ Date: _____

Re-Order No. OBST10 Revised October 2009

Appendix I

Labour and Birth Summary



ALL HEALTH PROFESSIONAL SPECIMEN SIGNATURES

COUNTIES MANUKAU DISTRICT HEALTH BOARD

Affix patient's identification label here

ALL HEALTH PROFESSIONAL SPECIMEN SIGNATURES

Explanation: A specimen signature and initials are required from **ALL** Health Professionals documenting in these Clinical Notes

Name (Print)	Specimen Signature	Specimen Initial	Designation	Name (Print)	Specimen Signature	Specimen Initial	Designation

COUNTIES MANUKAU DISTRICT HEALTH BOARD

LABOUR & BIRTH RECORD

LABOUR & BIRTH RECORD

COUNTIES MANUKAU DISTRICT HEALTH BOARD

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LABOUR RECORD – PARTOGRAM

Date	EDD	G	P

High Risk Factors

Membrane Ruptured: Date and time: Colour:

Heart rate maternal: x

Fetal: •

Blood Pressure:

Time

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60

Temperature

Liquor / Show

10 9 8 7 6 5 4 3 2 1 0

Cervix: x

Descent: o 0 1 2 3 4

Syntocinon Infusion

Contractions:
Strong
Moderate
Mild

Drugs, comments

Admission **Initials**
Urinalysis: **Output**

LABOUR RECORD – PARTOGRAM

COUNTIES MANUKAU DISTRICT HEALTH BOARD

Affix patient's identification label here

ABNORMAL LABOUR & BIRTH SUMMARY

COMPLICATIONS DURING LABOUR *(Please circle)*

Uterine Rupture Pyrexia - Temp >38°C Hypertension
Hypotension Intrapartum Haemorrhage
Fetal Distress Cord prolapse Cord presentation
Shoulder Dystocia Malpresentation Maternal Resuscitation
Other

Indication for Operative Delivery

Maternal Medical Condition Maternal Request
Multiple pregnancy Obstetric History Hypertension
Small for gestational age Chorioamnionitis
Cord Prolapse/presentation Fetal distress Failure to progress
Other

Lower segment CS

LSCS in labour/elective LSCS not in labour/elective
LSCS in labour/emergency LSCS not in labour/emergency

Classical CS

Classical CS in labour Classical CS not in labour

Forceps

Wrigley Neville Barnes Kielland's
Non-rotational Rotational
Initial position Station:
Final position Number of pulls
Failed forceps

Ventouse

Non-rotational Rotational
Initial position Station:
Final position Station:
Failed to Ventouse Number of pulls
Duration of Suction:

Operative Delivery comments:

BREECH

Legs: Both extended Flexed Footling
Other
Spontaneous Assisted Extraction
Forceps to head Internal version
Comments

POSTPARTUM HAEMORRHAGE

Source: Uterine site Cervix Vagina
Treatment:
Drug Dose: Time:
Drug Dose: Time:
Drug Dose: Time:
Drug Dose: Time:
Infusion: Blood Plasma Colloid
Comments

SHOULDER DYSTOCIA

Tick Order Time Performed by (name)
McRoberts manoeuvre
Suprapubic pressure and rotating traction
Axillary traction
Episiotomy
Wood screw/reverse wood screw manoeuvre
Delivery of posterior arm
Positional change - All fours Left lateral (circle one)

Time of delivery of head
Time of delivery of body

At delivery: Head facing mother's Left or Right (circle one)

Axillary traction applied to: Left shoulder Right shoulder

Comments

ABNORMAL PLACENTA *(please draw)*

Abnormal summary verified by:
Name Signature

ABNORMAL LABOUR & BIRTH SUMMARY

COUNTIES MANUKAU DISTRICT HEALTH BOARD

Affix patient's identification label here

LABOUR & BIRTH SUMMARY

(Please circle relevant options or write legibly in comments)

LABOUR & BIRTH - THIRD STAGE

Person responsible for 3rd stage
Assisted by

Placenta delivery date/time / / : :

PPH prophylaxis

None Syntometrine Syntocinon IV Syntocinon IM
Other
Dose Date/time: / / : :

Placenta delivery method

Spontaneous CCT Manual

Blood loss at birth ml

Plus additional blood loss *(including during theatre procedure)*

ml + ml + ml

Total blood loss = **ml**s

Placenta state

Normal Abruption Infarction Vela insert
Succ lobe Vasa Praevia Other abnormal
(please use Abnormal Labour & Birth Summary)

Placenta/Membranes complete

Complete Ragged Doubtful
Other
(please use Abnormal Labour & Birth Summary)

3rd stage problems

Nil Retained placenta PPOC
Perineal laceration Vaginal laceration Labial laceration
1° 2° 3° 4°
Other

3rd stage procedures

Nil Perineal laceration suture Vaginal laceration suture
Labial laceration suture
Other

Drugs during 3rd stage

Nil Paracetamol Diclofenac
Other

PPH treatment ***(please use Abnormal Labour & Birth Summary)***

Syntometrine Syntocinon IV Syntocinon IM bolus or Infusion
Prostaglandin Carboprost Other eclogic

PPH blood

Fluid Blood products PPH blood units

Placenta to be kept by mother Yes No
Other

SUTURING CHECKLIST

Examination completed PV Yes No PR Yes No
Equipment counted and correct
Instruments Yes No Needles Yes No
Swabs Yes No

Postnatal Observations

Mother - Highest temperature Time: :
Highest Blood Pressure / Time: :
Time passed urine post birth :

Post birth instructions or Comments

Baby and Third stage details verified by:
Name Signature

TRANSFER/DISCHARGE *(please circle one)*

From: AMAU Maternity Ward Botany Pukekohe Papakura
Other

To: AMAU Maternity Ward Botany Pukekohe Papakura
Home Other DHB Other

Feeding classification on Transfer/Discharge

Exclusive Fully Partial Artificial
Immediate transfer to NNU IUD/SIUBirth

Baby - Temperature prior to transfer/discharge

Mother's Blood group

Anti D required: **Yes** **No** **Awaiting results**

Discharge to address if not home:

Baby discharged with mother to same location: Yes No
If No, discharge address of baby:

If discharged to home care of:
LMC DHB Community Midwife DHB Team Midwife

Transferred/Discharged by:

LABOUR & BIRTH SUMMARY

COUNTIES MANUKAU DISTRICT HEALTH BOARD

Affix patient's identification label here

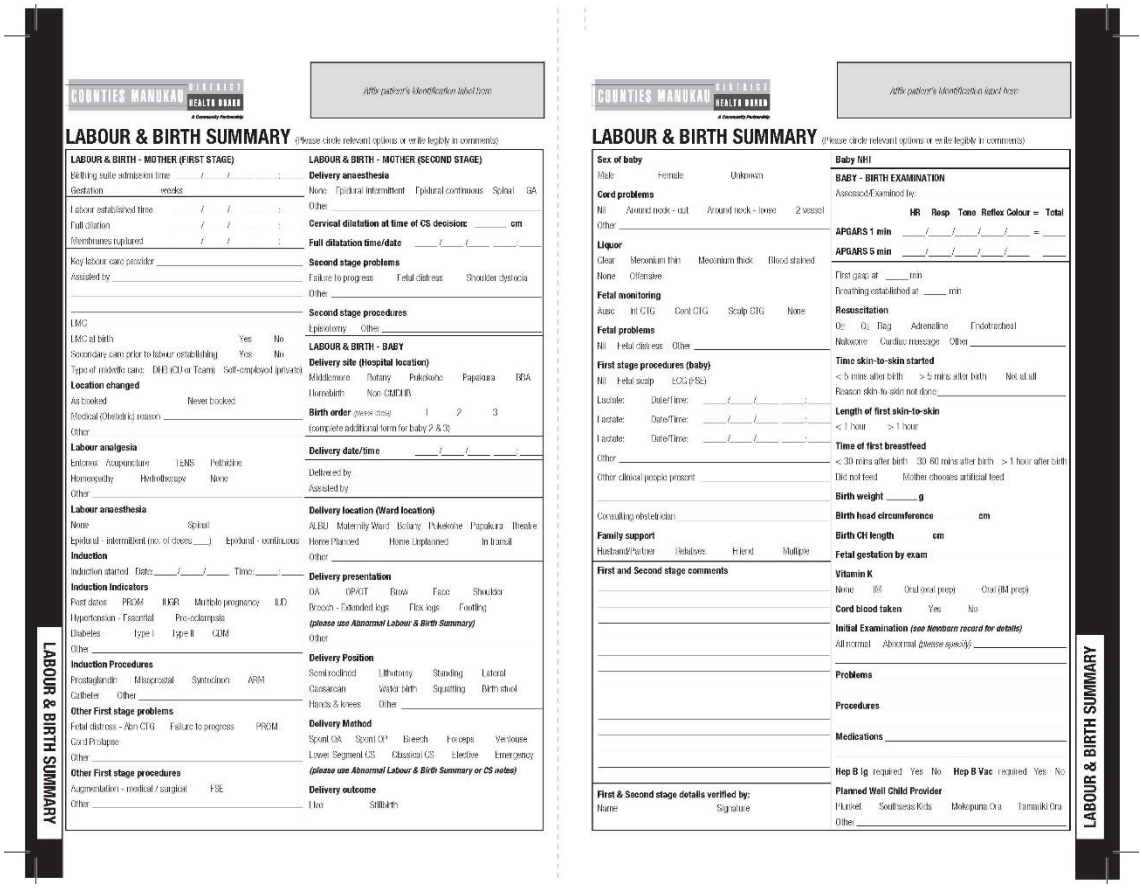
LABOUR – VE ASSESSMENTS AND CONSENTS

Date:	Time:	Date:	Time:
Cx/dil Canal length Consistency		Cx/dil Canal length Consistency	
Station		Station	
Caput Moulding		Caput Moulding	
Position		Position	
Fetal heart rate		Fetal heart rate	
Liquor		Liquor	
Comments		**Comments**	
Signature		Signature	

Date:	Time:	Date:	Time:
Cx/dil Canal length Consistency		Cx/dil Canal length Consistency	
Station		Station	
Caput Moulding		Caput Moulding	
Position		Position	
Fetal heart rate		Fetal heart rate	
Liquor		Liquor	
Comments		**Comments**	
Signature		Signature	

Verbal consents after discussion
Pain Relief Options
3rd Stage Tocolic IM / IM Declined Vit K for Baby IM Oral Declined
Cutting of the Cord
Skin to Skin Yes | No | Placenta Disposal Mother | Hospital |
Postnatal Care Mother and Baby Maternity Ward | Botany Maternity | Papakura Maternity |
Pukekohe Maternity | Home | Other
Comments

LABOUR – VE ASSESSMENTS AND CONSENTS



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LABOUR & BIRTH SUMMARY (Please circle relevant options or write legibly in comments)

LABOUR & BIRTH - MOTHER (FIRST STAGE)

Birthing suite admission time ___/___/___ : ___
Gestation ___ weeks

Labour established time ___/___/___ : ___
Full dilation ___/___/___ : ___
Membranes ruptured ___/___/___ : ___

Key labour care provider _____
Assisted by _____

LMC
LMC at birth Yes No
Secondary care prior to labour establishing Yes No
Type of midwife care: DHB (CU or Team) Self-employed (private)

Location changed
As booked Never booked
Medical (Obstetric) reason _____
Other _____

Labour analgesia
Entonox Acupuncture TENS Pethidine
Homeopathy Hydrotherapy None
Other _____

Labour anaesthesia
None Spinal
Epidural - intermittent (no. of doses ___) Epidural - continuous

Induction
Induction started Date: ___/___/___ Time: ___ : ___

Induction Indicators
Post dates PROM IUGR Multiple pregnancy IUD
Hypertension - Essential Pre-eclampsia
Diabetes Type I Type II GDM
Other _____

Induction Procedures
Prostaglandin Misoprostol Syntocinon ARM
Catheter Other _____

Other First stage problems
Fetal distress - Abn CTG Failure to progress PROM
Cord Prolapse
Other _____

Other First stage procedures
Augmentation - medical / surgical FSE
Other _____

LABOUR & BIRTH - MOTHER (SECOND STAGE)

Delivery anaesthesia
None Epidural intermittent Epidural continuous Spinal GA
Other _____

Cervical dilatation at time of CS decision: _____ cm

Full dilatation time/date ___/___/___ ___ : ___

Second stage problems
Failure to progress Fetal distress Shoulder dystocia
Other _____

Second stage procedures
Episiotomy Other _____

LABOUR & BIRTH - BABY

Delivery site (Hospital location)
Middlemore Botany Pukekohe Papakura BRA
Homebirth Non CMDHB

Birth order (please circle) 1 2 3
(complete additional form for baby 2 & 3)

Delivery date/time ___/___/___ ___ : ___

Delivered by
Assisted by

Delivery location (Ward location)
ALBU Maternity Ward Botany Pukekohe Papakura Theatre
Home Planned Home Unplanned In transit
Other _____

Delivery presentation
OA OP/OT Brow Face Shoulder
Breech - Extended legs Flex legs Footling
(please use Abnormal Labour & Birth Summary)
Other

Delivery Position
Semi-recl ined Lithotomy Standing Lateral
Caesarean Water birth Squatting Birth stool
Hands & knees Other _____

Delivery Method
Spont OA Spont OP Breech Forceps Ventouse
Lower Segment CS Classical CS Elective Emergency
(please use Abnormal Labour & Birth Summary or CS notes)

Delivery outcome
Live Stillbirth

LABOUR & BIRTH SUMMARY

COUNTIES MANUKAU DISTRICT HEALTH BOARD
A Community Partnership

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LABOUR & BIRTH SUMMARY (Please circle relevant options or write legibly in comments)

Sex of baby
Male Female Unknown

Cord problems
Nil Around neck - out Around neck - loose 2 vessel
Other _____

Liquor
Clear Meconium thin Meconium thick Blood stained
None Offensive

Fetal monitoring
Ausc Int CTG Cont CTG Scalp CTG None

Fetal problems
Nil Fetal distress Other _____

First stage procedures (baby)
Nil Fetal scalp ECG (FSE)

Lactate: Date/Time: ___/___/___ ___ : ___
Lactate: Date/Time: ___/___/___ ___ : ___
Lactate: Date/Time: ___/___/___ ___ : ___
Other _____

Other clinical people present _____

Consulting obstetrician _____

Family support
Husband/Partner Relatives Friend Multiple

First and Second stage comments

First & Second stage details verified by:
Name Signature

Baby NHI

BABY - BIRTH EXAMINATION
Assessed/Examined by:

	HR	Resp	Tone	Reflex	Colour	=	Total
APGARS 1 min	___/	___/	___/	___/	___/	=	___
APGARS 5 min	___/	___/	___/	___/	___/		___

First gasp at ___ min
Breathing established at ___ min

Resuscitation
O2 O2 Bag Adrenaline Endotracheal
Naloxone Cardiac massage Other _____

Time skin-to-skin started
< 5 mins after birth > 5 mins after birth Not at all
Reason skin-to-skin not done _____

Length of first skin-to-skin
< 1 hour > 1 hour

Time of first breastfeed
< 30 mins after birth 30-60 mins after birth > 1 hour after birth
Did not feed Mother chooses artificial feed

Birth weight _____ **g**
Birth head circumference _____ **cm**
Birth CH length _____ **cm**
Fetal gestation by exam

Vitamin K
None IM Oral (oral prep) Oral (IM prep)

Cord blood taken Yes No

Initial Examination ***(see Newborn record for details)***
All normal Abnormal *(please specify)* _____

Problems

Procedures

Medications _____

Hep B Ig required Yes No **Hep B Vac** required Yes No

Planned Well Child Provider
Plunket Southseas Kids Mokopuna Ora Tamariki Ora
Other _____

LABOUR & BIRTH SUMMARY

Appendix J

Results of cross tabulations of treatments and interventions by Place Presenting in Labour and Model of Care.

Table J1

Cross-tabulation of Type of Fetal Monitoring vs. Place Presenting in Labour

	Place Presenting in Labour		
	Tertiary	Primary	Total
Auscultation	526	834	1360
Auscultation / continuous CTG	67	11	78
Auscultation / scalp CTG	9	0	9
Continuous CTG	813	28	841
Continuous GTG with FSE	320	23	343
Admission CTG/Intermittent CTG	1110	160	1270
None	204	50	254
Not stated	44	8	52
Total	3093	1114	4207

Note: Pearson's Chi-Square (7) = 1292.952, $p < .001$

Table J2

Cross-tabulation of Type of Fetal Monitoring vs. Model of Care

	Model of Care		
	Fragmented	Continuity	Total
Auscultation	516	842	1358
Auscultation / continuous CTG	36	42	78
Auscultation / scalp CTG	3	6	9
Continuous CTG	317	523	840
Continuous GTG with FSE	128	215	343
Admission CTG/Intermittent CTG	448	818	1266
None	100	152	252
Not stated	21	31	52
Total	1569	2629	4198

Note: Pearson's Chi-Square (10) = 5.815, p =5.61

Table J3

Cross-tabulation of Labour and Birth Anaesthesia vs. Place Presenting in Labour

	Place Presenting in Labour		
	Tertiary	Primary	Total
No anaesthesia	2347	1053	3400
Epidural	466	29	495
Spinal	71	4	75
Pudendal	17	1	18
General anaesthetic	20	0	20
Local anaesthetic	141	24	165
Spinal / general anaesthetic	5	1	6
Epidural / general anaesthetic	4	1	5
Unstated	17	0	17
Epidural / spinal	4	1	5
Epidural / spinal / general anaesthetic	1	0	1
Total	3093	1114	4207

Note: Pearson's Chi-Square (10) = 190.889, $p < .001$

Table J4

Cross-tabulation of Labour and Birth Anaesthesia vs. Model of Care

	Model of Care		
	Fragmented	Continuity	Total
No anaesthesia	1260	1053	3392
Epidural	192	29	494
Spinal	36	4	75
Pudendal	8	1	18
General anaesthetic	7	0	20
Local anaesthetic	56	24	165
Spinal / general anaesthetic	3	1	6
Epidural / general anaesthetic	2	1	5
Unstated	4	0	17
Epidural / spinal	1	1	5
Epidural / spinal / general anaesthetic	0	0	1
Total	1569	2629	4198

Note: Pearson's Chi-Square (10) = 8.485, p =.582

Table J5

Cross-tabulation of Birth Type vs. Place Presenting in Labour

	Place Presenting in Labour		
	Tertiary	Primary	Total
Occipto anterior	2598	1045	3643
Occipito posterior	51	15	66
Breech	3	1	4
Ventouse	167	26	193
Forceps	37	4	41
Classical LSCS	2	0	2
Internal version	0	1	1
Lower segment caesarian section	231	20	251
Not stated	3	2	5
Total	3093	1114	4206

Note: Pearson's Chi-Square (9) = 80.385, $p < .001$

Table J6

Cross-tabulation of Birth Type vs. Model of Care

	Model of Care		
	Fragmented	Continuity	Total
Occipto anterior	1335	2301	3636
Occipito posterior	28	38	66
Breech	1	3	4
Ventouse	76	117	193
Forceps	17	24	41
Classical LSCS	2	0	2
Internal version	0	1	1
Lower segment caesarian section	108	143	251
Not stated	1	2	3
Total	1568	2629	4197

Note: Pearson's Chi-Square (8) = 9.675, p =.289

Table J7

Cross-tabulation of maternal position at birth vs. Place Presenting in Labour

	Place Presenting in Labour		
	Tertiary	Primary	Total
Birth stool	4	6	10
Caesarean section	234	20	254
Lithotomy	72	24	96
Semi reclined	1388	273	1661
Lateral	674	165	839
Standing	380	261	641
Squatting	75	50	125
Hands and knees	243	152	395
Water	22	141	163
Other	1	22	23
Total	3093	1114	4207

Note: Pearson's Chi-Square (9) = 623.011, $p < .001$

Table J8

Cross-tabulation of maternal position at birth vs. Model of Care

	Model of Care		
	Fragmented	Continuity	Total
Birth stool	5	5	10
Caesarean section	110	144	254
Lithotomy	34	62	96
Semi reclined	600	1057	1657
Lateral	325	513	838
Standing	244	394	638
Squatting	49	76	125
Hands and knees	140	255	395
Water	58	105	163
Other	4	18	22
Total	1569	2629	4198

Note: Pearson's Chi-Square (9) = 11.027, p=.274

Table J9

Cross-tabulation of Labour pain-relief and analgesia vs. Place Presenting in Labour

	Place Presenting in Labour		Total
	Tertiary	Primary	
None	1206	489	1695
Hydrotherapy	47	182	229
Entonox	1659	408	2067
Pethidine	163	22	185
Acupuncture	3	0	3
Homeopathy	5	8	13
Other	4	2	6
TENS	6	3	9
Total	3093	1114	4207

Note: Pearson's Chi-Square (7) = 413.383, $p < .001$

Table J10

Cross-tabulation of Labour pain-relief and analgesia vs. Model of Care

	Model of Care		Total
	Fragmented	Continuity	
None	644	1044	1688
Hydrotherapy	92	137	229
Entonox	745	1320	2065
Pethidine	70	115	185
Acupuncture	1	2	3
Homeopathy	6	7	13
Other	4	2	6
TENS	7	2	9
Total	1569	2629	4198

Note: Pearson's Chi-Square (7) = 11.629, p=.113