A COST ANALYSIS OF MIDWIFERY CARE IN ONTARIO

A COST-ANALYSIS OF MIDWIFE-ATTENDED HOME BIRTHS COMPARED TO MIDWIFE-ATTENDED HOSPITAL BIRTHS IN ONTARIO

By ELISSA PRESS, B.A., BHSc

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TITLE: A Cost-Analysis of Midwife-Attended Home Births Compared to Midwife-Attended Hospital Births in Ontario **AUTHOR**: Elissa Press, B.A., B.HSc **SUPERVISORS:** Dr. E. Hutton, Dr. A. Gafni, Dr. J. Beyene **NUMBER OF PAGES:** xii, 121

Lay Abstract

This thesis answers the question: Do midwifery-attended planned home births cost the Ontario health care system more or less than midwifery-attended planned hospital births? This thesis examined midwifery-attended births that occurred in Ontario between April 1, 2003 and March 31, 2006 and associated costs that were incurred for both the mother and the baby from the onset of labour until two days following the birth. Since 1994 when midwifery was legislated in Ontario, registered midwives have been providing care to women in both home and hospital settings. While there is general consensus within the midwifery community that home births do not cost the health care system more money, a thorough analysis of costs incurred by midwifery-attended births has not been meaningfully analyzed. Midwifery is the only group of health care professionals providing maternity care that is increasing in size. Given the shortage and the current crisis of maternity care providers, the number of midwives in this province is likely to continue growing. At the same time, a cost analysis of the resources consumed through the provision of maternity care – both at home and at hospital- has not been conducted. This study provides key stakeholders with information regarding resources used and needed and the costs associated with these resources so that resource allocation and planning can be conducted in a responsive manner.

Abstract

Introduction: In Ontario, prior to 1994, planned home birth attended by midwives was a self-paid service. Since the introduction of regulated midwifery in 1994, home birth is a government-funded service, and uses common resources. As such, there is a need to examine the impact that choice of planned location of birth puts on scarce resources. To date, costs associated with planned place of birth in Ontario have not been evaluated.

Objectives: The primary objective is to answer the question: Do planned midwifery-attended home births from the onset of labour cost the Ontario health care system more or less than planned midwifery-attended hospital births from the onset of labour among a comparable low-risk cohort of women? Specifically, this analysis examines the cost of midwifery intrapartum care, from the onset of labour until hospital discharge or the first two days after delivery.

Methods: This cost-analysis used a third-party payer perspective (health services costs) to analyze data from the Ontario Midwifery Program, which included 12, 886 midwife-attended births that occurred between April 1, 2003 and March 31, 2006. Three main sources of information were used to determine unit cost and health care utilization: the Ontario Midwifery Program data (2003-2006); data from the Ontario Case Costing Initiative; and the 2010 Schedule of Benefits for Physician Services. Data was analyzed using an intention to treat approach, i.e. based on planned rather than actual location of delivery.

Results: Hospital birth is more expensive than planned home-birth. Results were significant with a P value =< .001. The median cost from the onset of labour was $995.95 (IQR $995.95 to $995.95) for planned home birth compared to $2118.12 (IQR $1467.12 to $3610.00) for planned hospital birth.

Conclusions: Home birth, a choice that women in Ontario will continue to choose, does not result in costing the Ontario health care system more money.

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List of Abbreviations and Symbols

AOM – Association of Ontario Midwives

APGAR – A scale used to evaluate the newborn baby based on 5 criteria: Appearance, Pulse, Grimace, Activity, Respiration

CIHI – Canadian Institute of Health Information

CMO – College of Midwives of Ontario

CPI – Canadian Price Index

FFS – Fee For Service

ICU – Intensive Care Unit

IQR – Interquartile Range

L&D – Labour & Delivery

LHIN – Local Health Integration Network

MRA – Midwifery-Requested Assessment

MRSA – Midwifery- Requested Special Assessment

Multip - Multiparous

NICU – Neonatal Intensive Care Unit

NOS – Not Otherwise Specified

OB/GYNs – Obstetrician Gynaecologists

OCCI – Ontario Case Costing Initiative

OHIP – Ontario Health Insurance Plan

OMP – Ontario Midwifery Program

p = p-value – how likely the probability of obtaining a specific result is compared to what was actually observed

Primip – Primiparous

RMA – Regional Medical Associate

RVU – Relative Value Units

SES – Socioeconomic Status

SD – Standard Deviation

SVB – Spontaneous Vaginal Birth

VBAC – Vaginal Birth After Caesarean

Declaration of Academic Achievement

This thesis was written by Elissa Press with input from her thesis advisors Dr. E Hutton, Dr. A Gafni, and Dr. J Beyene.

Information was also obtained through interviews with nurses, midwives and other professionals.

Thesis Background

This thesis considers whether the costs to the Ontario health care system for women who choose midwifery care and are planning a home birth from the onset of labour according to the College of Midwives of Ontario (CMO) guidelines are more or less than the costs to the Ontario health care system for women who choose midwifery care and are planning a hospital birth from the onset of labour.

In Canada, midwives are the only care-providers who regularly offer the choice of home birth. The option of home birth is an important element of midwifery care – so much so that providing this option it is mandated by the College of Midwives of Ontario (CMO) (College of Midwives of Ontario, 2014) and reflects the midwifery philosophy that birth is a normal, physiologic event. While women have the right to choose home birth, it is imperative that we understand not only the clinical outcomes but also the monetary costs associated with this choice. Based on the maternal and newborn outcomes from prior study of midwifery-attended birth in Ontario that suggested lower resource use between women planning a home and a hospital birth (Hutton, Reitsma, & Kaufman, 2009; Hutton et al., 2015), it seems likely that planned home birth costs the same as or less than planned hospital birth. However, it is unclear if this is the case once costs associated with transferring from home to hospital, and subsequent complications are taken into account.

Review of the Home Birth Literature that Contains Costing Components

In this section other published home birth literature that contains costing components is reported on and summarized. Studies where births did not take place in the home or studies where births took place at home but were not attended by a trained practitioner were not included. Studies that only focused on cost differences between birth centers and hospitals were also excluded since costs associated with birth centres are likely to be significantly different from those at home. Consequently, only studies that focus on planned home births are included in this summary.

Table 1 summarizes the nine cost studies that were included in my review (Anderson & Anderson, 1999; Health Management Associates, 2007; Henderson & Mugford, 1997; Hendrix, Evers, Basten, Nijhuis, & Severens, 2009; Janssen, Mitton, Aghajanian, 2015; O'Brien et al. 2011; Ratcliffe, 2003; Schroeder et al., 2012; Stilwell, 1979) Seven of the studies are examples of cost-analyses (Henderson & Mugford, 1997; Health Management Associates, 2007; Hendrix et al., 2009; Janssen et al., 2015; O'Brien et al., 2010; Ratcliffe, 2003; Stilwell, 1979) and two of the studies are examples of cost-effectiveness studies (Anderson & Anderson, 1999; Schroeder et al., 2012). Four of the studies were conducted in the United Kingdom (Henderson & Mugford, 1997; Ratcliffe, 2003; Schroeder et al., 2012; Stilwell, 1979), two in the United States (Anderson & Anderson, 1999; Health Management Associates, 2007), one in the Netherlands (Hendrix et al, 2009) and two in Canada (Janssen et al., 2015; O'Brien et al., 2010).

Studies utilized different costing perspectives. While all nine studies calculated costs using a third payer perspective, three of the nine studies also

included some form of private/family costs in the analysis (Henderson & Mugford, 1997; Hendrix et al., 2009; Stilwell, 1979). Although a societal costing perspective is broad perspective, it has the potential to obscure the difference between voluntary and involuntary costs. The three studies using this approach used different variables to calculate societal costs.

The time horizon between studies also varied substantially, ranging from the immediate postpartum to six months following the birth. For example, for Hendrix et al. (2009) the study period is from 16 weeks of pregnancy until six weeks postpartum (Hendrix et al, 2009). Of all studies reported, O'Brien et al. (2010) have the greatest time horizon, reporting on all available health-related costing and statistical data for each participant from 300 days (10 months) before the birth and 180 days (six months) following the birth (O'Brien et al., 2010). In contrast, Anderson and Anderson (1999), Health Management Associates (2007), Ratcliffe et al. (2003) and Schroeder et al. (2012) exclude the antenatal period in their analysis and report only on intrapartum and immediate postpartum associated costs. While the Janssen et al. study (2015) also excludes antenatal costs, the study reports on costs from two days before time of delivery for the first 28 for mother and baby, as well as for the first 56 days for mother and 365 days for baby respectively.

Studies that define cohorts by intended place of delivery at the onset of labour have an arguably stronger methodology than studies that divide cohorts early on in the antenatal period. For example, a woman who chooses a home birth at 16 weeks may change her mind and choose the hospital prior to labour or may

develop a condition precluding home birth. If she is already assigned to a home birth cohort at 16 weeks but changes her plan for any number of reasons and elects to give birth in hospital at 30 weeks, costs associated with resource use based on planned place of birth will erroneously be attributed to the home rather than to the hospital cohort. Since the choice of place of birth is unlikely to impact the costs of antenatal care in any significant way, the inclusion of antenatal care may create 'noise' and obscure actual costs associated with choice of birth place.

Another challenge when comparing study outcomes related to the different components included to obtain costs. For example, for the antenatal period, Stilwell (1979) only reports on costs associated with antenatal physician clinic care and visits by midwives, including blood tests but excluding other antenatal tests – such as ultrasound – or visits to hospital that occurred during the antenatal period. Stilwell defines the delivery variables as attendance at birth by midwife and doctor; ambulance, "hospital costs" and probability of transfer. The elements that are used to calculate "hospital costs" are not reported (Stilwell, 1979). In contrast, for the antenatal period Henderson and Mugford (1997) exclude costs associated with antenatal visit appointments but report on ultrasound scan, cardiotocography, amniocentesis and Doppler costs. Delivery costs reported by Henderson and Mugford (1997) are based on data reported from the National Birthday Trust Fund Survey, and include a detailed breakdown of costs by staff present during labour and delivery (including a breakdown of midwifery staff by level or 'grade' of midwife i.e. by level of midwife experience); procedures, pain relief, mode of delivery and management of the third stage; transfers; cost of

equipment and daily hospital costs; and infant care (limited to resuscitation and special care baby unit) (Henderson & Mugford, 1997).

The approach to inclusion of costs associated with newborn care varied in these nine studies. Neither Stilwell (1979), Anderson and Anderson (1999) or the Health Management Associates (2007) included costs attributed to newborn care. It is unclear which costs for the newborn are included in the O'Brien et al. (2010) and Hendrix et al. (2009) analyses but it appears that only physician fee for service costs were calculated for newborn costs in the O'Brien et al. analysis and child health visits in the Hendrix et al. analysis. Likewise, Ratcliffe (2003) reports neonatal resuscitation as an outcome but no other resource use for neonates is reported. Henderson and Mugford (1997) report on both resuscitation and special care baby units, however, due to insufficient data they assume that the average costs for Special Care Baby Units was only for a single day (the median length of stay for home born babies who were admitted). The length of stay for hospital born babies was not available for this study. In the Janssen et al. article (2015) newborn costs include physician fees, hospital charges, transport and pharmaceuticals and is based on a possible 31 different case mix groups, rather than individual costs, for newborn infants. The Schroeder et al. article (2012) provides detailed information for neonatal care, including length of stay for baby by type of ward and level of care.

Research clearly demonstrates that parity is an important factor to consider when examining birth and resource utilization, as multiparity is associated with reduced resource when compared to nulliparity (Amelink-Verburg et al., 2008;

Brocklehurst, 2011; de Jonge et al., 2009; Hutton et al., 2009; Hutton et al., 2015; Janssen et al., 2009; Lindgren, Hildingsson, Christensson, & Rådestad, 2008; Miranda, Edwards, & Myers, 2011). The focus of the Hendrix et al. study (2009) is on nulliparous women only and hence, only costs associated with nulliparous women are reported (Hendrix et al, 2009). Janssen et al. (2015), Stilwell (1979), Schroeder et al. (2012) and O'Brien et al. (2010) report matching for parity in their methodology sections, however the Anderson and Anderson (1999), Health Research Associates (2007), Henderson and Mugford (1997) and Ratcliffe (2003) studies failed to take parity into account.

Study sample size in the studies compared ranged from 66 to 64, 538. The relatively small number of home births as well as selection bias due to small sample size may limit the analyses of Stilwell (N=66), O'Brien et al. (N= 438), Hendrix et al. (N= 418) and Ratcliffe (N=129). Several of the studies reported in the table below also failed to describe their inclusion/exclusion criteria in sufficient detail. For example, Stilwell (1979) reports that only "deliveries expected to be normal" were included in his study. 'Normal' is not defined. The Health Research Associates (2007) included all cases where Medicaid claims data was available for women planning a midwifery-attended home birth during their study time period. No other details are provided. Anderson and Anderson (1999) provide exclusion criteria for the hospital cohort (e.g. mothers under 16 and over 39 years old are excluded) however there is no discussion of exclusion criteria being applied to the home birth cohort or of a matching process being undertaken. Anderson and Anderson report including all of the midwifery responses that they

received, representing approximately two thirds of all home births attended by nurse-midwives during that time period (Anderson & Anderson, 1999). Similarly, Ratcliffe (2003) reports including all women that fit the criteria for birth centres but does not describe what this criteria is. Henderson and Mugford (1997) also fail to provide specific inclusion criteria for their study and an explanation of how their sample size was derived. Likewise, O'Brien et al. (2010) report including all women who had volunteered for midwifery care but no specific inclusion or exclusion criteria are noted. At the same time O'Brien et al. matched birth records according to antenatal risk score, maternal age, parity and postal code.

Cost analyses that report on the median rather than the mean are less vulnerable to being impacted by outlying values. However all nine of the studies reviewed report on the mean rather than the median. With the exception of the O'Brien et al. (2010) and Janssen et al. studies (2015) that report that distributions were not normally distributed (but still report on mean rather than median cost), none of these studies reported if costs were distributed normally (i.e. that the mean would be a more appropriate measure than the median). Typically however costs are *not* distributed normally, so one should report on the median.

The nine studies that were compared used mixed methodologies to calculate costs, including government databases and/or hospital records and/or survey results from midwives or women who had recently given birth. When survey response rates are discussed, response rates reported are low, resulting in a potential response bias. Anderson and Anderson (1999) report a 71% survey response rate while Henderson and Mugford (1997) report a 61% survey response

rate. The heterogeneity and quality discrepancy of the studies discussed makes it difficult both to compare outcomes between studies as well as to generalize findings beyond the individual study. Table 1 summarizes these studies:

Table 1: *Comparison of cost-related home birth analyses*

Authors	**Year of Study** **Country**	**Number of study participants**	**Type of data & method of analysis**	**Notable inclusions/ exclusions & limitations**	**Study Findings**
Anderson & Anderson (1999)	1987-1991 (United States)	23,380 (11, 788 planned home birth compared to 11, 592 obstetric births)	Cost effectiveness study (CE ratio = cost of increasing the likelihood of a normal birth by 1 in 1000). Intended home births 1987-1991 vs. hospital births across USA. Charges (for intrapartum & outcome data for midwifery births) obtained from survey results and literature (from 54 practices in 26 states). Charges for hospital births obtained from the literature.	Low-risk mothers with uncomplicated births Included intrapartum and postpartum only Limitations: 'low risk' defined for hospital cohort. Undefined for home birth and birth centre cohorts. 71% survey response rate. Neonatal costs excluded. No sub-analysis by parity.	Mean charges for home birth were $1,711 (1991 prices) vs. $5, 382 per delivery (1991 prices, USD). Conclusion: the average costs of uncomplicated vaginal births are less when delivery is planned to take place at home, as opposed to a birth center setting or the hospital.
Health Management Associates (2007)	Jan 2001-Dec 2004 United States	1036 (Washington State) (6065 women attended by licensed midwives over this time period. 2022 were planning home birth of which 1036 were covered solely	Retrospective cost analysis and simplistic cost-benefit analysis Medicaid claims data were obtained from the Department of Social & Health Services First Steps Database and used to estimate "cost-savings" to	Includes claims paid for any provider during the intrapartum period. For a hospital delivery, the claims included are those from admission to discharge of the childbearing woman. Based on planned place of birth	"Cost savings" of $2,971 for planned home births vs. planned hospital births resulting in vaginal delivery attended by licensed midwives and $5,550 for hospital births attended by midwives resulting in cesarean delivery (2001-2004 prices)

		by Medicaid) Of the 1036 Medicaid FFS deliveries there were: 415 home births, 235 birth centre births, 386 hospital births (263 vaginal, 123 C-section)	Medicaid Fee for Service (FFS) and to project gross estimates of "cost savings" to the health care system	Costs for prenatal *and* newborn care are excluded Limitations: 'Low-risk' not defined. No description of sample given or methodological discussion. No matching by parity or other variables. This study simply re-states cost presented from another (unpublished) database Unclear if costs also reflect the actual expenses incurred through hospital service use (i.e. hospital stay) or just provider FFS costs Overly simplistic. Costs 'saved' determined by summing all intended planned midwife home birth costs to obtain a cost estimate and subtracting this number from the total sum of non-midwife intended hospital birth costs	Birth setting cost for midwifery planned birth per delivery Home - $1000 Birth Center - $1635 Hospital (Vaginal) - $3971 Hospital (c-section) $6550 Benefit to cost ratio: Medicaid FFS Only, Excluding Cost Savings for Avoided Intervention (1.8:1) Benefit to Cost Ratio: All Payors, Excluding Cost Savings for Avoided Intervention (9.8:1)
Henderson & Mugford (1997)	1994 United Kingdom	7661 (4191 planned home births; 3470 planned hospital births (of the planned home birth cohort, 600 women, i.e. 15%, were transferred during labour or immediately after. Another	Retrospective Costing analysis Cohort Study. Women booked for home birth at 37 weeks compared with matched control group of women booked at hospital Data from the National Birthday Trust Fund	Limitations: No specific inclusion criteria described Unit costs from literature applied to antenatal, intrapartm and postpartum resource use Length of stay of hospital babies was not available. Costs to family included (although	Equivalent clinical outcomes, higher satisfaction in the home birth group, 15% transferred to hospital. Costs to National Health Service per delivery: home 205 pounds, hospital 332 pounds, home booked but hospital delivered 405 pounds (1994

		179 women booked for home but delivered in hospital either because they changed their planned place of birth in the final weeks of pregnancy or because data relating to their transfer was incomplete)	Cohorts matched for age, parity and obstetric background	not travel costs for antenatal care) Survey response rate (61%) of all births at home in the UK in 1994 (98% of those who registered in the study). Possible response and selection bias. Choice of birthplace captured at 37 weeks and includes women who transferred and who changed birth plan.	prices).
Hendrix et al. (2009)	2008 Netherlands	418 births (planned home birth, N=241; planned short-stay hospital birth, N=177) 100 midwifery practices sampled at random from across the Netherlands	Dutch multi-center prospective cost analysis Matched cohorts – home and short-stay hospital setting (nulliparous women) Cost calculations were done according to the Dutch manual for costing in health care. Contacts with health care professionals, medication, maternity care assistance, medical interventions during delivery, pain control, and hospitalization were identified as health care costs. The volumes of resources were measured as per cost diaries, questionnaires, and birth registration forms. Unit prices of resources used	Inclusion: Nulliparous women only Costs calculated from 16 weeks of pregnancy until 6 weeks postpartum Limitation: cohort determined prior to onset of labour. Relatively small cohorts Does not take the costs of planned delivery in hospital into account (only short-stay hospital births) Does not separate births attended by midwives & physicians Costs included in newborn care not well defined. Costs included in hospital stay not well defined Costs from societal perspective but productivity losses of parents are not	Giving birth in hospital was associated with the highest total costs (∈ 5,208) while giving birth in a short-stay hospital setting was found to be comparable to giving birth at home (∈3,950 vs. ∈3,695 per birth, 2008 prices) The most important differences in costs between these two groups were reported as being associated with maternity care assistance, hospitalization, and travelling costs Hendrix et al. conclude that no difference exists between the total costs of home births and short-stay hospital births among nulliparous women intending to give birth in these settings.

			were obtained from the standard costs given in the Dutch manual for costing and from expert financial resources.	included	
Janssen et al. (2015)	2001-2004 British Columbia, **Canada**	9,864 planned home birth with midwife (n=2243); planned hospital midwife-attended birth (n=3610) planned hospital physician birth (n=4011)	Retrospective cost analysis Third-payer perspective Data sources used included: BC Perinatal Data Registry Medical Services Plan Payment Information Registration & Premium Billing file BC Ambulance Service Discharge Abstract Database PharmaNet Similar low-risk status selected and matched on age, parity, marital status, and year of birth	Inclusion: all women who planned a home birth with a regulated midwife and all planned hospital midwife – attended births plus randomly selected physician sample (latter two cohorts had to meet eligibility requirements for home birth) Able to report costs assigned to individual hospitals within each study year (i.e. can account for potential confounding by hospital size and location). Sub-analysis by parity Exclusion: babies with ICD codes for congenital malformations 19 hospital births where cost per weighted case not available Excluded costs lost due to lost productivity Limitations: Long time horizon can obscure charges incurred that have nothing to do with place of birth	In the first 28 days postpartum there was a $2,338 average cost savings per birth among women planning home birth compared to hospital birth with a midwife and $2,541 compared to hospital birth planned with a physician (findings similar for nulliparous and multiparous women planning home birth) (2001-2004 prices). In longer term outcomes, similar findings were noted, with cost savings per birth at $1, 683 compared to the planned hospital birth with a midwife, and $1,100 compared to the physician group during the first eight weeks postpartum. Costs reduced for one year and when stratified by parity. Transport costs were higher for mothers in the home birth group. Provider fees, hospital costs and pharmaceutical costs were lower for both mothers and

				Unable to ascertain actual transport costs (but less than one percent of all costs). Also hospital costing data aggregated by membership in case mix group rather than individual costs	infants.
O'Brien (2010)	2009 Alberta, **Canada**	438 (146 midwifery clients compared to matched sample of 292 women planning hospital birth) *of the 146, 84 took place at home and six in a private birth centre	Cost-analysis Third-payer perspective Data used included: Alberta government databases, including practitioners' fee for service claims, ambulatory care fees, and provincial costing project data attached to hospital morbidity records. Cohorts defined prior to onset of labour	All available health-related costing and statistical data from 300 days (10 months) prior to 180 days (6 months) after the birth. Parity used as control variable in multiple linear regression analyses of costs Limitations: Missing data: hospital and outpatient costing data were not available for the two smaller regions. Moreover there were 11 individuals from larger regions with missing costs because hospital and outpatient data could not be retrieved. Excluded ambulance costs. It is unclear how many of the planned home birth group delivered in hospital Long time horizon may result in including costs that should not be attributed to birth place	Results from this study suggested that women who use midwifery care save the health care system an average of $1172 per course of care (when compared to a matched cohort receiving standard care). This cost includes a 6% home delivery rate Midwife-attended home were found to be significantly less costly than midwife-attended hospital deliveries (by an average of $3939). Mean hospital cost = $4781 and mean home birth cost= $842 per birth
Ratcliffe et al.	1998 data United	129 (35 planned birth center	Cost analysis from perspective of health care system.	Intrapartum period based on intended place of delivery at	The total mean health service costs were lowest for

2003	Kingdom	births, 26 planned home births and 68 planned hospital births)	Random sample of birth center and hospital planned births. Cost estimates were based on actual resource consumption, using local unit costs wherever possible. Resource use collected from a database. Unit cost obtained from the finance department for the financial year 1999-2000 and included type and duration of delivery, staffing, consumables, equipment, investigations, interventions, drugs, transfers, prenatal admissions, and length of stay. The unit cost of transfers, general staff time and overheads during labour and delivery and postnatal inpatient admissions were obtained from a previous costing study carried out in inner London.	booking (focus intrapartum & postpartum only) Clinical findings reported. Exclusion of capital costs in baseline analysis. When capital costs were included in the analysis, birth center costs increased by 59%, hospital costs increased by 53%. Limitations: Unspecified inclusion criteria for birth centre cohort. Small cohorts Neonatal resource use limited to neonatal resuscitation Limitations regarding results used from previous costing study not discussed.	women intending to give birth at home (£217.16), followed by giving birth in birth center (£392.30), and giving birth in the hospital (£608.90-£635.81). The low costs of home births reflected the low use of resources during birth by this group. (1999-2000 prices) When capital costs are included, the mean total health service costs per birth is: £624.68 in the birth center and £930.37 in hospital.
Schroeder et al. 2012	April 1, 2008 – April 31, 2010 United Kingdom	64 538 'low-risk' women before the onset of labour, -recruited from 142 of 147 trusts providing home birth services, 53 of 56 freestanding	Cost-effectiveness prospective study (cost effectiveness was expressed as incremental cost per adverse perinatal outcome avoided, per maternal moribidity avoided, or per	Matched for nulliparous and primiparous Private costs excluded Limitation: Limited time horizon-intrapartum and immediate	The total mean costs per low risk woman were £1631 ($2603) for an obstetric unit, £1461 ($2332) for an alongside midwifery unit, £1435 ($2290) for a free standing midwifery unit, and

		midwifery units, 43 of 51 alongside midwifery units and a stratified random sample of 36 of 180 obstetric units.	additional 'normal birth.') -health care system perspective/3rd payer perspective -Detailed unit costs from finance departments as well input from senior midwives. Individual data collection forms captured duration of labour, mode of delivery, some forms of pain relief, active management of the third stage of labour, whether an episiotomy was performed, clinical complications, length of stay for both mother and baby by type of ward and level of care, and transfers by duration and mode. Additional resource captured from data collection forms developed following focus groups held with midwives.	postpartum (when care for baby and mother ended after the birth). If higher care was required after the birth, this was included in the economic evaluation.	£1067 ($1701) for the home. (2009-2010 prices) Schroeder et al. conclude that unit overheads and staffing costs were the key drivers of cost in these analyses In their model, being multiparous or married was associated with reduced costs, while birth after 40 weeks' gestation, being overweight or obese, maternal age of 30 or more were each associated with increased costs. For multiparous women planned home birth generated the greatest mean net benefit when perinatal outcomes were considered (and the greatest incremental cost savings). However, an increased incidence of adverse perinatal outcomes were associated with planned birth at home in nulliparous women (and the greatest incremental cost savings).
Stilwell (1979)	1977 Dudley, United Kingdom	66 (22 home births compared to matched sample of hospital	Cost-analysis Matched cohorts Cost data from interviews with midwives & GPs	Private costs included limitations: small cohorts, hospital costs not defined,	Public sector costs 10% higher for a consultant unit birth than GP hospital birth

		births (GP unit births & consultant obstetric unit births)	and hospital notes Included antenatal, intrapartum and postnatal costs Home birth costs-based on # of hours midwife spent with woman in labour and presence of GP at birth	limited variables included in antenatal and intrapartum and postpartum costs, neonatal costs excluded. Poorly defined inclusion/exclusion criteria. Weak methodology	GP hospital birth 10% higher than home birth Overall, home birth was cheaper by 5% than GP hospital birth Average family costs = 68 pounds (1977 prices) Total costs: home birth 257.36, GP hospital birth 270.67 and OB birth 330.17 pounds.

The studies discussed above provided insight as to how other costing studies for maternity care have been conducted. However, because there are so many variables both in terms of factors that attribute to cost as well as to how these factors are chosen, valued and measured, it is difficult to compare studies and to generalize study findings to an Ontario setting. Different study time periods, inclusion criteria, time horizons, methodologies, home birth and medical intervention rates, as well as differences in medical practice, regional costs, and available resources all impact overall costs of any analysis. Nonetheless, these studies suggest that home birth does not place an additional burden on the health care system, no matter where the study is done or what type of economic costing methodology is selected. These studies also highlight the limitations associated with data issues as well as the need to address these limitation through various means: imputing data for missing values, extrapolating and using common case scenarios and monetary amounts for specific contexts, and acquiring subjective costing data through surveys or questionnaires.

While these studies may speak to certain data or methodological limitations, these studies are not generalizable to an Ontario context and cannot provide the answer to my specific question.

Rationale for a Cost Analysis

Birth is the most frequent reason for hospitalization in Canada (Canadian Insititute of Health Information, 2015). As such, resources consumed during birth and associated costs are of paramount importance.

In Ontario, prior to 1994, planned home birth attended by midwives was a self-paid service. Since the introduction of regulated midwifery in 1994, home birth is a government-funded service that uses common resources (Association of Ontario Midwives, 2014). As such there is a need to examine how choice of planned birth place impacts resource use and concomitant costs. The Ontario government, that views both home birth and hospital birth as being safe and permissible, allows women to choose where they wish to give birth. But, government needs to be accountable for the way in which limited resources are used, and needs to justify to the public why money directed to support home birth is a good use of finite resources. The costs associated with planned place of birth in Ontario have not been evaluated. In fact, with the exception of a pilot study from Alberta (O'Brien et al., 2010), and a recent cost study from British Columbia (Janssen et al., 2015), there is no other study that has examined the costs associated with midwifery-attended home and hospital births in any other Canadian province.

Prior research from Ontario suggests different resource consumption

between cohorts using midwives and planning home and hospital births (Hutton et al., 2009; Hutton et al., 2015). Specifically home birth has been associated with decreased intervention rates during the intrapartum period, less perineal trauma, reduced blood loss greater than 1000ml, and decreased cesarean section rates, compared to planned hospital birth (Hutton et al, 2009; Hutton et al., 2015). On the other hand, research suggests that women planning home birth have higher rates of ambulance transport from home during or immediately after birth and a higher postpartum transfer rate (Hutton et al., 2009). Thus, while we know that there are differences in resource use between cohort groups we do not know how costs are impacted by this difference in resource use.

In the year 2000, a report by the Office of the Provincial Auditor for the Ministry of Health and Long-Term Care of the Ontario Midwifery Program concluded, among other things, that the Ministry should assess whether the current delivery and funding model for midwifery services was "cost-effective" (Ministry of Health and Long-Term Care, 2000). Specifically, the audit recommends that the Program be examined to establish if it was managed with "due regard for economy and efficiency" (Ministry of Health and Long-Term Care, 2000, p.200). Although a directive that a cost-analysis be done there is no evidence that this was carried out. In 2003 the Ministry of Health and Long-Term care conducted a program evaluation comparing the outcomes – including the monetary outcomes – of midwifery care and family physician obstetrical care. The report of this evaluation is not publicly available. Even if this report were available, it would be limited and the validity of the report questionable given that

useable midwifery outcome data only started being collected electronically in 2003 when the Ontario Ministry of Health and Long Term Care mandated manual entry and validation of clinical, financial and utilization data of all midwifery-attended births (Katherine & Knox, 2006). This is the first study to use the Ontario midwifery database from 2003-2006 to conduct a cost analysis of midwifery comparing the costs associated with planned home births to the costs associated with planned hospital births.

More than half of Canadian midwives work in Ontario (Health Council of Canada, 2012). Now that midwifery serves a larger proportion of the population in Ontario and is continuing to increase exponentially, the proportion of healthcare dollars associated with midwifery care will also grow. According to the Health Council of Canada the number of midwives practicing in Ontario grew from 71 in 1994/5 to 693 in 2013/14. Midwife-attended births increased from 1,800 to over 24,000 (representing 12% of births in the province) during the same time period (Health Council of Canada, 2012). As more and more women in Ontario choose midwifery there is an even more pressing need to conduct a cost analysis to better understand costs associated with this choice.

This thesis is an example of a costing study undertaken from the perspective of the health system and will provide a detailed examination of the comparative costs during the intrapartum period of two alternatives – planned midwifery-attended home and planned midwifery-attended hospital births - to determine whether the model of care is sustainable from an economic perspective.

This cost analysis will inform maternity care planners about how choice of planned birth location impacts resource use and associated costs.

Home Birth – What it Means

Midwives attend women who are planning a home birth at their respective homes when they are in active labour. Midwives who are attending a planned home birth will bring all of the same birthing equipment as is usually found in a level 1 or community hospital. If all goes well the midwife will support the woman to birth at home and then will provide care to both mother and baby during the first hours following birth. Midwifery postnatal care is provided by home visits and clinic appointments until six weeks postpartum.

The literature suggests that the majority of women (75-90%) planning a home birth will be successful (Ackermann-Liebrich et al., 1996; Anderson & Murphy, 1995; Durand, 1992; Hutton et al., 2009; Hutton et al., 2015; Janssen et al., 2002; Janssen et al., 2009; Johnson & Daviss, 2005; Lindgren et al., 2008; Sandall, Soltani, Gates, Shennan, & Devane, 2013; Wiegers, van der Zee, & Keirse, 1998; Wiegers, Keirse, van der Zee, & Berghs, 1996; Woodcock, Read, Bower, Stanley, & Moore, 1994).

In the Ontario model of midwifery care, when labour does not progress as it should, the woman will transfer to the hospital along with her midwife. Intrapartum transfer rates range in the literature between 7-20% of planned home births (Ackermann-Liebrich et al., 1996; Anderson & Murphy, 1995; Durand, 1992; Hutton et al., 2009; Janssen et al., 2009; Johnson & Daviss, 2005; Lindgren et al., 2008; Wiegers et al., 1996). In general, the most commonly sited reason for

transfer in the research literature is failure to progress in the first or second stage of labour. Prolonged rupture of membranes is the second most common reason for transfer. Other reasons for transfer include non-reassuring fetal heart rate, meconium, pain relief, hypertension, bleeding and malpresentation (Ackermann-Liebrich et al., 1996; Anderson & Murphy, 1995; Blix, Kumle, Kjærgaard, Øian, & Lindgren, 2014; Johnson & Daviss, 2005). The two most common reasons for a transfer from a home to a hospital environment during labour are not medical emergencies and would not in-and-of themself necessitate an ambulance transfer to hospital or increase costs. Hemorrhage constitutes the most common reason for transfer after the delivery (Lindgren et al., 2008).

Home Birth Numbers in Ontario

In Canada, approximately 2% of babies are born out of hospital (1.2% at home and 0.8% in birthing centres) (Public Health Agency of Canada, 2009). Internationally, home birth numbers vary tremendously depending on policies and practices of the country in question. Home birth rates in countries such as Sweden and the United States are less than 1 per 1000 (Hildingsson, Lindgren, Haglund, & Rådestad, 2006; Wax et al., 2010). On the other hand, in the Netherlands approximately 20% of babies are born at home (Christiaens, Nieuwenhuijze, & de Vries, 2013). All other industrialized countries with advanced healthcare systems have home birth rates below three percent (Johnson & Daviss, 2005).

In the 2009 study published by Hutton et al. that examines midwifery-attended births in Ontario between 2003-6, midwives attended an annual average of 6.6% (8,600) of provincial births (130, 927 in 2003 to 135,595 in 2006).

According to their data, home births accounted for 1.6% of the total number of births in Ontario (n=2300) and 25% of midwife-attended births (Hutton et al, 2009).

Midwifery Funding and Map of Midwifery Practice Locations in Ontario

In Ontario, midwives who are independent practitioners are paid per course of care. A course of care refers to the total care provided to a woman throughout her pregnancy, labour and postpartum period. This care also includes care provided to the newborn for the first six weeks. Midwives are paid by the Ontario Ministry of Health and Long-Term Care according to care provided and also according to level of experience of the midwife care provider. The pay scale ranges from level one to level six. Depending on experience, midwives receive compensation that ranges from $1,984 to $2,564 per case (2010 prices). In addition to this an operational fee, money for overhead costs, is received by midwifery practices for each woman to whom care is provided (J. Berenstein, personal communication, December 2010).

Image 1 is a map of all midwifery practices in Ontario. According to the Association of Ontario Midwives (AOM) website there are currently 100 midwifery practice groups and in 2013, there were 625 registered midwives in Ontario (Association of Ontario Midwives, 2013).

Image 1: *Map of midwifery practices in Ontario*

Reprinted from: Association of Ontario Website. March 2016. URL: http://www.ontariomidwives.ca/

Study Design & Methods Section

Research Question

This thesis addresses the question of whether midwife-attended home births planned from the onset of labour costs the Ontario health care system more or less than midwife-attended hospital births planned from the onset of labour among a comparable low-risk cohort of pregnant women. Specifically, the question focuses on the cost of midwifery intrapartum, early postpartum, and newborn care, and only includes home birth cases planned according to the guidelines of the College of Midwives of Ontario (see Appendix A for these guidelines). The secondary research question is: from the Ontario health care system point of view, what is the impact of parity on the cost of midwifery-attended planned home and midwifery-attended planned hospital birth?

Study Design

This thesis is a retrospective cost-analysis using a third payer perspective (health service costs) to analyze data from the Ontario Midwifery Program (OMP)

Database, which included 12, 886 midwifery-attended births that occurred between April 1, 2003 and March 31, 2006. Cases from the OMP Database were divided into two cohorts: those planning a home birth from the onset of labour, and those planning a hospital birth from the onset of labour. After cleaning the data and applying logic checks, all remaining home birth cases were included in this study. Since the database contains more planned hospital than planned home birth cases, a random selection of planned hospital birth cases were selected to match the number of planned home birth cases. Cohorts were matched for parity, and data was analyzed using an intention to treat approach, i.e. based on planned rather than actual location of delivery. Women are analyzed within their cohort regardless of actual place of birth.

To ensure that the costs included were the same for both cohorts only intrapartum and immediate postpartum data was utilized since data related to maternal readmissions was not available. The time horizon for this analysis is from the onset of labour until hospital discharge or the first two days postpartum. Costs related to pregnancy were not included in this analysis since this was outside the period of interest.

Data Cleaning Process & Logic Checking Approach

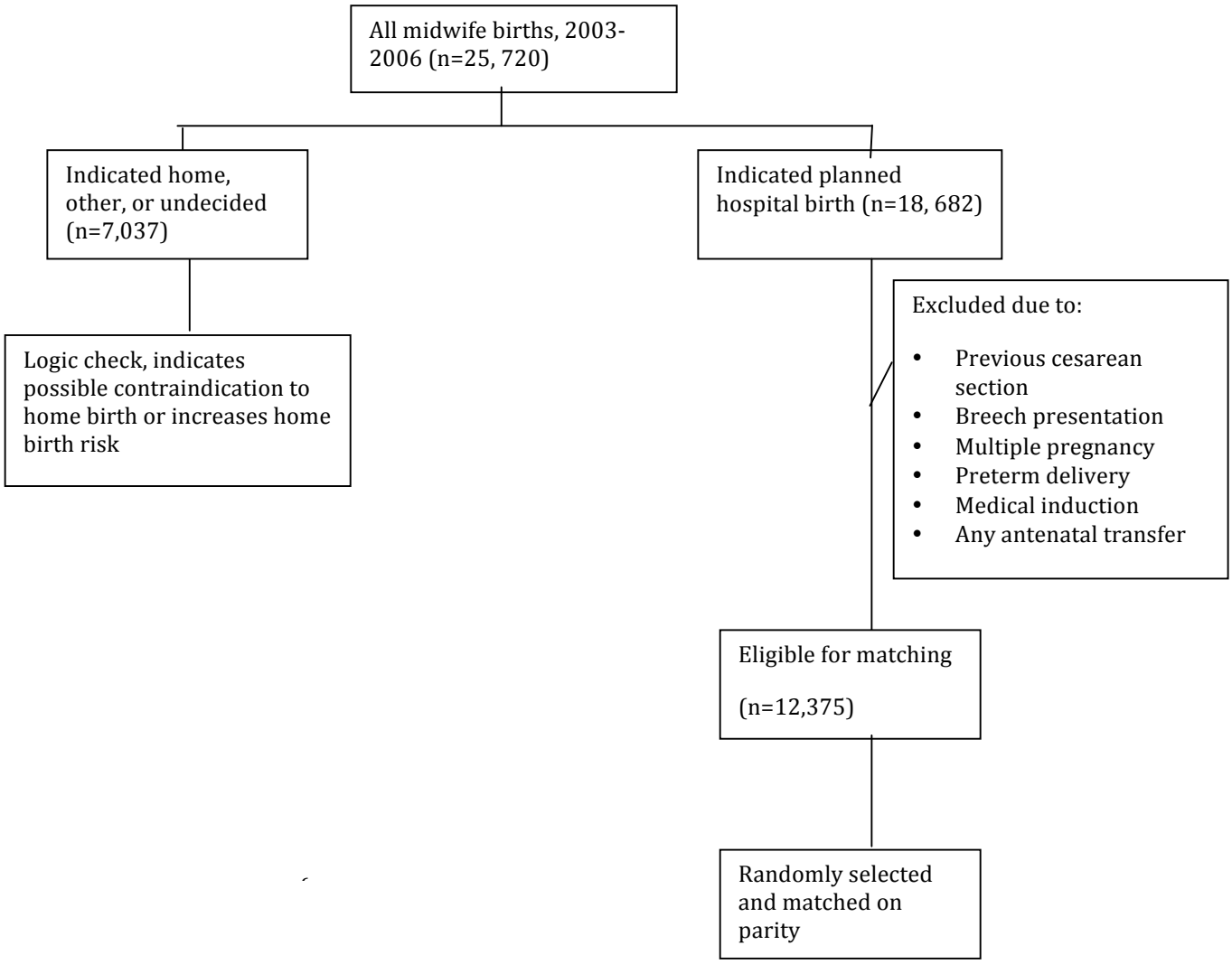
The entire Ontario Midwifery Program database from 2003-2006, from which my cohorts are derived, consists of data for 25, 852 pregnancies and birth. Data from these years was merged into a SPSS file and then reviewed for duplicate cases. In total, based on the criteria established to identify duplication (fiscal year, postal code of hospital, age, birth weight and date on which birth

occurred), 46 cases were determined to be duplicate cases and were removed.

Logic checks based on similar criteria to that reported by Hutton et al. (2009) were then applied to cases in the OMP Database to determine appropriate low-risk candidates for home birth. Logic checks were necessary since, as reported by Hutton et al., the correct category for home birth was not always correctly indicated in the database (sometimes reflecting a desire to birth at home rather than an actual possibility as, for example, would be the case where an induction of labour occurred) (Hutton et al., 2009). The College of Midwives of Ontario (CMO) *Indications for mandatory discussion, consultation and transfer of care* (see Appendix A) was also used to determine homebirth eligibility (College of Midwives of Ontario, 2000). Although the College guidelines support vaginal birth after cesarean (VBAC) at home this subset was removed from both the home and hospital cohorts. The percentage of potential VBAC births in the hospital group was substantially larger (n=1102, %=14.6) than the home birth group (n= 209, %=3.1) The inclusion of VBAC births could bias the hospital group as failed VBAC is associated with both higher maternal and neonatal morbidities (Martel & MacKinnon, 2005; Oboro et al., 2010).

Figure 1 illustrates this cleaning process.

Figure 1: *Selection of included records*



Hospital data: cleaning process

From the 18 682 women who were now in the planned hospital group, the following cases were excluded (thereby ensuring that I had a comparable low-risk cohort): women with an antenatal transfer of care (n=2415); women who gave birth prior to thirty seven weeks gestation (n=588); women with a breech presentation at birth (n=322); women who required an oxytocin induction of labour (1524); women who had multiple births (n=15); and women who had had a previous cesarean section (n=1102). See Table 2.

Table 2: *Records excluded from analysis*

Type of Record	Number Excluded Hospital Births	Number Excluded Home Births
Breech presentation	322	66
Multiple pregnancies	15	0
Preterm delivery prior to 37 weeks' gestation	588	63
Oxytocin induction of labour	1524	164
Prostaglandin cervical ripening	341	27
Antenatal transfer of care to physician	2415	49
Prior Cesarean Section	1102	209

After this cleaning process, 12, 375 women remained in the hospital group cohort.

Home data: cleaning process

Seven thousand and thirty eight women were in the original home group cohort. One hundred and sixty four cases of oxytocin induction and intended home birth were removed from the data set. Some cases where oxytocin induction was indicated also indicated outcomes such as home birth (n=3) or transport during labour (n=1), likely misclassifications of oxytocin inductions. These four cases were retained in the data set. The rest of the cases were probably misclassifications of intended place of birth at the onset of labour and were removed from the data set. Although oxytocin inductions were removed from the analysis, cases requiring oxytocin augmentation were retained. In seven cases where oxytocin augmentation was selected as having occurred, birth was both

planned and actually took place at home. In these cases the rest of the case was analyzed to determine if it was the oxytocin that was erroneously entered or location of delivery. In all cases, there was no other indication of medication (e.g. epidural or spinal), all births were spontaneous and there was no indication of intrapartum consultation with an obstetrician. Lack of any other indication of a hospital birth led me to conclude that oxytocin augmentation was likely a data entry error.

Records of breech presentation were also examined. In total, there were 78 cases of breech birth in the planned home birth group. Planned home birth with a known breech is unlikely and not indicated but undiagnosed breech can occur. There were 12 cases that fit the criteria for undiagnosed breech with home birth occurring or transport in labour. Another 36 cases were excluded due to either an antenatal transfer of care or a planned/elective cesarean section and no labour. Another 30 cases were also excluded due to lack of documentation as to whether this was a known or unknown breech. In these cases there was no antenatal transfer of care and no written indication of planned/elective cesarean section. Hutton et al. (2009) previously examined these same 30 cases. In their sensitivity analysis, no significant differences were noted between cohorts (Hutton et al., 2009).

The CMO considers preterm births between 34 to 37 weeks gestation a category 2, i.e., requiring consultation with a physician (College of Midwives of Ontario, 2000). As such, all planned home birth preterm births were removed from the dataset, resulting in the removal of 85 preterm cases. Two cases were

retained as a result of data entry error for gestational age at birth.

In order to rule out coding errors for home birth, cases where an antepartum transfer of care took place were examined. In total there were 41 cases that were retained in the home birth group. The bulk of these cases comprised of a "temporary transfer of care" in the antenatal period for conditions such as threatened preterm labour or hyperemesis. Forty nine cases were excluded when the reason for the antenatal transfer of care ruled out planned home birth (such as elective caesarean section for VBAC, gestational diabetes, fetal concerns and pregnancy induced hypertension) or where there was a transfer of care for an unknown condition and it was unclear if care had been resumed by midwives.

In cases where there was an indication of a previous cesarean section, 209 home birth cases were removed from the primary analysis. Twenty-seven cases where prostaglandin induction was indicated were also removed from the home birth cohort. In general all home birth cases in which medications were used and the birth occurred at home and that required monitoring in hospital were removed from the database. Hutton et al. (2009) included these 27 cases in a sensitivity analysis and found no significant influence on outcomes between cohorts.

After cleaning the data 6, 443 home births remained in the home birth group (See Table 3).

Table 3: *Details of records inconsistent with home birth criteria*

Record Allocation	**Record Details**	**Number of Cases**
Retained in primary analysis (n=57)	Breech delivering at home or transferred in labour	12
	Preterm? Query gestational age data error	2
	Antenatal transfer of care with possible return to midwifery care	41
Removed from any analysis	Breech with antenatal transfer of care and elective section	66
	Preterm < 35 weeks	82
	Preterm> or = 35 weeks	16
	Antepartum transfer of care for conditions judged to be permanent or where it was unclear if care was returned back to midwifery	49
	Oxytocin induction	164
	Prostaglandin induction	27
	Prior cesarean section	209

Matching Cohorts

A comparison group was derived from the remaining 'cleaned' records in the data set from the same time period, all of which indicated that the hospital was the planned place of birth at the outset of labour. Women who planned a home birth at the outset of labour were matched by parity with a comparable low-risk group of women who planned a hospital birth at the outset of labour. All eligible home births (6, 443) were selected and compared to the same number of randomly

selected hospital births from the same data set. However, there were six cases in the home birth group where parity was not entered. To deal with this missing data, six other cases were randomly selected from those remaining in the hospital group cohort.

Ethics

The Research Ethics Board indicated that ethics approval was not necessary for this study since clinical and economic outcome data was derived from retrospective databases, and for purposes of this study no personal identifiers were used.

OCCI Section: Overview

The Ontario Case Costing Initiative (OCCI) analyzes resource utilization by integrating financial, clinical and statistical information. Total hospital costs incurred by direct and indirect patient care are then allocated to individual patients within a given costing time frame (Ministry of Health and Long-Term Care, 2006). While costs of different interventions are system dependent, OCCI uses a standardized method to allow for costs to be compared and synthesized in a compatible manner.

The Ontario Case Costing Initiative (OCCI) is the initiative of the Ontario Ministry of Health and Long Term Care (MHLTC) that attaches a monetary value to patients for medical procedures and services received from various OCCI-participating hospitals (Ministry of Health and Long-Term Care, 2006). The table below reports on the OCCI-participating hospitals for the 2008-9 fiscal year, i.e.

hospitals that submitted data to OCCI for the 2008-9 year and from which case-costing for this year was derived (K. Ward, personal communication, 2009).

Table 4: *Hospitals participating in OCCI 2008-2009 financial reporting*

Name of Hospital	**Location**	**Classification**
Clinton Public Hospital	Clinton (serves Clinton and area – Huron)	Level I
Mount Sinai Hospital	Toronto	Tertiary Care Centre
St. Michael's Hospital	Toronto	Tertiary Care Centre
Stratford General Hospital	Stratford	Level II
Hamilton Health Sciences Corp-McMaster	Hamilton	Tertiary Care Centre
St. Joseph's Health Care System – Hamilton	Hamilton	Level II
Southlake Regional Health Centre	Newmarket	Level II
York Central Hospital	Richmond Hill	Level I
Trillium Health Corporation	Mississauga	Tertiary Care Centre
Lakeridge Health Corporation – Oshawa Site	Oshawa	Level II+
Sunnybrook Health Sciences Centre	Toronto	Tertiary Care Centre

The principal activities of the OCCI include data maintenance for case-costed records, distribution of the Ontario Guide case-costing standards, and evaluation of data quality (Ministry of Health and Long-Term Care, 2006). Participation in the OCCI is voluntary, although the Ministry of Health and Long-Term Care provides a small annual stipend to hospitals based on the number of case-costed records submitted. Intended to complement the Management Information Systems guidelines and provincial reporting standards, the Ontario

Guide to Case Costing links patient care departments (such as nursing or diagnostic imaging) to costing intermediate products (such as laboratory services or x-rays) **(**Ministry of Health and Long-Term Care, 2006**).** Relative value units (RVUs) are used to ascertain specific costs per patient. In general, RVUs calculate the relative amount of resources used to generate the specific service/product for patients, and can be specific to each functional centre (Ministry of Health and Long-Term Care, 2006).

Functional Centres (defined as administrative, supportive or patient care) 71 25020**** to 71 25090*** are included by the OCCI to obtain maternal and neonatal obstetrical costs. Unit costs for neonates are adjusted through a scaling process based on birth weight (See Table 5 below) (Ministry of Health and Long-Term Care, 2006).

Table 5: *OCCI scaling factor based on neonatal birth weight*

Cost of Neonates greater than 2500g	=(2/3)*patient hours * hourly unit cost
Cost of Neonates between 2000g to 2500g	=(3/4) *patient hours * hourly unit cost
Cost of Neonates less than 2000g (not scaled)	= patient hours * hourly unit cost
Cost of Mother (not scaled)	= patient hours * hourly unit cost

For this thesis OCCI charges were only applied to births that actually took place in the hospital or that resulted in using hospital services within the two-day horizon postpartum. Births that took place at home, and did not require hospital

services in the immediate postpartum, were not subject to OCCI costs as there was no charge to the system beyond direct midwifery costs for these births.

Cost Components

Costs are composed of resources used, their quantities and their unit costs. Three main sources of information were used to determine unit cost and health care utilization: the Ontario Midwifery Program data (2003-2006); data from the Ontario Case Costing Initiative; and the 2010 Schedule of Benefits for Physician Services. For each case, resources, quantities and unit costs were summed to determine the cost of midwifery intrapartum and early postpartum and newborn care, as well as all costs associated with hospital use and costs that resulted from midwifery-initiated consultations that were incurred for both the mother and baby from the onset of labour. For planned home births this cost analysis included any transfer to hospital during the actual labour as well as a transfer or admission to hospital within the first two days after delivery. Costs associated with hospital use and costs that resulted from midwifery-initiated consultations that were incurred for both the mother and baby from the onset of labour were also included.

Costing hospital services involved determining health care resource use (type and quantities) and associated unit costs for all women and infants in both cohort groups. Hospital costs obtained were calculated for the 2008-2009 year and adjusted to 2010 dollars and physician costs were taken from the Physician Fee for Service Schedule used for 2010. 2008-2009 costs were converted using the inflation rates presented in the Canadian Price Index (CPI). Discounting was not performed since the time frame for this analysis is less than one-year duration.

Health care utilization

Two databases, the Ontario Ministry of Health database on midwifery care (OMP database) and the Ontario Case Costing Initiative (OCCI), were used to calculate health care utilization pertaining to the two cohorts.

OCCI costs account for all direct and indirect expenditures with the exception of fee for service costs resulting from consultant care, and are very specific according to a number of possible outcomes for each procedure. For example, vaginal birth may be characterized as "manually assisted vaginal delivery (vertex), without episiotomy)" or "manually assisted vaginal delivery (vertex) with episiotomy" or "unassisted spontaneous vaginal delivery, using approach/technique NOS (not otherwise specified)." For each OCCI category, the cost estimates associated with the greatest number of cases were chosen, thereby making the assumption that the normal standard of care can be defined by the greatest number of cases. Costs associated with different types of birthing modalities (as applied from OCCI data) can be found in Tables 6 & 7. These costs account for all direct and indirect expenditures with the exception of fee for service costs resulting from consultant care.

Table 6: *OCCI codes and associated costs used in analysis (2008-2009 data) – primiparous women*

Procedure Code	**Procedure**	**Number of cases**	**Average total cost primip**
5MD50AA	Manually assisted vaginal delivery (vertex), without episiotomy	7047	$3354
5MD53KL	Forceps traction and rotation, with episiotomy low forceps (e.g. Pajot maneuver	229	$3809

5MD54KL	Vacuum traction, with episiotomy low vacuum traction	308	$3878
5MD55KL	Combination of vacuum and forceps delivery, with episiotomy low vacuum/forceps	24	$3759
5MD56NL	Breech delivery, without episiotomy with spontaneous delivery of head partial breech extraction (assisted breech delivery	12	$8400
5MD60AA	Cesarean section, lower segment transverse incision, without instrumentation	4345	$5232

Table 7: *OCCI codes and associated costs used in analysis (2008-2009 data) – multiparous women*

Procedure Code	**Procedure**	**Number of cases**	**Average total cost multip**
5MD50AA	Manually assisted vaginal delivery (vertex), without episiotomy	9864	$2548
5MD53KK	Forceps traction and rotation, without episiotomy low forceps (e.g. Pajot maneuver	18	$3335
5MD54NE	Vacuum traction, without episiotomy NOS	155	$2708
5MD55KL	Combination of vacuum and forceps delivery, with episiotomy low vacuum/forceps	5	$3092
5MD56NL	Breech delivery, without episiotomy with spontaneous delivery of head partial breech extraction (assisted breech delivery	15	$5956
5MD60AA	Cesarean section, lower segment transverse incision, without instrumentation	3983	$4034

Resource utilization

OCCI costs factor in costs of staff personal but do not include costs for midwives or consultant care, neither of whom are typically salaried hospital staff. Thus for resource use for these care providers (obstetricians, anesthetists, pediatricians and midwives), associated costs were calculated. For midwifery-attended births, physician resource utilization occurs primarily from physician consultations (e.g. non-reassuring fetal heart rate) and physician procedures, including: delivery of infant; repair of complex tears; administration of pharmaceutical pain relief; and the provision of care for neonates.

The Ontario Case Costing Initiative (OCCI) provided costs associated with labour & delivery and postpartum based on length of time and parity. Since OCCI does not analyze resource utilization or costs by an hourly rate, a weighted methodology was used to calculate the time of admission until the time of delivery and the time of delivery until the time of discharge. Two labour & delivery nurses were contacted and asked to rate resource intensity from the time of maternal admission until delivery and from the time of delivery of a newborn until the time of discharge (A. Chapman, personal communication, 2011; J. Pizalle, personal communication, 2011). The nurses were asked to select a number from 1-10 (where one is the lowest amount of resource utilization and ten the highest) and to rate the resource intensity for both of these time frames. Respondents were asked to base their answers on the average or typical case and to respond to the resource utilization question for all subtypes of birth captured in the OMP database. The nurses were asked to rate each scenario by parity and to rate each type of birth both from the time of admission until delivery and from

delivery until discharge (see Appendix C for questions regarding resource intensity). Scale ratings along with OCCI data was then used to determine an hourly rate. From the OCCI database an average time from admission to delivery for both primiparous and multiparous women could be obtained as well as the average time from delivery to discharge. Information pertaining to the average general cost for primiparous and multiparous women by birth modality type (e.g. spontaneous vaginal birth or forceps) was also available. The midwifery database provided four generalized time period categorizations for admission to delivery and four generalized time period categorizations from delivery to discharge (e.g. delivered within 6 hours, delivered between 6-12 hours and so fourth). Hourly rates were applied to each woman from the midwifery database based on her respective midpoint time from admission to delivery and from delivery to discharge. Basing costs on the midpoint is unlikely to either over or underestimate costs.

Unit costs

With the exception of professional fees, which are based on health care utilization recorded in the midwifery database, all other unit costs including nursing workload and hospital hotel fee were collected from the Ontario Case Costing Initiative (OCCI) database. Thus, services provided by nurses were not analyzed separately as they are already included in the total OCCI reported costs as a component of direct costs. OCCI unit cost for hospital stay – intrapartum and postpartum- is based on both direct and overhead costs related to the provision of patient care. Among other variables, direct costs include nursing, operating room,

ICU, diagnostic imaging, pharmacy and labs. Overhead expenses related to the running of hospitals include administration, finance, human resources, plant operations and so forth (Ministry of Health and Long-Term Care, 2006). OCCI unit costs were collected in Canadian dollars for the fiscal year 2008-9.

Physician fees were calculated from the 2010 Schedule of Benefits for Physician Services Under the Health Insurance Act. A representative from the Regional Medical Association (RMA) who assists with physician billings as well as other health care experts and clinicians was contacted to assist with the identification and interpretation of the most appropriate fees (J. Elliott, personal communication, 2010).

The midwifery data forms do not capture time of day or length of time that a physician spends on a procedure, which introduces an element of imprecision into the calculation of unit costs since remuneration amounts are day and time dependent. Since both cohort groups started labour spontaneously, the assumption was that if there were variation between the groups regarding time of consultations and delivery, it would not be significant. As such, costs were calculated following the day time (7:00am to 7:00pm) Schedule of Benefits. Weekend costs as well as special call out costs and premium costs were not included in this analysis.

For obstetrical consultation information a Regional Medical Associate (RMA) representative provided information regarding unit cost and appropriate billing codes. For a six month period, with a sample of five Obstetrician/Gynecologist (OB/GYNs), billings reflected a total of 90 Midwifery Requested Assessments

(MRAs) and nine Midwifery Requested Special Assessments (MRSA) (Elliott, 2010). Despite this small sample, I choose to use this information to weight unit costs charged by obstetricians for midwifery consultations.

For anesthesia consultations, the midpoint time from admission to delivery was used to determine resource utilization up until the maximum amount of time for which an anesthetist is allowed to bill was reached (six hours). For anesthesia, time, unit cost and the type of intervention/procedure that was administered was analyzed to determine overall anesthesia cost (J. Elliott, personal communication, 2010).

Resource utilization for nurses, respiratory therapists and medications were captured in the total direct costs reported by the OCCI. Consequently, it was not necessary to detail the unit costs for these three categories.

Midwives in Ontario are paid per course of care. There is no algorithm that subdivides this total into different aspects of care provision (i.e. antenatal, intrapartum and postpartum). However, because costs were obtained for services of all other health personnel during the intrapartum period, a model that would fairly represent what a midwife was compensated for attending a birth had to be created. Assigning a value to midwifery intrapartum care ensures that the costs of midwifery-in-and-of itself are accounted for. Because the model of midwifery in Ontario is similar to the model of midwifery in British Columbia (BC), the midwifery association of British Columbia was contacted for information regarding midwifery remuneration. Because the British Columbian model divided the costs of midwifery care into three distinct time periods; antenatal, intrapartum

and postpartum, the Ontario remuneration was modeled on the breakdown used for midwives in BC as illustrated in Table 8 (Midwifery Association of British Columbia, personal communication, 2010).

Table 8: *Breakdown of midwifery remuneration in British Columbia*

Midwifery Remuneration in British Columbia	**Dollar amount**	**Description**
Full Course of Care (FCC)	$3042.19	Prenatal, intrapartum and postpartum
Labour and Delivery	$1014.04	Midwife must attend the entire labour and delivery (33% of FCC)
Transfer of care 'out' during L&D	40% i.e. $405.62	Amount that midwife who transferred care to another midwife or physician receives
Transfer of care 'in' during L&D	60% i.e. 608.42	Midwife now assumes responsibility for care and attends birth
Postpartum care	$1014.04	Full amount receivable if care is provided by midwife for at least 2 weeks postpartum

* based on 2010 rates

At the time of this analysis Ontario midwives were paid between $1,984-$2564 per course of care (J. Berenstein, personal communication, 2010). Including the operational fee, for which each clinic receives $744 extra per client for office overhead (irrespective of billing level), midwives are paid between $2,728 and $3,308 (J. Berenstein, personal communication, 2010). To calculate unit cost, the mean cost of midwifery remuneration ($3,018) was used and, following the BC methodology for the valuation of different aspects of care provision, this cost was multiplied by 33% to obtain a total cost for midwifery intrapartum care.

To calculate the individual cost per woman/case, unit costs were entered into an EXCEL spreadsheet and applied to the midwifery database (See table 9 for variable definitions/codes used). Data was then converted back into SPSS.

Table 9: *Variable definitions used to calculate unit costs*

Variable	**Criteria**
Attendance of Obstetrical Consultant at Spontaneous Vaginal Birth	If 'yes' to hospital birth AND 'yes' to intrapartum transfer of care AND 'yes' to spontaneous vaginal birth = Attendance of OB at SVB.
OutcomeDForceps	If 'yes' to hospital birth AND 'yes' to forceps but not 'vacuum AND forceps' and not breech and not cesarean then = Vacuum
OutcomeDVacuum&Forceps	If 'yes' to hospital birth AND 'yes' to vacuum and forceps but not breech and not cesarean = Vacuum & Forceps
OutcomeDCesarean	If 'yes' to hospital birth and 'yes' to cesarean then = Cesarean
OutcomeDBreech	If 'yes' to hospital birth AND 'yes' to breech but not cesarean = Breech
Ambulance Transport	If 'yes' to ambulance transport then = Ambulance Transport. (If maternal and infant indication both checked, count twice). Or if 'yes' to either maternal or fetal indication for ambulance transport (if both, only count once) or if 'yes' to infant indication for ambulance transport = ambulance transport.
Labour Augmented Oxytocin	If hospital birth and 'yes' to oxytocin augmentation= labour augmented oxytocin
Pain relief epidural	If hospital birth and 'yes' to pain relief epidural but not spinal = epidural
Pain relief spinal	If hospital birth and 'yes' to pain relief spinal = pain relief spinal

Pain relief general	If hospital birth and 'yes' to pain relief general but not cesarean section = pain relief general for purposes of removing placenta If hospital birth and 'yes' to pain relief general and 'yes' to cesarean section = pain relief general for cesarean section
Lacerations Perineal third	If 'yes' to third degree perineal lacerations and if 'yes' to discharge from hospital then = lacerations perineal third
Lacerations perineal fourth	If 'yes' to fourth degree perineal lacerations and if 'yes' to hospital discharge then = lacerations perineal fourth
OB consult intrapartum	If 'yes' to hospital birth and 'yes' to any of the intrapartum consult categorizations provided MINUS consultations for epidurals, spinals and/or general anesthetic = Obstetric consult intrapartum
OB consult postpartum	If obstetric consultation indicated as a result of excessive blood loss or tear repair and no OB intrapartum consult noted then = OB consult postpartum
OB manual removal of placenta	If manual removal of placenta manually entered into reason why OB was consulted intra- or postpartum OR if 'yes' to a general anesthetic but not cesearean section = OB manual removal of placenta
OB postpartum hemorrhage	If 'yes' to hospital birth OR 'yes' to transport to hospital postpartum and 'yes' to blood loss greater than 1000ml = OB postpartum hemorrhage
OB postnatal care in hospital	If 'yes' to intrapartum or postpartum transfer of care then = OB postnatal care in hospital (fee multiplied by number of days in hospital)
Pediatric attendance at maternal delivery	If 'yes' to hospital birth AND meconium manually charted OR 'yes' to PPV but NOT PPV with chest compressions and NOT NICU admission then = pediatric attendance at maternal delivery

Pediatric consultation	If 'yes' to pediatric consultation for respiratory distress and not NICU admission then = Pediatric consultation
Level 2 nursery	If 'yes' to infant admission any time after birth to neonatal or pediatric intensive care unit & neonatal age = 0,1,2 days OR if 'yes' to readmission to hospital & infant age = 0,1,2 days OR if 'yes' to admission to hospital from home birth & infant age = 0,1,2 days then = level 2 nursery

Various approaches were used to describe the data, namely: summary measures, graphs and tables. Describing the data helped to clarify the nature and distribution of the data (see Table 10 & Figures 2, 3,4, 5,6,7 in the Results section).

Cost, a continuous variable is usually distributed in a skewed manner. Starting with the assumption that these results are not normally distributed (as the charts/graphs located in the Results section seem to suggest), a non-parametric test, the Mann-Whitney test, was used to compare mean and median costs (a continuous variable) between planned and home and planned hospital birth cohorts and between multiparous and primiparous women.

A P-value of less than 0.05 was considered to indicate statistical significance for difference in clinical outcomes and costs between groups.

Results Section

Descriptive Statistics

Descriptive statistics were used to report on baseline characteristics (see Table 10). Overall, the groups were similar in baseline characteristics. In both cohorts the majority of the women who gave birth were between 25-34 years of age, were multiparous, lived in the southern urban part of the province, booked into midwifery care at the median gestation of 11 weeks, and gave birth at a median

gestation of 40 weeks. More women planning home birth (44.8%) had received care from a midwife in a previous pregnancy compared with those in the hospital birth group (33.1%).

Table 10: *Baseline characteristics of women planning home and hospital birth*

Characteristic	**Planned Home (n=6443)** **No. (%)**	**Planned Hospital (n=6443)** **No. (%)**
Age (yr)		
<25	715 (11.1)	842 (13.1)
25-34	4275(66.4)	4470 (69.4)
35-39	1186 (18.4)	941 (14.6)
>/=40	237 (3.7)	171 (2.7)
Missing	30 (0.5)	19 (0.3)
Parity		
Nulliparous	2275 (35.3)	2286 (35.5)
Multiparous	4162 (64.6)	4157(64.5)
Missing	6 (0.1)	-
Geographical location		
South rural	984 (15.3)	883 (13.7)
South urban	5104 (79.2)	4747 (73.7)
North rural	88 (1.4)	178 (2.8)
North urban	264 (4.1)	633 (9.8)
Missing	3 (0)	2 (0)
Repeat Ontario midwifery client		
Yes	2888 (44.8)	2134 (33.1)
No	3555 (55.2)	4308 (66.9)

Results from Statistical Analysis

All costs associated with birth (e.g. birthing modality, neonatal admissions, consultation fees, prolonged maternal stays in hospital and so forth) were tallied per case to calculate an overall per cohort cost.

The median cost of planned hospital birth from the onset of labour and from a third-payer point of view was more expensive [$2118.12 (IQR: $1467.12 to $3610.00)] compared to planned home birth [$995.94 (IQR: $995.94 to $995.94)]. Since the majority of other studies published use the mean rather than median costs, mean results are presented as well as median results to make comparison to other published data easier. Thus, the mean cost from the onset of labour was $1747.09 for planned home birth (SD: 2563.97) compared to $3050.79 for planned hospital birth (P=<0.001; SD: 2525.18).

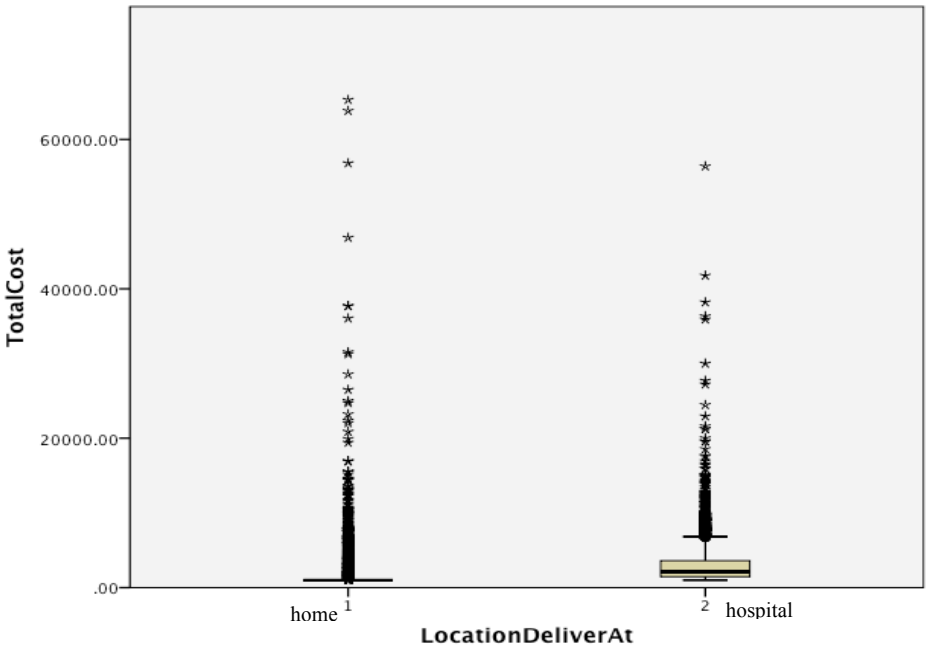
The cost difference between home and hospital planned birth can be explained in part by the high percentage of individuals who were planning a home birth and were successful in giving birth at home. In this study, 79.2% of individuals who were planning a home birth gave birth at home (5102/6443). Twelve hundred and eighty women in the home birth cohort gave birth in hospital and 61 women in the home birth cohort gave birth elsewhere. Of these 61 cases, four involved ambulance transport and potential birth in the ambulance. The other 57 cases likely reflect successful home birth that occurred in a clinic setting or other home-like location but not where the woman resides (and not the hospital). In the hospital birth cohort, 96.7% of individuals who were planning a hospital birth gave birth there. Two hundred and five women from the hospital cohort gave birth at home and nine gave birth elsewhere (three in an ambulance en route to the

hospital).

Costs for the hospital birth cohort ranged from $995.94 (for those who delivered at home) to $56, 405.97. The lower range for the home birth cohort was also $995.94 while the upper range was higher at a value of $65, 305.72. The fifth and 95th centile costs for hospital birth was $1374.66 and $7759.89 and for home birth was $995.94 and $5351.30.

The standard deviation and variance indicate that the data points are spread out over a large range of values (and are spread far from the mean).

Figure 2: *Box plot of total cost by cohort 1 (planned home) and cohort 2 (planned hospital) births*



These box-plots show that the total costs for both cohorts stretch out over a large range of values. For the hospital cohort, most of the costs are concentrated around the median (depicted by the presence of the upper and lower quartile), although above the whisker (positively skewed) are numerous outliers.

The histograms below (Figure 3 & 4) also reflect the positively-skewed nature of this distribution (*note while this distribution deviates from the normal curve it is a common type of distribution to see in cost studies).

Figure 3: *Histogram depicting distribution of total cost for planned home birth*

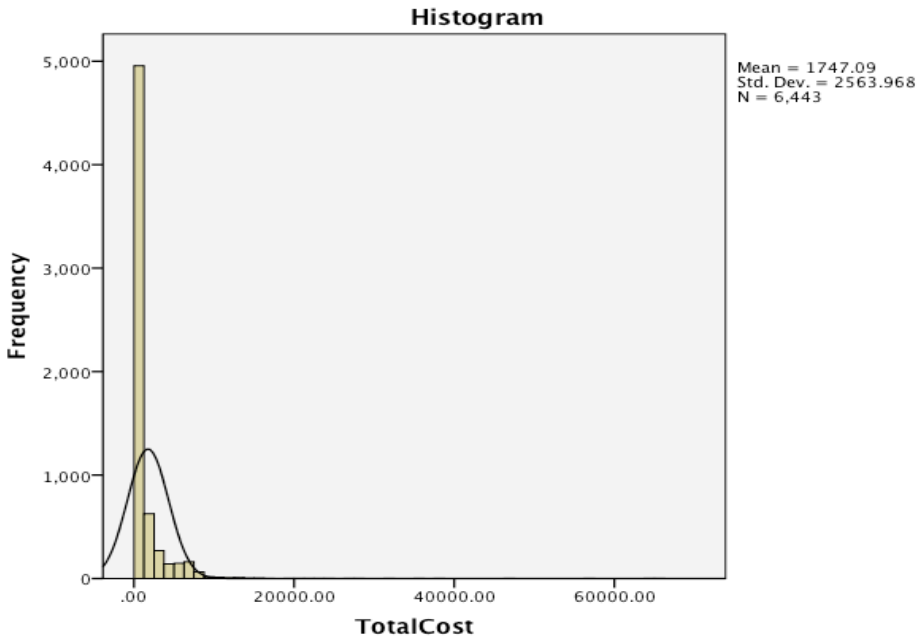
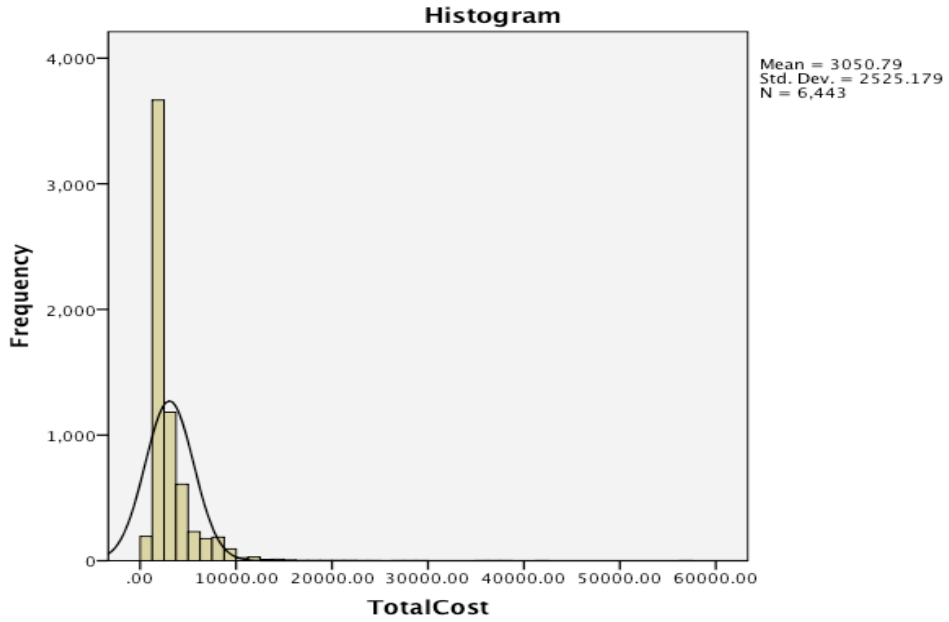
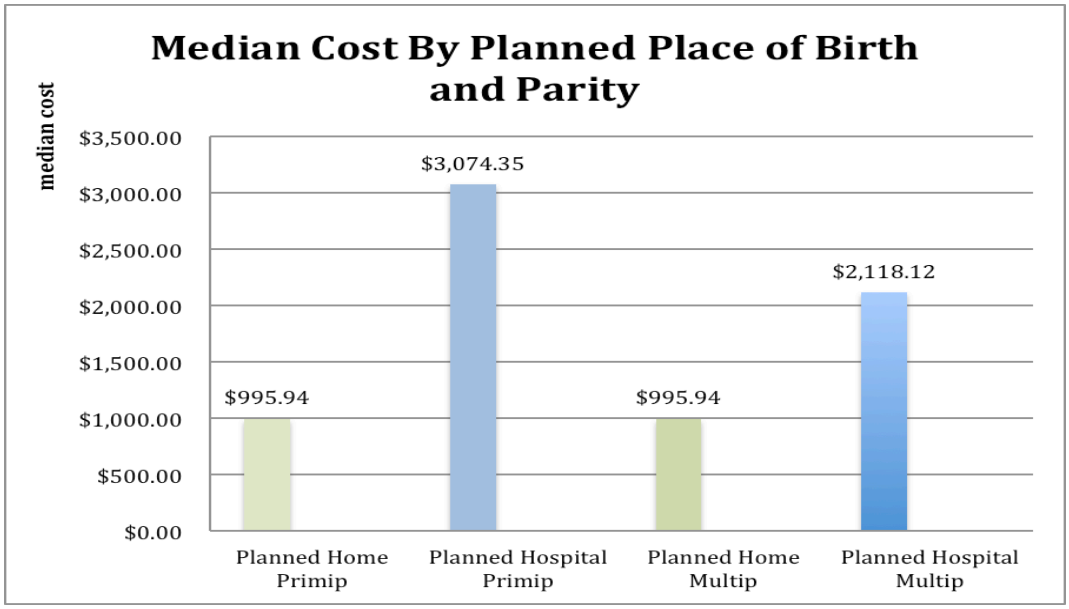


Figure 4: *Histogram depicting distribution of total cost for planned hospital birth*



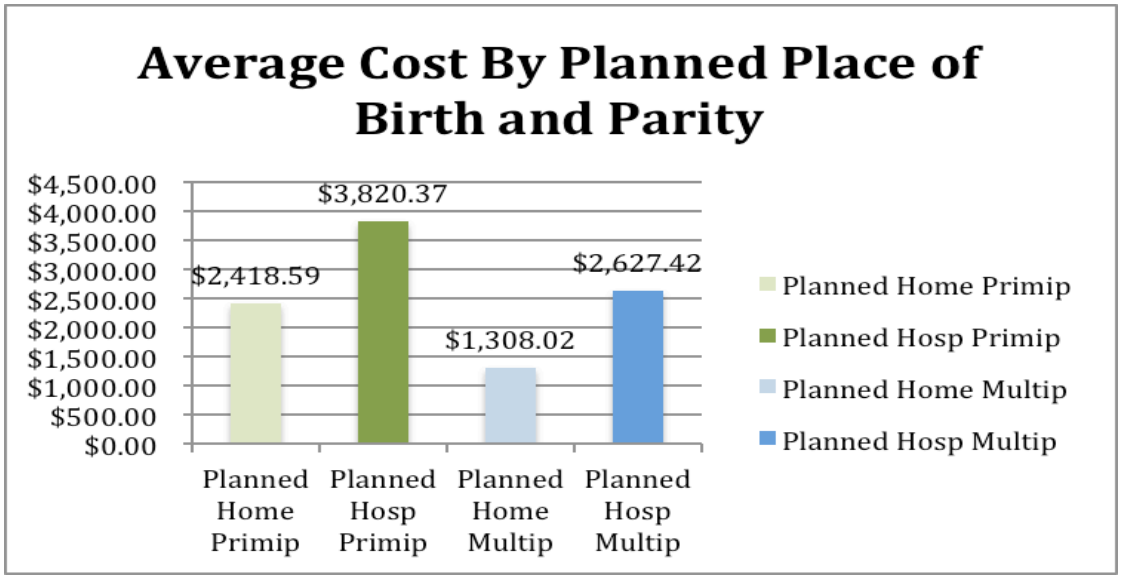
To determine the impact that parity exerted on cost, a sub-analysis was conducted based on parity. The median cost for primiparous and multiparous planned home births were $995.94 (IQR: $995.94 to $3013.14, and IQR: $995.94 to $995.94 respectively). The median cost for primiparous planned hospital births was $3074.35 (IQR: $1960.15 to $5004.83) while the median cost for multiparous planned hospital births was $2118.12 (IQR: $1467.12 to $3099.74) (Figure 5).

Figure 5: *Median cost by planned place of birth and parity*



The average cost for a planned home primiparous birth was $2, 418.59 (SD: 2721) and for a planned hospital primiparous birth was $3, 820.37 (SD: 2732), p <0.001. For planned home multiparous birth the average cost was $1, 308.02 (SD: 2232) compared to $2, 627.42 (SD: 2290) for hospital multiparous birth, p <0.001.

Figure 6: *Mean by Planned Place of Birth and Parity*



Although the original thesis question related to the overall cost of birth, costs by birthing modality were analyzed to better understand the quality of the data as well as the overall contribution that birthing modality had on total cost. The charts below illustrate the median cost by parity, planned place of birth and birth modality. In both cohorts, birthing by unplanned cesarean section was the most costly while spontaneous vaginal birth was the least expensive birthing modality.

Figure 7: *Median cost by planned place of birth & birth modality*

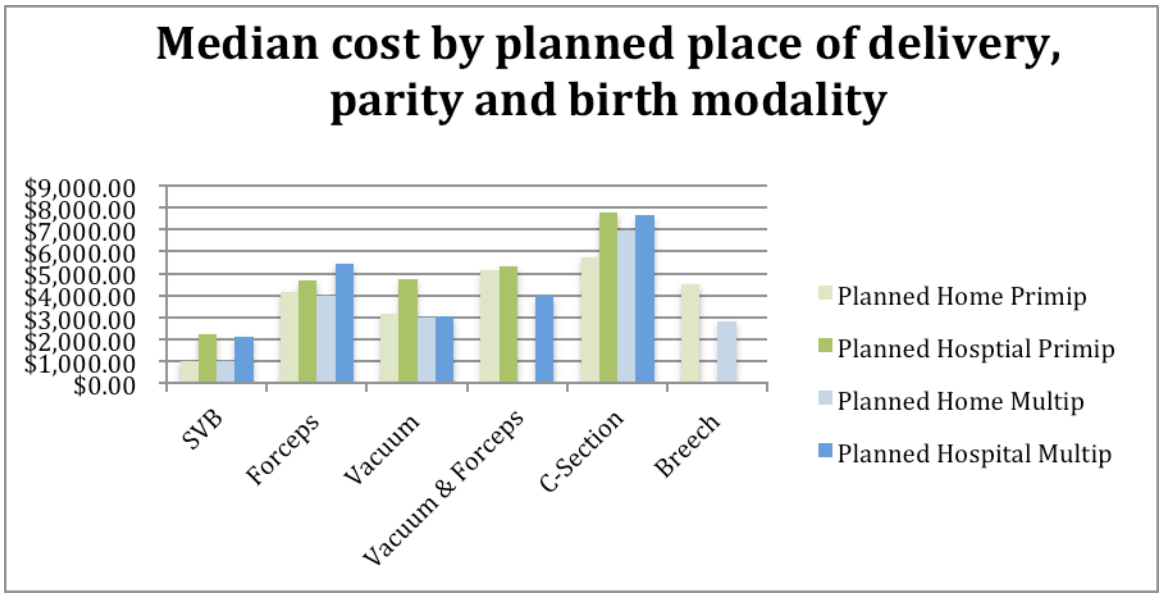


Table 11 summarizes the costs for home and hospital births by parity and birthing modality. Chart areas with no monetary value imputed result from having no cases within that category.

Table 11: *Summary of median cost by planned place of delivery, parity and birthing modality*

Median Cost by Birthing Modality	**Home Primiparous**	**Home Multiparous**	**Hospital Primiparous**	**Hospital Multiparous**
Spontaneous vaginal birth	$995.94 (IQR: $995.94-$1500.71)	$995.94 (IQR: $995.94 - $995.94)	$2204.46 (IQR: $1469.1 - $3562.96)	$2118.12 (IQR: $1467.12-$2768.17)
Forceps	$4164.74 (IQR: $3156.08-$5487.22)	$4005.32 (IQR: $3469.12-$5341.97)	$4669.43 (IQR: $3732.08-$6187.26)	$5458.96 (IQR: $3695.19-$6184.49)
Vacuum	$3170.84 (IQR: 2777.35-$4384.59)	$3010.31 (IQR: $2815.31-$4520.34)	$4749.22 (IQR: $3571.46-5864.27)	$3070.37 (IQR: $2815.31-$4597.26)
Vacuum & Forceps	$5124.23 (IQR: $3108.58-$6163.29)	-	$5317.64 (IQR: $4164.83-$6168.79)	$3969.16 (IQR: $3969.16-$3969.16)
Cesarean Section	$5736.86 (IQR: 5283.54-$6479.14)	$6964.07 (IQR: $6205.12-$7526.80)	$7759.89 (IQR: $6682.05-$8915.85)	$7642.72 (IQR: $7035-$8816.47)
Breech	$4496.29 (IQR: $2604.48-$4815.89)	$2828.59 (IQR: $995.94-$6383.80)	-	-

Table 12 reflects the number of cases associated with the above costs.

Table 12: *Number of cases by planned place of delivery, parity and birthing modality*

Number of cases by birthing modality	**Home Primiparous**	**Home Multiparous**	**Hospital Primiparous**	**Hospital Multiparous**
Spontaneous vaginal birth	1836	4113	1697	3999
Forceps	60	4	98	16
Vacuum	93	14	127	42
Vacuum & Forceps	10	0	17	1
Cesarean Section	272	29	341	98
Breech	7	5	0	0

Of the 741 women who had a cesarean section, the majority were discharged 25-60 hours after the birth (n=412). Another 310 of the 741 women who had cesareans were discharged greater than 60 hours after the birth. In contrast, of the women who delivered vaginally in the hospital, the majority were discharged within six hours after birth (n=2751). Another 2452 women who delivered vaginally in hospital were discharged 6-24 hours after the birth. Of the 741 cesarean cases, 116 cases were associated with a neonatal ICU admission (15.65%). In contrast, of the total 12, 145 home and hospital vaginal births, 514 were associated with an ICU admission (4.2%). This finding helps to explain the higher costs among cesarean born infants.

Since a large proportion of the costs is attributed to length of hospital stay,

an examination of length of stay by cohort as well as by parity provides useful insights.

Table 13: *Maternal stay in hospital (excluding readmissions): admitted in labour & delivered within:*

Length of Time (Number of women)	**Primip Planned Hospital birth**	**Multip Planned Hospital birth**	**Total Hospital**	**Primip planned Home birth**	**Multip Planned Home birth**	**Total Home**
Unknown	6	18	**24**	8	6	**14**
Did not go to hospital	86	127	**213**	1372	3767	**5143**
6 hours	1042	3391	**4433**	409	327	**737**
12 hours	768	551	**1319**	317	52	**369**
24 hours	370	66	**436**	160	10	**171**
48 hours	14	4	**18**	9	0	**9**

Of the 6206 women who delivered in hospital in the planned hospital birth group 71.4% delivered within six hours of admission to hospital and another 21.25% delivered within 12 hours of admission. Of the 1,286 women from the planned home birth cohort who delivered in hospital, 57.3% delivered within six hours and another 28.7% delivered within 12 hours. These results seem to suggest that as a percentage, the home birth cohort spent a longer amount of time in hospital than the hospital cohort from admission to delivery.

Table 14: *Length of time from birth to discharge home (postpartum hospital)*

Length of Time (Number of women)	**Primiparous Planned Hospital birth**	**Multiparous Planned Hospital birth**	**Total Hospital (13 missing = .2%)**	**Primiparous planned Home birth**	**Multiparous Planned Home Birth**	**Total Home**
Did not go to hospital/ unknown	91	140	**231**	1327	3756	**5132**
Discharged < 6 hours after birth	588	1691	**2279**	259	214	**474**
Discharged 6-24 hours after birth	673	1436	**2109**	253	105	**358**
Discharged 25-60 hours after birth	708	786	**1494**	265	70	**336**
Discharged >60 hours after birth	226	105	**330**	126	17	**143**

Of the 6212 women who were discharged from hospital in the planned hospital cohort 27.2% were discharged less than six hours after birth and another 33.95% were discharged 6-24 hours after birth. In contrast of the 1311 women who were discharged from hospital in the planned home cohort, 36.16% were discharged less than six hours after birth and another 27.3% were discharged 6-24 hours after birth. Thus a greater percentage from the home birth cohort were discharged home earlier.

Results of Independent-Samples Mann-Whitney U Test (Median Test)

Data was analyzed both by planned place of birth for the total group as well as for subgroups (with parity equalling zero and greater than or equal to one). A non-parametric Mann-Whitney U test was used in both cases to test for significance.

Results by planned place of birth

The median cost was significantly higher by planned place of birth for women planning to give birth in hospital ($p=<.05$).

Results by parity

Parity was analyzed to determine the impact that parity alone exerts on birth outcome and hence on cost. Total cost is significantly different both by planned place of birth as well as by parity alone, irrespective as to where the birth was planned to take place. There is also a significant difference by parity within each cohort ($p<.05$), with nulliparous women costing more from a third payer perspective than multiparous women.

Maternal Mortality and Stillbirths

In my database no cases of maternal mortality were reported in either cohort. In total four stillbirths were reported – all among primiparous women: one in the homebirth group and three in the hospital group. In the stillbirth from the home birth cohort an ambulance transport occurred and an emergency cesarean section took place. One of the planned hospital births was a stillbirth that occurred at home and resulted in a neonatal resuscitation and ambulance transport to the hospital following delivery. The other two hospital stillbirths were delivered in the hospital. In the Hutton et al. analysis (2009), there were three home birth

stillbirths. This is due to the fact that this analysis excluded women who had had a previous cesearean section while their primary analysis included this subset (i.e. among women in the home birth cohort who were attempting a VBAC, two stillbirths occurred). Costs for stillbirth followed my regular costing methodology with the exception that neonatal cost for postpartum was not calculated, as there was no indication in any of the stillbirth cases that the infant was admitted to an intensive care unit. Moreover APGAR scores for all four cases were 0 at both 1 and 5 minutes. As such the assumption was that the infant died in utero or within the immediate postpartum and no resources for the infant past the initial resuscitation were required.

Results Related to Ambulance Costs

Ambulance costs were derived from the midwifery-tracking sheet. The question asked on the tracking sheet "was there an ambulance transport from home during or immediately after home birth?" does not capture *readmissions* from either home or hospital where mother or infant may have been transported via ambulance. While true costs are at risk of being underestimated, because the focus is the intrapartum period and is limited to the first two days thereafter, this risk is minimal. Hospital birthing women would be at similar risk of using this service.

Ambulance use costs the health care system an average of $195/hour (for a total of $240 with a $45 co-payment from the patient). This cost varies slightly between municipalities as a result of a 50/50 cost split between the municipalities and the province. The cost of $195 includes ambulance use as well as labour

charges of paramedics, irrespective of paramedic training level (usually two paramedics respond to a call) (B. Addley, personal communication, 2010).

The assumption relating to ambulance costs was that one ambulance was used per individual. For cases where both maternal and *fetal* concern was indicated for reason for ambulance use, only one charge was applied. For cases where both maternal and *infant* concern was indicated for reason for ambulance use, two charges were applied. In the home birth cohort, there were 346 ambulance transports of which seven involved transport for both a maternal and infant-related reason. In the hospital birth cohort there are 49 reported cases of ambulance transport of which six were for both a maternal and infant-related concern (and a charge of $390 rather than $195 was applied).

Results related to resource utilization for consultation and fee for service procedures

Results for obstetric resource utilization

Table 15 in Appendix B outlines resource utilization for consultations and fee for service procedures included in this analysis and the associated unit costs. Obstetric fee for service costs for vacuum, forceps and vacuum and forceps are included under code P020 for operative delivery fee. For the purposes of costing obstetric consultant care these three operative delivery types were summed together. However, they were kept as distinct categories for purposes of applying OCCI costing data (since data provided by OCCI indicated that costs varied).

For obstetric resource utilization costs analyzed included those that have an associated fee for service charge in the schedule of benefits and are specifically reported in the midwifery database, namely: consultations, operative birth, 3rd and

4th degree tear repair, and post-partum hemorrhage. Information pertaining to manual removal of placenta was also analyzed since there is a fee for service charge (both anesthetic and obstetric). However, because information related to manual removal of placenta is entered under an 'other' category rather than reported as its own category, midwives need to fill out the reason as to why consultation took place for this category to be valid. In total, eight consultations are listed as being for manual removal of the placenta. While non-documented cases are at risk of being missed as are cases that were documented incorrectly (e.g. retained placenta), on a whole the section related to why 'other' consultation took place in the intrapartum period is well filled out (with only 11 blanks). No cases of manual removal are documented for postpartum consultation. Reason for 'other' consultation in the postpartum section is also documented well (only five blanks). In cases where general anesthesia was administered but a cesarean section did not take place the assumption made was that manual removal of the placenta occurred (even if not documented). There were seven cases in the hospital cohort group where this scenario applied. Five of these seven cases listed "retained placenta" as the reason and the other two were left blank – and were assumed to have been for the manual removal. There were two cases in the home birth cohort where a general anesthetic was given but no cesarean took place. Both cases listed "retained placenta" as the reason for 'other' consult.

Likewise, the number of spontaneous births at which obstetricians are present is not specifically captured in the midwifery database. To determine the number of spontaneous births where obstetricians were present, the number of

spontaneous births where intrapartum transfers of care were noted as having taken place were calculated. This resulted in calculating costs for 776 cases where an obstetrician was assumed to have been present at the delivery of a spontaneous vaginal delivery (292 cases for planned home birth and 484 cases for planned hospital birth). Code P010 that enables an obstetrician to charge $211.20 for being at a delivery, was applied to these 776 cases. The assumption, confirmed by a RMA correspondent, was that if there had just been an obstetric consult but not a transfer of care, then the obstetrician was not present at the delivery. (J. Elliott, personal communication, 2010)

Lastly, the midwifery database has no specific category that captures the number of visits that an obstetrician makes in the postpartum period. To determine the number of visits that an obstetrician made in the postpartum period it was first determined if a transfer of care occurred either during the intrapartum or postpartum period. Postpartum discharge data (median time) was used to determine number of visits that would have been made. For example, if it was noted that the woman was discharged 25-60 hours after birth (median= 42.5hrs), the assumption was that most likely the obstetrician made two visits (one per day) and costs were calculated accordingly ($55.15 x 2) using code P007 from the fee for schedule benefits.

Results for anesthesia consultations

Anesthesia charges were calculated through the use of specific pain relief categories (spinal, epidural and general) rather than through pain relief consultation in general. This was necessary for two reasons. Firstly there are

different remuneration amounts on the Fee for Schedule Benefits for different anesthetic types when administered for pain control during labour (note: if used as pain control during cesarean sections there is a set fee). Moreover while there is a category for intrapartum consultation for pain control (epidural/spinal) this category is poorly used. For example, of the 741 cesarean sections listed in the database only 244 cases list an intrapartum consult for epidural or spinal pain control. It is possible that the midwife thought it sufficient to check the epidural and cesarean section pain relief categories without needing to check the pain consultation box. Therefore, using the summation of epidurals, spinals and generals to determine number of anesthesia consults and costs is more valid than using pain consult for epidural/spinal category.

Eight planned home birth entries for pain consultation stated that consult for pain relief epidural/spinal occurred but there was no indication of epidural, spinal or general noted. The most likely explanation is that delivery occurred prior to initiation of pain relief. Two entries that report outcomes of cesarean sections fail to report any use of spinal, epidural or general. This is likely a coding error.

In terms of operative delivery, the assumption (based on personal experience and that of colleagues) was that an anesthetist was present for all births involving forceps but not for births that only involved vacuum. This assumption led to analyzing costs for 210 forceps deliveries; 76 in the home birth group and 134 in the hospital birth group. Excluding anesthetists from vacuum delivery (although there is a fee on the schedule of benefits) resulted in potentially missing

108 home birth cases and 171 hospital birth cases where an anesthetist was indeed present.

Calculating anesthesia costs based on time units

The midwifery database does not collect information pertaining to length of time for a procedure or for drug duration. Moreover, even if this information were collected, database reporting of epidural duration prior to cesarean section is often considered unreliable due to missing values. For example, insertion time may be documented but not epidural removal time, or the actual time the anesthetist spends delivering the epidural minus the time s/he is out of the room. Since information required to calculated anesthesia costs was not available, an assumption was made that the midpoint for each time range (reported in the midwifery database under the category "Maternal Stay in Hospital" from admission to delivery) represented the length of time that anesthesia was used. Length of time was then calculated based on codes P014C and P016C. For the first time range (0-6 hours from admission to delivery) anesthesia was calculated for a three-hour duration. For the next three time ranges, anesthesia was calculated up to its maximal point, i.e. six hours, resulting in maximal unit charge of $263.70. An additional fee of $50 was added to the cost if a spinal was administered as per code E111C.

The cost of an epidural initiated specifically to perform a cesarean section is included in an anesthetist's fee to perform the cesarean section. On the other hand, anesthetists can bill for epidurals separately when initiated for pain during labour. If a cesarean section then occurs, the anesthetist can still claim a fee for

both pain relief and cesarean section. Because there are no planned cesarean sections in the two cohorts, the assumption was that if a cesarean section took place, an anesthetist would bill both for pain relief and a cesarean section. For example if a woman had a cesarean section and if both an epidural and a general were noted as having been administered to her, one was assumed to have been for pain relief during labour and the other for use during a cesarean section. For these cases, pain relief for epidural was calculated based on time in labour, and pain relief for GA was calculated based on a fixed fee for anesthesia as per the Schedule of Benefits.

In the planned home birth group there were 622 epidurals, 91 spinals and 20 general anesthetics documented. In the hospital group there were 1321 epidurals, 137 spinals and 42 general anesthetics documented.

For anesthesia use where the outcome was a cesarean section code P009 was used. To determine length of procedure, data pertaining to cesarean sections from a prior 2011 study (EECV2) was used. This study used data from 68 centres in 21 countries and found that based on 828 women who had cesarean sections the average length of cesarean section was 1.5 hours (Hutton et al., 2011).

To calculate other anesthesia unit costs (such as operative delivery and third or fourth degree tears), one midwife and one physician were contacted to report on the average amount of time that these procedures take based on their own personal experience (P. McNiven, personal communication, 2010; D. Reddy, personal communication, 2010).

The assumption made was that if the birth took place in the hospital

anesthesia was present when a post partum hemorrhage (PPH) was documented and code Z774 (six units) was applied to calculate costs. Presence of an anesthetist (and obstetrician) was judged to have likely resulted when the midwifery database indicated that estimated intrapartum maternal blood loss was greater than 1000ml. Cases where the outcome was a cesarean section were excluded due to the fact that blood loss often exceeds 1000ml during a cesarean section (and an anesthetist will receive a flat rate for services performed during a cesarean section). Thus, unless a postpartum hemorrhage was specifically charted in the 'other' section, cesarean sections were not used to tally postpartum hemorrhages where blood loss exceeded 1000ml. This assumption likely results in an overestimation of anesthesia costs and an underestimation of costs for postpartum hemorrhages associated with cesarean sections.

Results related to resource utilization for pediatric consultations

A pediatrician was assumed to be present at all hospital deliveries in which meconium was charted (irrespective as to whether a pediatric consult was marked) as well as if there was a resuscitation involving positive pressure ventilation. The College of Midwives of Ontario does not require midwives to consult with a pediatrician for either of these cases – meconium or resuscitation. Nonetheless, it is common practice to consult for these events, especially if the birth is taking place in hospital. This assumption also allowed for costing out what should have taken place in ideal practice. In reality, consultation probably *did* take place: of the 132 counts of meconium charted (which occurred in the hospital and where the infant was *not* admitted to the Intensive Care Unit (ICU)), 130 of them

list consultation with an obstetrician. In practice, the obstetric consultant would have initiated a consultation with a pediatrician (or respiratory therapist). Although pediatricians were likely present at other meconium births than those calculated above, births where meconium may have occurred but the infant went directly to the NICU (Neonatal Intensive Care Unit) or where positive pressure ventilation with chest compressions is also documented were calculated differently. Although the assumption was that a pediatrician was present at hospital deliveries involving positive pressure ventilation with chest compressions, infants with chest compressions documented in the midwifery database all went to the ICU. In these cases, cost for pediatric attendance at maternal delivery was not calculated since a G code would have been billed and, according to the Schedule of Benefits, cannot be used in conjunction with another code. Likewise in other cases where pediatric consultation is documented (such as for respiratory distress) but the infant went to the NICU a G-code would have precluded the cost for pediatric consultation.

For infant consultation(s) and transfer of care, the assumption was that all consultations with the exception of breastfeeding problems, took place with a paediatrician. Because time of consultation could not be verified, the assumption made was that only consultations relating to respiratory distress occurred within the first two days following birth as this is the most likely scenario. The other reasons listed for pediatric consultation likely fall outside of the two-day horizon or are not relevant to this dataset (failure to thrive/slow to gain, jaundice). In total there were 149 consultations documented for respiratory distress and where the

neonate was not admitted to an ICU (68 in the planned home birth and 81 in the planned hospital birth).

For cases where positive pressure ventilation took place in a hospital setting, there were no cardiac compressions, and the infant was not admitted to the ICU, a pediatric consultation was assumed to have occurred. Again, this assumption may reflect the ideal more than the actual situation in which case there is a risk of overestimating costs. To determine how the system would be charged for a pediatrician assisting with positive pressure ventilation at delivery a practicing pediatrician was which resulted in the recommendation to use the code for pediatric consultation (B. Klein, personal communication, 2010).

In total there were 616 pediatric consultations of which 282 were attributed to the home birth cohort and 334 were attributed to the hospital birth cohort.

Although there is a code to bill for pediatric newborn care in the hospital this charge was not applied for a couple of reasons: a) there is no indication in the midwifery database if infant transfer of care took place. If the neonate was transferred to the ICU the assumption was that a transfer of care took place. In these cases a G code would have replaced the code for pediatric newborn care in hospital b) there is not enough information in the midwifery database regarding the number of days infants spent in the hospital. Although the length of time in an ICU is given, when the infant was discharged from the ICU, the assumption was that he or she would have been discharged directly to home. This results in a potential to miss calculating charges for the period of time when an infant may

have been discharged from an ICU but stayed in hospital (and may therefore have been under the care of a pediatrician).

Results related to resource utilization for neonatal admissions and readmissions

No midwifery-related neonatal readmissions were reported to OCCI for the 2008-2009 fiscal year. In comparison, based on 2003-2006 midwifery data, in the home group birth there were 15 readmissions (17 readmissions that took place from day three onwards were excluded) while in the hospital group there were 17 readmissions from days zero to two (114 readmissions that took place from day three onwards were excluded).

For an infant born in the hospital there is no indication in the midwifery dataset of the number of days spent in hospital if not discharged with mother. While the number of days in the ICU is recorded (although the level of ICU care is not captured in the database), the number of days between being discharged from the ICU to being discharged home is not recorded (note: this information *is* available for babies born at home who were admitted or babies readmitted to hospital).

The assumption that babies were discharged directly home was more reasonable once an assumption was made that babies in the midwifery database were admitted to Level 2 instead of NICU. This assumption was checked with a pediatrician who agreed that it was reasonable since the babies from both cohorts were term infants (B. Klein, personal communication, 2010). However, while it is likely that the majority of infants went to level 2, given varying hospital resources and geographical realities depending on if level 2 or level 3 exists within a given

hospital, it is unlikely that *all* infants requiring specialized care went to level 2. The price differentiation between the codes for level of care (level 2 or level 3), especially from day two onwards is not extreme so the assumption regarding level of care would not be expected to have a significant impact on cost variations. Another assumption was that all infants who were born at home but later admitted and all infants who were discharged from hospital but later admitted to an intensive care unit were admitted to Level 2. In reality some infants are admitted to the neonatal intensive care unit Level 2 while others are admitted to the pediatric intensive care unit depending on regional practice. Because the midwifery-tracking sheet has one question regarding the admission of an infant at any point to an intensive care unit but does not differentiate between care units an assumption had to be made.

To calculate NICU Level 2 rates information provided by OCCI regarding the average total cost for NICU admissions ($17, 283) was utilized. Based on the number of cases and the average length of stay, the total for one day of NICU-Level 2 admission was $49.32/hr or $1,183.77/day.

When no NICU stay was indicted the assumption was that infants that were born in hospital spent the same amount of time in hospital as their mother (i.e. they were discharged together).

To calculate normal newborn care rates the above methodology was applied to normal newborn care data. An hourly rate ($19.98) was then applied to the midpoint time of the mother's hospital discharge as listed in the midwifery client-tracking sheet (e.g. If the client was discharged 25-60 hours after birth, the

rate was calculated by multiplying 42.5hrsx $19.98).

Problems occurred with calculating newborn stay (and maternal stay) when a woman was admitted to the hospital following a planned home birth. For example, if a postpartum consult was noted for maternal bleeding but the infant was born at home costs could not be calculated. The midwifery database did not have a specific category to determine if a woman was admitted or readmitted to hospital, nor did it have length of time a woman was admitted if admission to hospital occurred in the immediate postpartum period. If an infant was admitted due to maternal concerns there was an assumption that the baby would have been in the normal nursery unless specifically indicated otherwise.

In the midwifery database, 197 ambulance transports occurred in the home birth cohort due to maternal concerns. Of these 197 cases, 95 of them delivered at home and four cases delivered elsewhere (most likely in the ambulance, although ambulance birth is only recorded for two of the four births). Of the 99 cases, 88 of them provide no discharge information for the mother and 66 of these cases provide no information on newborn admission to hospital. Thus, there is a risk of underestimating true costs for the home birth cohort.

Assumptions Regarding Consultations

To determine the total resource utilization that resulted from consultation, various assumptions had to be made. The first assumption was that costs could be calculated using a fee-for-service remuneration scheme as outlined in the Schedule of Benefits under the Health Insurance Act. In reality however there are many mechanisms through which physicians can be paid, such as Alternative

Payment Plans.

Because the midwifery database does not report the type of practitioner with whom consultations occurred, another assumption made was that all intrapartum consultations with the exception of epidural, spinal and general anesthetic took place with an obstetrician. Similarly, the assumption was that all intrapartum anesthetic pain relief recorded in the database took place in consultation with an anesthetist. The total number of epidurals, spinals and general anesthetic was summed and subtracted from the total number of intrapartum consultations reported. The former was the resource utilization resulting from anesthesia consultation and the latter the resource utilization resulting from obstetric consultation.

According to the regional medical associate who provided information for this project, obstetricians did not charge for oxytocin augmentation if a MRA or MRSA code was charged (J. Elliott, personal communication, 2010). One of the assumptions made however is that physicians will bill when able and will also use the most lucrative code when possible. Since there is a specific oxytocin augmentation code that is permissible to use in conjunction with both a MRA and MRSA code, the assumption was that this code was used, and calculated costs accordingly. It is possible that because the obstetricians who were included in the sample that the regional medical associate analyzed were all academically affiliated they were already earning the maximal amount for which they were able to bill.

Because the midwifery database does not link time of consultation with consultation, certain assumptions had to be made. For postpartum, if excessive blood loss was listed as the reason for consultation, the assumption made was that this consultation took place in the immediate post partum period. On the other hand, all postpartum consultations for infection were assumed to have taken place after the immediate postpartum period. Consultation judged to have taken place after the immediate postpartum period (i.e. after the first two days) were excluded from cost calculations. It is important to note that there is a 'total' number of postpartum consultations column. This column is likely more accurate than the other three columns (blood loss, infection and other) as there are no missing values – whereas the three individual postpartum fields (blood loss, infection and other) have missing values. To compensate for a potential under-reporting for intrapartum blood lost, data reporting the amount of blood lost was examined. When the estimated amount reported was >1000 ml and a hospital birth or transfer to hospital was reported, the assumption made was that obstetric consultation occurred even if not documented.

Multiple Consultations

To calculate total obstetric postpartum consults, the number of cases where intrapartum consults also occurred was subtracted since obstetricians can only charge for one MRA or MRSA consult per woman over the same time period (J. Elliott, personal communication, 2010). Charges were not tallied when consultations were deemed to have occurred in the immediate postpartum period and could therefore be considered as part of the intrapartum period. A review was

undertaken to consider which postpartum consultations could be considered as an extension of the intrapartum period. Postpartum consults that most likely took place in the immediate postpartum period (e.g. retained placenta, repair of tears, episiotomy) were only counted once. In reality, some of these consultations may have resulted in a second consultation if they occurred on a different day of the birth or if a different obstetrician was on-call from the attending obstetrician. This assumption risks underestimating true costs.

In total five multiple postpartum consultations were excluded from home birth group data analysis and 38 multiple postpartum consultations were excluded from the hospital group data analysis. Therefore, although the midwifery-tracking sheet may have indicated two consultations only one charge can be administered to the health care system. It is important to note that even in cases where multiple consultations are determined to have a single consultation fee, there can still be a charge for the procedure itself (e.g. 3rd or 4th degree tear or postpartum hemorrhage). In these cases, a consultant fee was calculated only once but a separate procedure fee was applied when applicable. For example, because the postpartum fee for service for obstetricians for excessive blood loss was judged to have occurred within the immediate postpartum period a charge for postpartum consultation was NOT added. However, a charge of $93.80 was added for all cases where consultation for excessive blood loss was indicated (as per the obstetric schedule of benefits).

Individual with whom consultation took place

To determine with whom the consultation most likely took place, rationale for a given consultation had to be reviewed. When the rationale provided related to anesthesia (i.e. spinal or epidural procedure or postpartum complication such as headache or anesthetic complication) these cases were removed from the total number of obstetric consultations and put into a separate category to determine anesthetic consultations. In general the assumption was that all obstetric consultations (with the exception of epidural/spinal/general consultations) took place with an obstetrician. In reality, some consultations may have taken place with a family physician or other professional. Likewise the assumption made was that newborn-related consultations took place with a pediatrician. This may not be the case as there are regions in which a family doctor or respiratory therapist may have been consulted instead. Remuneration for respiratory therapists are part of a hospital budget, i.e. data on which this thesis is based may already account for the costs associated with respiratory therapists as part of total direct costs and there is a risk of overestimating costs.

Likewise the assumption made was that all breastfeeding consultations took place with a lactation consultant but there is no way – without reviewing individual charts- to verify these assumptions. Costs associated with breastfeeding consultations are part of a hospital budget and were therefore not separately costed.

Place of consultation

An assumption made was that all postpartum consultations – regardless of whom they were with – took place in hospital. Of course, this assumption may not

have been correct in which case there is a risk of overestimating costs. For example, postnatal care in hospital and/or home receives a compensation of $55.15 (code P007) while postnatal care in the office (code P008) receives a compensation of $32.35. However, the risk of overestimating costs is small especially given that only the first two days postpartum are being calculated.

Neonatal readmissions was defined to include nursery and level 2 care units but not outpatient clinics or emergency department visits. While this assumption may miss costs associated with emergency department or outpatient consultation, without being able to refer directly to individual patient charts (which was beyond the scope of this thesis) such an assumption had to be made and likely captures the majority of cases where readmission took place.

According to a senior health economist for the Ontario Hospital Association, hotel costs that occur as a result of readmissions would be similar to hotel costs that occur if the infant were still in hospital care (A. Gaber, personal communication, 2010). Consequently, OCCI data detailing costs of ICU and nursery care were applied to neonatal readmission data.

For admissions and readmissions that were non-NICU cases, individual cases were reviewed and a pediatrician was consulted to determine which level of care this infant would most likely have received. All non-NICU admission and readmission cases due to neonatal concerns (such as jaundice, respiratory distress and so forth) were counted as level 2 admissions. Without more specific case details, this was the most reasonable assumption. Costs were calculated accordingly.

Consultations outside of midwifery care

There may be a few cases where clients using midwifery care initiated consultations without the involvement of a midwife. However, given the close relationship between midwives and the women with whom they work as well as the short postpartum period included in this analysis, this type of consultation is likely infrequent.

Timing of consultation

The timing during which both maternal and neonatal consultation and transfer of care took place is not readily available. Thus, while certain assumptions are necessary, such as assuming that pediatric consultations for respiratory distress occurred within the first two days, in reality, consultation could have occurred at any point within the first six weeks following delivery. On the other hand no assumption was needed for babies who were admitted to the NICU because the dataset reports the age (in days) when the infant was admitted.

Discussion & Conclusion Section

Discussion of Results

Similar to other research studies, this study found that from a third payer point of view, when a hospital birth is planned at the onset of labour it is more expensive [$2118.12 (IQR: $1467.12 to $3609.95)] than a birth planned at the onset of labour to take place at home [$995.94 (IQR: $995.94 to $995.94)]. Although it is difficult to compare these results directly to other study findings due to different geographical settings, regional practices and methodological differences, like other studies that have compared planned home to planned

hospital birth, this study found that the option of home birth is a choice that is not associated with an increased cost to the health care system. This finding held true among nulliparous women as well as for multiparous women.

These findings demonstrate that women with low-risk pregnancies should continue to have the choice of birth place (home or hospital) due to the fact that offering this option does not create an additional financial burden on the system. The decreased cost associated with home births can be attributed to the high rate of actual home birth among women planning them, lower rates of cesarean and operative birth, fewer obstetric Fee for Service charges, fewer cases of maternal and neonatal ICU charges, and shorter mean postpartum hospital stays. Of the 6443 women in the home birth cohort 5102 women successfully gave birth at home (79.2%). The only fee from a third payer point of view associated with births that took place at home when there was no transport postpartum was the fee attributed to the cost of midwifery intrapartum care (i.e. $995.94). While practices have established different mechanisms to pay second midwives, the cost to the health care system is based on the number of primary cases that the midwife attends and as such, the cost for the second midwife was excluded from this analysis. When births did take place in the hospital, as with other research studies, this analysis found that straightforward spontaneous vaginal births (SVB) cost the health care system the least and caesarean sections cost the health care system the most.

In this study, among women who had planned a home birth, 301 had a cesarean section. In comparison, among women who had planned a hospital birth

439 had a cesarean section. One hundred and eighty one women in the planned home birth group had a vacuum, forceps or vacuum and forceps compared to 301 women in the planned hospital birth group. The median cost ranges for SVB were $995.94 (for both primiparious and multiparous women planning a home birth) to $2204.46 ($2118.12 for multiparous women planning a hospital birth and $2204.46 for primiparous women planning a hospital birth). The median ranges for cesarean section, forceps and vacuum were all also less expensive in the planned home birth cohort than the planned hospital birth cohort.

Among women in the planned home birth cohort there were also fewer charges for obstetric consultations compared to women in the planned hospital birth cohort. For example, for spontaneous vaginal births occurring in the hospital an obstetric fee of $211.20 was charged in 292 planned home birth deliveries and 484 planned hospital deliveries for having an obstetrician present at the delivery. Moreover, this study found that infants in the planned hospital cohort were more often admitted to the ICU compared to infants in the planned home cohort. Based on the 2003-2006 midwifery data, 263 infants were admitted from the home birth group to the ICU and another 140 were readmitted to hospital but not to ICU from the home birth group. From the hospital group 373 infants were admitted to the ICU following birth and another 104 were readmitted to hospital, but not admitted to the ICU after birth.

On the other hand, among the planned home birth cohort, there were 346 ambulance transports of which seven involved transports for both a maternal and infant-related reason (and a charge of $390 rather than $195 was applied

following the assumption that two ambulances were utilized). In the hospital cohort there were only 49 reported cases of ambulance transport of which six were for both a maternal and infant-related concern. Although ambulance transport was a higher cost to the health care system for the home birth group, overall, this cost did not significantly drive up the cost of home birth for the group as a whole.

When the database for resource use by modality of birth was examined, of the women who delivered vaginally in the hospital, the majority were discharged within six hours after birth (n=2751). Another 2452 women who delivered vaginally in hospital were discharged 6-24 hours after the birth. On the other hand, the majority of women who had a cesarean section were discharged 25-60 hours after the birth (n=412). Another 310 of the 741 women who had cesareans were discharged greater than 60 hours after the birth. Of the 741 cesarean cases, 116 cases were associated with an ICU admission (15.65%). In contrast, of the 12, 145 vaginal births, 514 were associated with an ICU admission (4.2%). These findings are in line with CIHI findings that suggest that increased cost for cesarean section births are linked to increased resource use (Canadian Institute for Health Information, 2006).

Based on prior research that found that intervention rates and clinical outcomes for nulliparous women planning home birth tend to be similar to nulliparous hospital cohorts (Hutton et al., 2009; Hutton et al., 2015), one might expect that the cost for primiparous women planning home birth to be relatively similar to the cost for primiparous women planning to birth in hospital. However,

as greater than 50% of primiparous women who planned to give birth at home were successful, the median cost for planned home primiparous birth in this study was $995.94 (IQR: $995.94 to $3012.14) compared to a median cost of $3,074.35 (IQR: 1960.15 to $5004.83) for planned hospital primiparous birth. The mean for a planned home primiparous birth was $2, 418.59 compared to $3,820.37 for a planned hospital primiparous birth ($p<0.001$). This finding can be explained by the fact that the median is less responsive to outliers than the mean. Desire to avoid intervention among the home birth cohort may also explain the cost difference noted. For planned multiparous home birth the median, as expected, was also $995.94 (IQR: $995.94 to $995.94). Despite the higher transport and cesearean section rates among nulliparous women compared to multiparous women, the lack of variance noted in the median between planned home births for primiparous and multiparous women reflects the successful home birth rate among both cohorts in this study and the fact that the median is less responsive to outliers than the mean. The median for planned multiparous hospital birth was $2118.12 (IQR: $1467.12 to $3009.74), lower than the median of primiparous hospital birth, which is in line with the research literature that multiparous women tend to consume fewer resources than primiparous women.

Low occurrences of events may help to explain some higher costs that were noted for multiparous women. For example, there is only one case in the hospital group of a multiparous woman having a vacuum and forceps delivery. Because the cost of her birth alone is used to determine cost, a sample bias whereby only one case is selected, may result in producing a higher cost.

Likewise there are only four cases of home birth multiparous women delivering via forceps. The impact of so few cases may skew results, in part explaining why multiparous forceps births are more expensive than primiparous forceps birth as well as being more expensive than a combined vacuum and forceps delivery. The low number of multiparous cesarean births can also be used to explain the high costs associated with them.

As a percentage, women planning home birth that birthed in hospital stayed a greater number of hours during labour and delivery and a shorter number of hours during the postpartum compared to women in the planned hospital birth cohort. This result is not surprising given that the home birth group had intended to give birth at home and likely came to hospital due to stalled labour or for pain relief. On the other hand, given the low-risk nature of the cohorts, most women in the hospital cohort had straightforward deliveries. However, because the majority of women planning a home birth did NOT go to hospital, on average, women in the planned home birth group stayed in hospital for a shorter amount of time overall than women in the planned hospital cohort. More than double the number of women in the planned hospital group (n=330) compared to the planned home birth group (n=143) were discharged greater than 60 hours after delivery (which likely means that their infants were also discharged greater than 60 hours after delivery). This finding is not surprising given that there were more cesarean sections and operative deliveries in the planned hospital birth cohort.

Of the 6212 women who were discharged from hospital in the planned hospital cohort 27.2% were discharged less than six hours after birth and another

33.95% were discharged 6-24 hours after birth. In contrast of the 1311 women who were discharged from hospital in the planned home cohort, 36.16% were discharged less than six hours after birth and another 27.3% were discharged 6-24 hours after birth. Thus a greater percentage from the home birth cohort were discharged home earlier. Again, this finding is not surprising given the desire of the women from this cohort to be at home (and likely to return home as quickly as possible after the birth).

Contextualizing Cost Differences

Although these thesis results suggest that planned hospital births cost the system more money than planned home births, caution needs to be used when extrapolating these 'savings' and translating them into true costs. Costing studies/costing analyses are partial evaluations that strictly compare the costs of programs without measuring and valuing program outputs: "Ascertaining actual health care costs is complex, especially when additional benefits or costs might be accrued later but were initiated by a particular health care approach" (O'Brien et al., 2010, p.651).

Safe home-based midwifery care is only possible because hospitals exist and have the capacity to admit a midwifery client in labour should she require a hospital setting. Thus to truly ascertain costs or savings one would have to determine what percentage of hospital costs should be attributed to ensuring safe midwifery care for home deliveries and how this percentage should respond to a potential growth in home birth numbers. For this thesis, for midwifery births that took place in the hospital a specific amount of hospital-related direct and indirect

costs were apportioned to each case. The same is not true for home births that successfully took place at home. Yet, one can argue that a portion of the hospital costs must be shared by women who birth at home as safe home birth could not occur if there were not a hospital, with hospital personnel and technology, readily available should it be required.

Henderson and Mugford (1997) caution that even if home births were the less expensive option, if they increased in popularity, extra resources would be needed in the short term because a shift to the community would not translate immediately into resource availability in the hospital. While increase in the number of planned home births would have little impact on cost to system until they reached a tipping point, additional resources would need to be available during this period of flux and uncertainty. Thus while a shift to the community would mean that beds could be freed up for more complex obstetric cases, a certain amount of obstetric resources would still need to be available on a contingency basis for the planned home birth group. If a policy were developed that shifted birth out of hospitals (i.e. a sizeable shift to the community), at that point one could see savings to the system. Cost savings could then be recognized in the release of hospital staff or space (Henderson et al., 1997). However, as long as a high proportion of births continue to take place in a hospital setting the cost savings will be minimal.

Moreover, applicability of the results from this analysis is contingent upon a specific home birth rate. For example, if 30% rather than 10-20% of planned

midwifery-attended home births were transferred to hospital during labour, the impact on the health care system would be significantly different.

Limitations of Data

Two-day postpartum time horizon

The decision to use a two-day cut-off following the birth was in part informed by missing data regarding maternal readmissions. However, it is justifiable as after this point it is less likely that cost differences detected between home and hospital birth are directly related to place of birth. Although intrapartum complications may impact long-term costs, associated costs *after* the immediate postpartum were not included in this analysis. The midwifery database reports only on short-term clinical outcomes (until six weeks following delivery) and accurate long-term costs are difficult to obtain since a system that links long-term outcomes with midwifery care has yet to be developed.

In order to capture clinically important outcomes from the birth, such as postpartum hemorrhage, that occur in the early postpartum period, the immediate postpartum period was defined as the first two days following birth.

At the same time, a two-day time horizon increases the risk of overlooking true costs associated with planned place of birth but which may not have resulted in a neonatal (or maternal) admission or readmission to hospital within the first two days following labour. For example, while the rate of iatrogenic infections is undoubtedly higher in the hospital cohort and is directly linked to choice of birth place, it is important to note that most complications that are directly related to the birth itself will present within this two day time frame.

While the period of interest for this thesis is the first two days postpartum, the way in which two days is documented varies with some midwives entering '0' and '1' and others entering '1' and '2.' Although the standard is to enter day '0' as the first day of life, most midwives are not correctly charting neonatal age. For example, for infant readmissions, there were five cases with '0' representing the infants' first day of life (and 35 cases in total from day zero to two). Thus, because there were relatively few '0' values, day two was defined to include all values of '0', '1' and '2'.

Limitations of data-sets

One of the greatest challenges faced with analyzing health care utilization related to the necessity of working with multiple data sets. The way in which information is collected and reported varies from database to database. For example, the way in which the mode of delivery is reported in the midwifery database and in the OCCI database is different. Whereas midwifery-tracking sheets report on the type of delivery (e.g. spontaneous vaginal, vacuum, or cesarean birth), the OCCI database further differentiates between sub-types of delivery within each category. As an example, for vaginal birth the following sub-types are included: "manually assisted vaginal delivery (vertex), without episiotomy"; "manually assisted vaginal delivery (vertex), with episiotomy"; and, "unassisted spontaneous vaginal delivery, using approach/technique NOS (not otherwise specified)." Each of these categories has different monetary values based on both sub-type of delivery and on parity. In order to reconcile the discrepancy between these two databases and to be able to apply OCCI costs to

numbers of deliveries reported in the midwifery database, the cost estimates provided by OCCI associated with the greatest number of cases for each birthing modality were selected, thereby making the assumption that the normal standard of care can be defined by the greatest number of cases. This approach is defensible. Individuals who use multiple data sets frequently encounter this problem: selecting a rationale and justifiable methodology to apply findings from one data set to another allows the user of the data to circumvent the inherent limitations of using data sets that were developed for different purposes.

Working within the limitations of the Midwifery Database

Limitations regarding the nature of data collected

Another limitation of this thesis relates to the nature and quality of the data that was being used. The data from the midwifery-tracking sheets that has been collected has been validated, but as with any database, one is limited by data that is collected and there are gaps. Although the tracking sheet has a question regarding professional with whom the midwifery consultation took place, this information is not entered into the database. However, this lack of information should not impact on the analysis as the same assumptions regarding professional with whom consultations took place were made for both cohorts.

Moreover, as previously noted, both time and location of consultation is not specified. Times which are noted, such as for admission and discharge are too broadly defined to provide meaningful analysis. This lack of specificity risks concealing true differences between groups from being detected. However, because women in both cohorts entered labour spontaneously and because both

cohorts were matched with respect to parity one can assume that both time and location of consultation would be similar between groups (See Appendix D in the Results Section for list of assumptions).

As the midwifery database only records time ranges (e.g. delivered within six, 12, 24 or 48 hours of admission) midpoint rather than real time was used. This risks minimizing real time differences and hence real costs accrued by parity. For example, a multiparous woman who delivered within one hour from admission and a primiparous woman who delivers within five hours from admission will both have the same midpoint (three hours). Having matched the cohorts by parity helps to minimize this difference.

Limitations regarding the quality of data reported

Moreover there are challenges related to the open-field categories in the midwifery database. Because open-field information is not collected systematically (i.e. a midwife can choose to fill out the field or to leave it blank), outcomes that are reported are not meaningful; there is no way to know who else may have experienced this outcome but simply not had it reported. For example, in one case, the midwife documented that the woman received a blood transfusion. As there is no specific section in which to place 'other procedures' or 'other services' obtained while in hospital, there is a dependency on the midwife choosing to report this outcome as well as a dependency on coming across this comment by chance during the analysis. Although the cost for blood transfusion would be included in the aggregate costs obtained from the OCCI database, any costs associated with the Physician Fee for Service Schedule would not be

captured.

Moreover, there is no direct linkage in the midwifery database to actual utilization of services. For example, the tracking sheets do not distinguish between neonatal level of care. Because midwifery tracking sheets only ask about ICU care, level A versus level B for infant care could not be determined. Consultation with a pediatrician and review of the Physician Fee for Service Schedule helped to deal with this limitation and enabled a reasonable assumption as to where infants admitted to ICU care would have been seen. Because the same set of assumptions applied to both cohort sets of neonates, this limitation to should not skew the data.

Another limitation of the midwifery data relates to missing or incomplete data entry. For all cases with missing or incomplete data entry logic checks were applied, following which a decision was made as to whether the data should be excluded or retained. For example, there are fifteen cesarean cases reported where there is no mention of epidural spinal, or general having been received. As part of a logic check these 15 cases were examined for women who had been discharged from hospital in 24 hours or less. As there were no cases among these 15 cesarean cases where discharge took place from hospital in 24 hours or less, a different part of the database was examined in which cesarean section was reported as having occurred (N=9). The other six cases were reviewed to determine the most likely scenario and how best to attribute costs.

Despite the limitations mentioned above, the tracking sheets still provide a rich body of solid data regarding resource utilization based on clinical outcomes

that can be used for evaluative purposes. Since 2003, the Ontario Ministry of Health has mandated that specified information pertaining to midwifery-attended births be recorded in a midwifery-specific database. To ensure midwifery compliance, data forms have been linked to midwife remuneration. A government review of the data reported that this information source was both reliable and valid (Katherine, & Knox, 2006) (a sample of the midwifery tracking sheet is located in Appendix B).

Limitations of Ontario case-costing data

The Ontario Case Costing Initiative data was developed as a management decision- making tool to ascertain hospital-funding methodologies. Using a database for a different purpose than for what it was created presents challenges. While OCCI database is not a perfect fit, it provided important aggregate costing data. A decision was then made regarding how to extrapolate hourly hospital care costs as well as which costs could be left in an aggregate form. For example, medication costs and nursing costs are subsumed within a birthing modality. While total costs by subtype of delivery for all women who gave birth in the 2008-9 fiscal year is available (from participating hospitals in the OCCI data collection) and while there is a list of the functional centres which were included in influencing costs for all women who gave birth in the 2008-2009 fiscal year as well as for midwifery clients only, the exact breakdown/make up of costs cannot be determined. As a result, there were cases where information from the midwifery tracking sheets could not be used because this information was already included in the aggregate OCCI data. To illustrate this point, the Ontario

Midwifery Program records resource utilization for medications such as oxytocin and nitrous oxide. General information is also obtained regarding the use of narcotic analgesics (although specification of type of analgesic e.g. morphine, demerol, nubain etc.) is not recorded. The midwifery-tracking sheets also have general information as to whether the woman using midwifery services made use of epidural, spinal, local or general anesthetic (although the specific medication is also not recorded). Because resource utilization pertaining to medications is included in OCCI procedure codes for delivery type, and because medications are not a major contributor to overall hospital cost, the resource utilization and the associated unit costs for medications as a discrete category were not obtained.

For the 2008-2009 fiscal years OCCI had collected information pertaining to midwifery care costs from eleven different hospitals in Ontario that submitted data with direct and indirect costs for mothers and infants who delivered in their hospitals (see Table 4 – Methods Section). However, it is important to note that the OCCI does not have data separated by geographical classification. Thus although data pertaining to all midwifery births that took place between 2003-2006 in Ontario is available, corresponding costs for hospital designations cannot be obtained and it is not possible to determine if these costs would hold true for rural as opposed to urban hospitals or northern as opposed to southern Ontario hospitals. At the same time there is great strength in being able to use data that was derived from 11 different hospitals with varying locations and practices.

Moreover, the OCCI data pertaining to length of hospital stay (by parity) is an average. The distribution or the median or the breakdown of time per

subtype of delivery is not available. This is problematic because an average for all primiparous and all multiparous women had to be used to calculate an hourly rate per subtype of birth. Therefore hourly rates presented in this thesis are not 'real' hourly rates but rather average hourly rates. If admission to delivery is greater than the average then costs will be underestimated while they will be overestimated for individuals who stayed at the hospital for a period of time that is less than the average.

One of the biggest limitations with the OCCI dataset is that births provided reflect the average cost of *all* obstetric births (including high-risk births). Because data pertaining exclusively to low-risk births was not available, and because data pertaining to primiparous and multiparous birthing costs by delivery modality for midwifery clients only was not available, this data is limited. There was a dependency on the information that was obtainable. As such, applying the data from OCCI to midwifery birth costs likely reflects an inflated rather than a true cost, resulting in a problem regarding the generalizability of these findings. Not having data specific to midwifery birthing modality cost outcomes from OCCI also limits future research capability to compare midwifery home and hospital birth costs to physician birth costs using the OCCI approach since all direct and indirect delivery procedure costs that result in hospital charges would be based on an aggregate of high and low-risk women who receive physician-provided care. Despite being confined to using a generic average cost, the ability of these results to illustrate relative cost differences by desired place of birth has

not been compromised. These findings highlight an important relative rather than true cost difference between cohorts.

Limitations of Canadian Price Index

The Canadian Price Index (CPI) is a standard tool to use when converting prices. However, health care does not always abide by the same inflation rules as the rest of the economy. That being said, the CPI is a recognized and standardized tool and any measurement error that may have resulted from its use should be evenly spread across both cohorts and therefore should not impact study results.

Subjectivity of Resource Rating

Another limitation relates to the use of a subjective rating for the resource intensity of admission to delivery and from delivery to discharge. As a result, when the hourly rate for primiparous and multiparous women was first calculated, it was a surprised to encounter cases where the hourly rate for multiparous women was more than the hourly rate for primiparous women. Although the face value of these results seems questionable, one plausible explanation for this discrepancy has to do with the fixed cost component. If one assumes that the fixed cost was high enough relative to the variable cost then per unit time is more expensive when shorter periods of time are used. Although intensity of resource use is different, fixed cost does not depend on intensity. For example, if cleaning a labour and delivery room, assigning a nurse, sterilizing and preparing labour and delivery equipment and so forth costs $500 as a start up cost and each hour costs $50 additional dollars, then a multiparous woman who only spent one hour in the labour and delivery ward will have a higher hourly rate than a primiparous woman

who spent ten hours in the same ward. Because the costs for hourly rates are dependent on a subjective rating of resource intensity rather than on actual prices, results therefore should be understood as a representation of relative rather than true costs.

Confounders

As in any non-randomized sample there is a risk that confounders can skew the data. Confounders that were taken into consideration for this thesis are examined in this section.

Limitations of data exclusion

The College of Midwives of Ontario, the regulatory body of midwives, creates eligibility criteria for home birth. Ineligible home birth cases would include women with twin, breech or medically complicated pregnancies; women with more than one previous cesarean section, women with gestation less than 37 weeks or more than 43 weeks at labour onset (College of Midwives of Ontario, 2000). Although the midwifery college supports home risk for slightly riskier situations, e.g. vaginal birth after delivery, this data was excluded from this study. As previously explained, there was a desire not to bias the hospital group (which had a substantially larger group of women who were having VBACs) with this potential confounder as failed VBAC is associated with both higher maternal and neonatal morbidities. Thus, to control for this potential confounder, home birth cases in which women had experienced a previous cesarean section or had had a prostaglandin induction were excluded. A sensitivity analysis that was conducted to determine what impact VBACs would have had if they had been included in

the original study found that their inclusion did not alter results (i.e. they were non-significant).

Parity as a confounder

One of the most important potential known confounders in this study is parity. Studies demonstrate a consistent relationship between parity and planned home birth. Increased risk of adverse perinatal outcomes is higher in primiparous women, and multiparous women are more successful than primiparous women at birthing at home (Amelink-Verburg et al., 2008; Anthony et al., 2005; de Jonge et al., 2009; Hildingsson et al., 2006; Hutton et al., 2009; Janssen et al., 2007; Johnson & Daviss, 2005; Lindgren et al., 2008). The literature suggests that women who give birth for the first time use a greater number of resources than women who have already experienced a prior delivery. For example, intrapartum transport rates, when subdivided by parity range from roughly 2 -11% for multiparous women and 19.5-40% for nulliparous women (and 7-20% for all women combined) (Ackermann-Liebrich et al., 1996; Anderson & Murphy; Durand, 1992; Hutton et al., 2009; Janssen et al., 2002; Johnson & Daviss, 2005; Lindgren et al., 2008; Sullivan & Beeman, 1983; Wiegers et al., 1998; Wiegers et al., 1996; Woodcock et al., 1994).

To deal with this potential confounder cohorts were matched by parity and a pre-planned sub-group analysis related to costs associated with parity was performed.

Self-selection bias as a confounder

The impact of self-selection bias may partially explain why women who prefer to plan for a home birth often experience fewer interventions than women who plan for a hospital birth, resulting in lower costs for the planned home birth group. Studies suggest that choice of both birth attendant and birth place reflects women's overall perceptions of childbirth itself (Howell-White, 1997; Van Der Hulst et al., 2004; Wiegers et al., 2000). Women opting for home birth have the psychological advantage of believing in their ability to give birth safely and may be more motivated to avoid medical intervention (de Jonge et al., 2009; Johnson & Daviss, 2005; Van Der Hulst et al., 2004).

In an Ontario-based study (2014) that examined factors that impact a woman's decision about where to give birth, the authors found that women's beliefs and values about birth significantly impacted planned birth place (Murray-Davis et al., 2014). Women planning home birth listed their top decision-making priorities as: birth as a natural process; desire to avoid interventions; and feeling more comfortable at home. While women planning a hospital birth also listed birth as a natural process, other decision-making priorities included: feeling safer in hospital; wanting access to pain medication; and feeling more comfortable in their chosen location (Murray-Davis et al., 2014).

Consequently, any cost analysis that concludes that a specific birth location is associated with a specific cost may actually be reflecting the different psychological beliefs associated with the cohort who would choose that location rather than an innate cost that can be attributed to the desired place of birth itself.

Setting as a confounder

Studies have also demonstrated the vital role of a facilitating environment – home or hospital – on labour processes and outcome. The roles that midwives play in enabling and managing home or hospital births have important clinical, emotional and economic ramifications. In a hospital setting, with easily accessible medical technology, midwives might be more likely both to use and to find women more receptive to the use of medical interventions. On the contrary, at home, where such access is limited and women are more likely to reject interventions, midwives are also less likely to employ them (Van Der Hulst, et al., 2004; Wiegers et al., 2000).

Midwife selection bias as a confounder

International studies have found that women who were planning a home birth were well-informed about available options but that those planning hospital births felt less informed about their options for childbirth, including place of delivery (Madi & Crow, 2003).

We do not how or to what extent midwives in Ontario are truly offering all low-risk women the choice of home birth. Indeed, the way in which home birth is discussed as an 'informed choice topic' is variable throughout the province. It is possible that midwives contribute to the problem of selection bias by providing women whom they feel will be more successful of having a home birth with a more positive and in-depth discussion of the home birth option.

It was not possible to explore if there was a connection between a midwife's years of experience and the percentage of home or hospital births she assisted yearly ('successfully' and 'not successfully'). Since this information is

not publically available, a test for any correlation between the two could not be conducted. It is possible that more experienced midwives have greater numbers of home births or greater numbers of successful homebirths than non-experienced midwives.

Demographic factors: older age, level of education, degree of urbanization, socioeconomic status and ethnicity as confounders

Demographic factors correlated with planning a home birth may also be correlated with the likelihood of having a successful home birth. For example, higher level of education and employment may be a proxy for greater degree of self-confidence, resilience and health. These qualities, in turn may impact clinical birth outcomes. Factors that have been correlated with higher rates of planned home birth include:

- older age, (Hildingsson et al., 2006; Johnson & Daviss, 2005; Lindgren et al., 2008)

- higher level of education (Hildingsson et al., 2006; Johnson & Daviss, 2005; Madi & Crow, 2003; Wiegers et al., 1998)

-less urban geographic location. (Anthony et al., 2005)

-being employed (Ackermann-Liebrich et al., 1996; Lindgren et al., 2008)

-living with a partner (Ackermann-Liebrich et al., 1996)

-having previously received midwifery care (Hutton et al., 2009)

-belonging to a certain ethnicity (white – North America; Dutch – Netherlands; non-Swedish – Sweden) (Amelink-Verburg et al., 2008; Anthony et al., 2005; de Jonge et al., 2009; Hildingsson et al., 2006; Johnson & Daviss, 2005; Wiegers et al., 1996)

-higher socioeconomic status (de Jonge et al., 2009)

-socioeconomic factors (home birth women less likely to smoke, be overweight or have a medical condition (Ackermann-Liebrich et al., 1996; Hildingsson et al., 2006; Van Der Hulst et al., 2004)

Findings regarding socioeconomic factors and their relationship with planned place of birth have been contradictory (Janssen et al., 2002; Johnson & Daviss, 2005; Lindgren et al., 2008; Wiegers et al., 1996). Although research suggests that clinical outcomes and economic resource consumption are impacted both by regional and income variations, midwifery-attended births have not been analyzed by obstetrical outcome or resource consumption according to LHIN/geographical region or socioeconomic status (SES).

In contrast to the above characteristics defined for women planning a home birth, according to the research reported by Murray-Davis et al. (2014), women who are planning a hospital birth have been described as older, higher income, more likely to have used assisted reproduction, experienced a previous pregnancy loss, have a depressive disorder, and are more likely to be worried about health (Murray-Davis et al., 2014).

The Economic Impact of Transferring from Home to Hospital during Labour

From an economic viewpoint it seems intuitive that successful home births are also the least costly from a third payer point of view. However, despite the high home birth success rates, it is necessary to understand both the clinical and monetary outcomes that result from unsuccessful home births. From an economic viewpoint morbidity is the main contributor to obstetrical-related health-care

costs. While the majority of women who plan a home birth (75-90%) will have a home birth and will deliver vaginally without complications, complications that occur among the other 10-25% of women result in increased health care costs (Ackermann-Liebrich et al., 1996; Anderson & Murphy, 1995; Durand, 1992; Hutton et al., 2009; Hutton et al., 2015; Janssen et al., 2002; Johnson & Daviss, 2005; Lindgren et al., 2008; Sullivan & Beeman, 1983; Wiegers et al., 1998; Wiegers et al.,1996; Woodcock et al., 1994). Postpartum transfer rates have been shown to range from approximately two to three percent (Ackermann-Liebrich et al., 1996; Hutton et al., 2009; Johnson & Daviss, 2005; Lindgren et al., 2008). After delivery, hemorrhage constitutes the most common reason for transfer (Lindgren et al., 2008). Transfers were considered urgent (usually defined by ambulance transport) in roughly 3-3.5% of all cases (Johnson & Daviss, 2005). In this study, in the planned home birth cohort there were 353 ambulance transports during or after labour for maternal, fetal and/or neonatal indications (note: in seven cases two ambulances were used). This represents a total transport to hospital rate of 5.5%.

Summary

Although there were numerous confounders and limitations that were confronted with this analysis, confounders were adjusted for as best as possible and limitations are stated and discussed. As a result this is a sound cost analysis that suggests that planned home birth does not cost to the Ontario Health Care system more money to support it and is therefore a choice that should continue to be supported. This analysis is robust and is important in that it provides insight

into the relative cost difference between planned home and planned hospital births: both cohorts were described and are demographically similar, cohorts were matched by parity, a rigorous data-cleaning process took place, the methodology is transparent and easy to follow, noted limitations applied to both cohorts, experts were consulted to determine ICU level and OHIP Fee for Schedule Codes, and logical rationale was provided for assumptions that were made.

Although this data is now more than 10 years old, findings from this study continue to be relevant. In the 2015 study by Hutton et al. that is based on 2003-2009 Ontario data, findings regarding resource use patterns among planned home and planned hospital births were similar to their previous 2009 study. Consequently, it is reasonable to assume that a similar pattern of resource use would continue to result in a similar type of distribution of costs.

Contributions of this Thesis

This thesis adds to the limited body of knowledge comparing costs associated with home and hospital planned birth. This study found that home birth in an Ontario context does not cost the health care system more money than hospital birth.

These findings are similar to other home birth costing studies conducted in varying geographical locations. Like other cost studies that have examined home and hospital birth, the result from this study suggest that home birth is a cost-appropriate option. This analysis also provides insight into resources used by planned place of birth, parity and birth modality and has contributed to the body

of knowledge regarding how resource use and associated costs differs by planned place of birth.

For women with low-risk pregnancies (as defined by CMO guidelines), choice of birthplace is a crucial part of midwifery care in Ontario. Despite the difficulty of translating the relative costs to actual savings for the health care system, it is clear from the analysis undertaken in this thesis that planned midwifery home births, even when accounting for those planned home births that took place in hospital, did not result in additional costs to the health care system. Since the outcomes for women and babies among women planning home birth in Ontario are comparable to the outcomes of women planning hospital birth in Ontario, and since the home birth option is an important reproductive choice, and is economically sound, our government has the duty to support this choice.

As midwives continue to support a larger percentage of women in Ontario who are giving birth, the economics of midwifery care becomes all the more critical to understand. This thesis provides a first step in understanding the costs associated with the provision of midwifery care to two comparable low-risk cohorts and how planned place of birth impacts resource use and concomitant costs.

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Appendix A

Indications of Mandatory Discussion, Consultation and Transfer of Care

Approved December 2, 1999
Effective June 15, 2000

INDICATIONS FOR MANDATORY DISCUSSION, CONSULTATION AND TRANSFER OF CARE

As a primary caregiver, the midwife together with the client is fully responsible for decision-making. The midwife is responsible for writing orders and carrying them out or delegating them in accordance with the standards of the College of Midwives.

The midwife discusses care of a client, consults, or transfers primary care responsibility according to the Indications for Mandatory Discussion, Consultation and Transfer of Care.[1] The responsibility to consult with a family physician/general practitioner, obstetrician and/or specialist physician lies with the midwife. It is also the midwife's responsibility to initiate a consultation within an appropriate time after detection of an indication for consultation. The severity of the condition and the availability of a physician(s) will influence these decisions.

The informed choice agreement between the midwife and client should outline the extent of midwifery care, in order to make clients aware of the scope and limitations of midwifery care. The midwife should review the Indications for Mandatory Discussion, Consultation and Transfer of Care with the client.

DEFINITIONS

Category 1: Discuss with another midwife or with a physician

It is the midwife's responsibility to initiate a discussion with or provide information to another midwife or physician, with whom the care is shared, in order to plan care appropriately.

Category 2: Consult with a physician

It is the midwife's responsibility to initiate a consultation and to clearly communicate to

[1] *For a discussion of how this document is used to guide decisions about choice of birth place, see Indications for Planned Place of Birth.*

the consultant that she is seeking a consultation. A consultation refers to the situation where a midwife, in light of her professional knowledge of the client and in accord with the standards of practice of the College of Midwives, or where another opinion is requested by the client, requests the opinion of a physician competent to give advice in this field. The midwife should expect that:

> The consultation involves addressing the problem that led to the referral, an in-person assessment of the patient, and the prompt communication of the findings and recommendations to the patient and the referring professional.
>
> Following the assessment of the patient by the consultant(s), discussion can occur between the health professional and consultant regarding future patient care.[2]

The consultation can involve the physician providing advice and information and/or providing therapy to the woman/newborn or prescribing therapy to the midwife for the woman/newborn.

Consultation must be documented by the midwife in her records in accord with the regulations of the College of Midwives.

After consultation with a physician, primary care of the client and responsibility for decision-making together with the client either:

a) continues with the midwife, or
b) is transferred to a physician.

Once a consultation has taken place and the consultant's findings, opinions and recommendations are communicated to the client and the midwife, the midwife must discuss the consultant's recommendations with the client and ensure the client understands which health professional will have responsibility for primary care.

Where urgency, distance or climatic conditions make an in-person consultation with a physician not possible, the midwife should seek advice from the physician by phone or other similar means. The midwife should document this request for advice, in her records, in accord with the requirement of the College of Midwives and discuss with the client the advice received.

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[2] *"Clinical Practice Parameters and Standards for Consultation and Transfer of a Woman/Newborn in or from a Birth Centre Where Only Midwives Provide Primary Care, to a Physician/Health Facility," College of Physicians and Surgeons of Ontario, December 23, 1993.*

The consultant may be involved in, and responsible for, a discrete area of the client's care, with the midwife maintaining overall responsibility within her scope of practice. Areas of involvement in client care must be clearly agreed upon and documented by the midwife and the consultant.

The College of Midwives has agreed that:

> One health professional has overall responsibility for a patient at any one time and the patient's care should be co-ordinated by that health professional whose identity should be clearly known to all of those involved and documented in the records of the referring health professional and consultant. Responsibility could be transferred temporarily to another health professional, or be shared between health professionals according to the patient's best interests and optimal care; however, transfer or sharing of care should only occur after discussion and agreement among patients, referring health professionals, and consultants.[3]

Category 3: Transfer to a physician for primary care

When primary care is transferred, permanently or temporarily, from the midwife to a physician, the physician, together with the client, assumes full responsibility for subsequent decision-making. When primary care is transferred to a physician, the midwife may provide supportive care[4] within her scope of practice, in collaboration with the physician and the client.

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[3] *"Clinical Practice Parameters and Standards for Consultation and Transfer of a Woman/Newborn in or from a Birth Centre Where Only Midwives Provide Primary Care, to a Physician/Health Facility," College of Physicians and Surgeons of Ontario, December 23, 1993.*

[4] *Supportive care is defined in the Standard on Supportive Care.*

INDICATIONS: Initial History and Physical Examination

Category 1:

- adverse socio-economic conditions
- age less than 17 years or over 35 years
- cigarette smoking
- grand multipara (para 5)
- history of infant over 4500 g
- history of one late miscarriage (after 14 completed weeks) or preterm birth
- history of one low birth weight infant
- history of serious psychological problems
- less than 12 months from last delivery to present due date
- obesity
- poor nutrition
- previous antepartum hemorrhage
- previous postpartum hemorrhage
- one documented previous low segment cesarean section
- history of essential or gestational hypertension
- known uterine malformations or fibroids

Category 2:

- current medical conditions for example:[5] cardiovascular disease, pulmonary disease, endocrine disorders, hepatic disease, neurologic disorders
- family history of genetic disorders
- family history of significant congenital anomalies
- history of cervical cerclage
- history of repeated spontaneous abortions
- history of more than one late miscarriage or preterm birth
- history of more than one low birth weight infant
- history of gestational hypertension with proteinuria and adverse sequelae
- history of significant medical illness
- previous myomectomy, hysterotomy or cesarean section other than one documented previous low segment cesarean section
- previous neonatal mortality or stillbirth
- rubella during first trimester of pregnancy
- significant use of drugs or alcohol

[5] *Refer to Guidelines to Antepartum Consultations for Clients of Midwives to Anaesthesia, July 1996.*

- age less than 14 years

Category 3:
- any serious medical condition, for example: cardiac or renal disease with failure or insulin dependent diabetes mellitus

INDICATIONS: Prenatal Care

Category 1:
- presentation other than cephalic at 36 completed weeks
- no prenatal care before 28 completed weeks
- uncertain expected date of delivery
- uncomplicated spontaneous abortion less than 12 completed weeks

Category 2:
- anemia (unresponsive to therapy)
- documented post term pregnancy (42 completed weeks)
- fetal anomaly
- inappropriate uterine growth
- medical conditions arising during prenatal care, for example: endocrine disorders, hypertension, renal disease, suspected significant infection, hyperemesis
- placenta previa without bleeding
- polyhydramnios or oligohydramnios
- gestational hypertension
- isoimmunization
- serious psychological problems[6]
- sexually transmitted disease
- twins
- vaginal bleeding other than transient spotting
- presentation other than cephalic, unresponsive to therapy, at 38 completed weeks

Category 3:
- cardiac or renal disease with failure
- insulin dependent diabetes
- multiple pregnancy (other than twins)

[6] *Notwithstanding the requirement for consultation with a physician, consultation may be with another appropriate health care professional; for example, a mental health worker.*

- gestational hypertension with proteinuria and/or adverse sequelae
- symptomatic placental abruption
- vaginal bleeding, continuing or repeated
- placenta previa after 28 completed weeks

INDICATIONS: During Labour and Birth

Category 1:
- no prenatal care
- non-particulate meconium

Category 2:
- breech presentation
- preterm labour (34 - 37 completed weeks)
- prolonged active phase
- prolonged rupture of membranes
- prolonged second stage
- retained placenta
- suspected placenta abruption and/or previa
- third or fourth degree tear
- twins
- unengaged head in active labour in primipara
- preterm prelabour rupture of membranes (PPROM) between 34 and 37 completed weeks
- particulate meconium
- gestational hypertension

Category 3:
- active genital herpes at time of labour
- preterm labour (less than 34 completed weeks)
- abnormal presentation (other than breech)
- multiple pregnancy (other than twins)
- gestational hypertension with proteinuria and/or adverse sequelae
- prolapsed cord or cord presentation
- placenta abruption and/or previa
- severe hypertension
- confirmed non-reassuring fetal heart patterns, unresponsive to therapy
- uterine rupture

- uterine inversion
- hemorrhage unresponsive to therapy
- obstetric shock
- vasa previa

INDICATIONS: Post Partum (Maternal)

Category 2:
- suspected maternal infection e.g. breast, abdomen, wound, uterine, urinary tract, perineum
- temperature over 38° C (100.4° F) on more than one occasion
- persistent hypertension
- serious psychological problems[7]

Category 3:
- hemorrhage unresponsive to therapy
- postpartum eclampsia
- thrombophlebitis or thromboembolism
- uterine prolapse

INDICATIONS: Post Partum (Infant)

Category 1:
- feeding problems[8]
- failure to pass urine or meconium within 24 hours of birth

Category 2:
- 34 to 37 weeks gestational age
- infant less than 2,500 g
- less than 3 vessels in umbilical cord
- excessive moulding and cephalhematoma
- abnormal findings on physical exam
- excessive bruising, abrasions, unusual pigmentation and/or lesions
- birth injury requiring investigation
- congenital abnormalities, for example: cleft lip or palate, congenital dislocation of hip, ambiguous genitalia

[7] *Notwithstanding the requirement for consultation with a physician, consultation may be with another appropriate health care professional; for example, a mental health worker.*

[8] *Notwithstanding the requirement for discussion with a physician or midwife, discussion may be with another appropriate health care professional; for example, a lactation consultant.*

- abnormal heart rate or pattern
- abnormal cry
- persistent abnormal respiratory rate and/or pattern
- persistent cyanosis or pallor
- jaundice in first 24 hours
- suspected pathological jaundice after 24 hours
- temperature less than 36° C, unresponsive to therapy
- temperature more than 37.4° C, axillary, unresponsive to non-pharmaceutical therapy
- vomiting or diarrhea
- infection of umbilical stump site
- significant weight loss (more than 10% of body weight)
- failure to regain birth weight in three weeks
- failure to thrive
- failure to pass urine or meconium within 36 hours of birth
- suspected clinical dehydration

Category 3:

- APGAR lower than 7 at 5 minutes
- suspected seizure activity
- major congenital anomaly requiring immediate intervention, for example: omphalocele, myelomeningocele
- temperature instability

Appendix B

Copy of Midwifery Tracking-Sheet

ONTARIO MIDWIFERY PROGRAM
CLIENT TRACKING SHEET

(Note: when selecting boxes, please use an "X" rather than a check mark; to correct a mistake, please use white out!)

1. **BILLABLE COURSE OF CARE?** YES ☐ NO ☐

2. **INVOICE DATE** DD ☐☐ MM ☐☐ YY ☐☐

3. **COURSE OF CARE IDENTIFICATION**

TPA Code ☐☐☐

Practice Code: ☐☐☐

Client Code: ☐☐☐☐☐☐

(Client code is unique and is assigned by practice group)

Maternal OHIP number ☐☐☐☐☐☐☐☐☐☐

Infant OHIP Number ☐☐☐☐☐☐☐☐☐☐

(provided with consent of client)

Consent signed YES ☐ NO ☐ NO OHIP ☐

CLIENT BIRTH DATE DD ☐☐ MM ☐☐ YY ☐☐

HOME POSTAL CODE OF CLIENT ☐☐☐ – ☐☐☐

4. **PROVIDER IDENTIFICATION**

Co-ordinating Midwife Provider Number 7 0 ☐☐☐☐

Primary Attending Midwife at Birth Provider Number 7 0 ☐☐☐☐

Second midwife At Birth? YES ☐ NO ☐

Second Midwife at Birth Provider Number 7 0 ☐☐☐☐

IF No Second Midwife, Indicate Attending Second Attendant (Check One)

TAPA ☐

CLERK ☐

NO Second Attendant ☐

Midwife Billing Level for Course of Care **MW** ☐☐

5. **REPEAT ONTARIO MIDWIFERY CLIENT?** YES ☐ NO ☐

6. **WAS CARE DURING THIS PREGNANCY PROVIDED BY ANOTHER ONTARIO MIDWIFERY PRACTICE?** YES ☐ NO ☐

AUTHORIZATION

Practice Group Partner Signature _____

TPA verified Course of Care (intial here) _____

TPA paid Course of Care DD ☐☐ MM ☐☐ YY ☐☐

7. **MIDWIFE PERFORMED NEWBORN HEARING TEST** YES ☐ NO ☐

8. **BOOKING DATE** DD ☐☐ MM ☐☐ YY ☐☐

9. **DISCHARGE DATE** DD ☐☐ MM ☐☐ YY ☐☐

10. **NUMBER OF MIDWIFE VISITS**

Clinic Prenatal	☐☐
Home Prenatal	☐☐
Hospital Prenatal	☐☐
Hospital Postnatal	☐☐
Home Postnatal	☐☐
Clinic Postnatal	☐☐

11. **OBSTETRIC HISTORY**

Previous pregnancies	☐☐
Term births	☐☐
Pre-term births (<37 weeks)	☐☐
Abortions/miscarriages	☐☐
Living children	☐☐
Vaginal births	☐☐
Cesarean sections	☐☐
Previous VBACs	☐☐

12. **GESTATIONAL AGE**

At booking	☐☐	*weeks*
At birth	☐☐	*weeks*
If discharged prior to birth, at discharge	☐☐	*weeks*

13. **DATE CLIENT GAVE BIRTH** DD ☐☐ MM ☐☐ YY ☐☐

ONTARIO MIDWIFERY PROGRAM
CLIENT TRACKING SHEET

(Note: when selecting boxes, please use an "X" rather than a check mark; to correct a mistake, please use white out!)

14. OUTCOMES OF CURRENT COURSE OF CARE (A-E BELOW)

14A. Yes ☐ No ☐

Woman left Ontario midwifery care prior to the birth

If Yes, *(please select (X) one box)*

Woman moved to different area ☐

Woman chose to leave care for another reason ☐

14B. Yes ☐ No ☐

Miscarriage/abortion at < 20 weeks

If Yes,

Location of miscarriage/abortion:

☐ Home ☐ Hospital ☐ Other

Was the midwife present?

☐ Yes ☐ No

14C. Multiple Birth Yes ☐ No ☐

If yes, number of babies born: ☐

NB: Finish completing this form for the first baby. Complete a separate form for each additional baby. Include Client ID and other relevant items for each baby. Staple forms together.

14D. Live Birth ≥ 20 Weeks Yes ☐ No ☐

If Yes, ***(please select (X) all that apply)***

Spontaneous vaginal delivery ☐

Forceps assisted ☐

Vacuum assisted ☐

Cesarean section ☐

Cephalic Position at Birth ☐

Breech Position at Birth ☐

14E. Stillbirth ≥ 20 Weeks Yes ☐ No ☐

If Yes, *(please select (X) all that apply)*

Died before labour ☐

Died during labour ☐

Induced abortion ≥ 20 weeks ☐

15. ANTENATAL TRIAGE/HOSPITAL CARE AT ≥ 20 WEEKS?

15A Outpatient assessment / triage? ☐ Yes ☐ No

If Yes, Reason:

15B Woman admitted to hospital? ☐ Yes ☐ No

If Yes,

Number of days in hospital ☐

Reason:

16. INTENDED AND ACTUAL BIRTH LOCATION

(please select (X) one box /row)

	Home	Hospital	Undecided	Other
Began labour intending to deliver at:	☐	☐	☐	☐
Location of birth:	☐	☐	n/a	☐

If Hospital Birth, Postal Code Of Hospital ☐☐☐ ☐☐☐

17. WAS THERE AN AMBULANCE TRANSPORT FROM HOME DURING OR IMMEDIATELY AFTER HOME BIRTH?

☐ Yes ☐ No

If Yes , please select (X) all that apply

Maternal Indication ☐

Fetal Indication ☐

Infant Indication ☐

18. WAS LABOUR INDUCED?

☐ **YES** ☐ **NO**

If yes, were any of the following administered:

Oxytocin ☐

Prostaglandin ☐

ARM ☐

If yes, skip to question 20

19. IF NO INDUCTION, WAS LABOUR AUGMENTED?

☐ **YES** ☐ **NO**

If yes, were either of the following used:

Oxytocin ☐

ARM ☐

ONTARIO MIDWIFERY PROGRAM
CLIENT TRACKING SHEET

(Note: when selecting boxes, please use an "X" rather than a check mark; to correct a mistake, please use white out!)

20. PHARMACEUTICAL FORMS OF PAIN RELIEF DURING INTRAPARTUM CARE? *(please select (X) all that apply)*

- None ☐
- Nitrous oxide ☐
- Narcotic analgesic (Morphine, Demerol, Nubain etc.) ☐
- Epidural ☐
- Spinal ☐
- Local Anaesthetic ☐
- General Anaesthetic ☐

21. WERE THERE LACERATIONS OR AN EPISIOTOMY?

(please select (X) all that apply)		Repaired by **RM**	Repaired by **MD**
No trauma	☐	n/a	n/a
Episiotomy	☐	☐	☐
Laceration:			
a) *Perineal*	1st ☐ 2nd ☐ 3rd ☐ 4th ☐	☐	☐
b) Labial	☐	☐	☐
c) Vaginal	☐	☐	☐
d) Other *(specify)*	☐	☐	☐

↳ _____

22. ESTIMATED INTRAPARTUM MATERNAL BLOOD LOSS *(please select (X) one box)*

☐ < 500 ml ☐ 500 - 1000 ml ☐ > 1000 ml

23. MATERNAL STAY IN HOSPITAL, EXCLUDING READMISSION *(please select (X) one box)*

A. Did not go to hospital for delivery ☐

B. Admitted in labour and: *(please select (X) one*

- -Delivered within 6 hours of admission ☐
- - Delivered within 12 hours of admission ☐
- - Delivered within 24 hours of admission ☐
- - Delivered within 48 hours of admission ☐

C. Postpartum hospital: *(please select (X) one box)*

- - Discharged < 6 hours after birth ☐
- - Discharged 6 – 24 hours after birth ☐
- - Discharged 25 – 60 hours after birth ☐
- - Discharged > 60 hours after birth ☐

Reason for stay of > 60 hours

↳ _____

24. MATERNAL READMISSION TO HOSPITAL OR ADMISSION TO HOSPITAL FOLLOWING HOME BIRTH?

Woman readmitted/admitted? ☐ yes ☐ no

If yes,

A. When, after birth, was woman readmitted/admitted? ☐ days

B. Number of days in hospital ☐ days

Reason

↳ _____

25. BIRTH WEIGHT **grams** ☐

26. APGAR SCORE

ONE MINUTE	FIVE MINUTES
☐	☐

27. INFANT RESUSCITATION *(please select (X) all that apply)*

- None ☐
- Stimulation ☐
- Suction ☐
- Oxygen free flow ☐
- PPV ☐
- PPV and cardiac compressions ☐
- CPAP ☐

28. SIGNIFICANT CONGENITAL ANOMALIES *(please select (X) one)*

- None ☐
- Major Anomalies ☐
- Minor Anomalies ☐
- Life Threatening Anomalies ☐

↳ List: _____

ONTARIO MIDWIFERY PROGRAM - CLIENT TRACKING SHEET

(Note: when selecting boxes, please use an "X" rather than a check mark; to correct a mistake, please use white out!)

29. MATERNAL CONSULTATION (S) AND TRANSFER(S) OF CARE ***Clinical Reason***	i. Consultation was with:				ii. Need for consultation determined by:			iii. Transfer of Care?				
	Number of consultations	Ob/ Gyn	FP/ GP	Other Professional	Required by College of Midwives of Ontario	Hospital or physician protocol	Other Determinant	No transfer of care occurred	A transfer was Required by College of Midwives of Ontario	A transfer was Required by Hospital or physician protocol	A transfer was Required by Other Determinant	If transfer occurred, care was returned to the midwife
A. ANTEPARTUM *No Consult* ☐ go to B		*(please select (X) all that apply)*			*please select (X) all that apply)*				*(please select (X) all that apply)*			
A1 Gestational hypertension		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
A2 Post dates pregnancy		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
A3 Malpresentation		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
A4 Fetal Concerns		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
A5 Other *(please specify)*:		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B. INTRAPARTUM *No Consult* ☐ go to C		*(please select (X) all that apply)*			*(please select (X) all that apply)*				*(please select (X) all that apply)*			
I1 Prolonged Labour		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I2 Non-reassuring fetal status		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I3 GBS antibiotics prophylaxis		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I4 Pain Control intramuscular / narcotic / sedative:		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I5 Pain Control epidural / spinal:		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I6 Other *(please specify)*:		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
C. POSTPARTUM *No Consult* ☐ go to # 30		*(please select (X) all that apply)*			*(please select (X) all that apply)*				*(please select (X) all that apply)*			
P1 Excessive bleeding		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
P2 Infection		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
P3 Other *(please specify)*:		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

ONTARIO MIDWIFERY PROGRAM - CLIENT TRACKING SHEET

(Note: when selecting boxes, please use an "X" rather than a check mark; to correct a mistake, please use white out!)

30. INFANT BORN IN HOSPITAL

☐ Yes ☐ No

If No, go to Question 31

If yes,

30A

Infant left hospital with mother?

☐ Yes ☐ No

30B

Was infant readmitted to hospital for any reason?

☐ Yes ☐ No

If yes,

Age when infant readmitted ☐ *days*

Number of days in hospital ☐ *days*

Reason for readmission

↳ _____

_____

31. INFANT BORN AT HOME (OR ANOTHER PLACE, BUT NOT IN HOSPITAL)

☐ Yes ☐ No

If yes,

Infant admitted to hospital after the birth?

☐ Yes ☐ No

Age when infant admitted ☐ *days*

Number of days in hospital ☐ *days*

Reason for infant's admission:

↳ _____

_____

32. WAS THE INFANT, AT ANY TIME AFTER BIRTH, ADMITTED TO A NEONATAL OR PAEDIATRIC INTENSIVE CARE UNIT?

☐ Yes ☐ No

If yes,

Age when infant admitted ☐ days

Length of stay ☐ days

33. INFANT DEATH IN FIRST 6 WEEKS

☐ Yes ☐ No

If yes, infant's age at death ☐ *days*

34. INFANT FEEDING IN FIRST 6 WEEKS

Please mark one (X) under each week to describe the infant feeding method(s)

Week	1	2	3	4	5	6
Breastfeeding only						
Both						
Formula Only						

ONTARIO MIDWIFERY PROGRAM - CLIENT TRACKING SHEET

(Note: when selecting boxes, please use an "X" rather than a check mark; to correct a mistake, please use white out!)

35. INFANT CONSULTATION(S) AND transfer of care	**i. Consultation was with:**				**ii. Need for consultation determined by:**			**iii. Transfer of Care?**				
Clinical Reason	Number of consul-tations	Paediatrician	FP/ GP	Other Professional	Required by College of Midwives of Ontario	Hospital or physician protocol	Other Determinant	No transfer of care occurred	A transfer was Required by College of Midwives of Ontario	A transfer was Required by Hospital or physician protocol	A transfer was Required by Other Determinant	If transfer occurred, care was returned to the midwife
	(please select (X) all that apply)				*(please select (X) all that apply)*				*(please select (X) all that apply)*			
No Consultation ☐												
Respiratory distress		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pre-term 34-37 weeks		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pre-term < 34 weeks		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Failure to thrive/slow to gain		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Jaundice		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Breastfeeding Problems		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other (specify):		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Appendix C

Questions asked to L&D nurses regarding labour resource intensity use

i) How would you rate resource intensity (scale 1-10 where 10 is the highest resource use) from admission until delivery for a PRIMIP for:
   a. Spontaneous vaginal birth
   b. Vacuum birth
   c. Forceps birth
   d. Vacuum and forceps birth
   e. Breech birth
   f. Cesarean birth

ii) How would you rate resource intensity (scale 1-10 where 10 is the highest resource use) from admission until delivery for a MULTIP for:
   a. Spontaneous vaginal birth
   b. Vacuum birth
   c. Forceps birth
   d. Vacuum and forceps birth
   e. Breech birth
   f. Cesarean birth

iii) How would you rate resource intensity (scale 1-10) from DELIVERY until DISCHARGE (postpartume) for a PRIMIP for:
   a. Spontaneous vaginal birth
   b. Vacuum birth
   c. Forceps birth
   d. Vacuum and forceps birth
   e. Breech birth
   f. Cesarean birth

iv) How would you rate resource intensity (scale 1-10) from DELIVERY until DISCHARGE (i.e. postpartum for a MULTIP for:
   a. Spontaneous vaginal birth
   b. Vacuum birth
   c. Forceps birth
   d. Vacuum and forceps birth
   e. Breech birth
   f. Cesarean birth

(please use standard cases (a-f) rather than outlier cases.)

Appendix D

Assumptions Around Resource Utilization

1. Time horizon
    a. including the first two days following the birth will allow for the majority of clinically significant outcomes relating to the birth to be captured.
2. Ambulance transport assumptions:
    a. Two ambulances would have been used for maternal and neonatal indications. One ambulance would have been used for a maternal indication, a fetal indication, or a maternal and fetal indication
    b. Ambulance transport in labour: cost for emergency room not calculated. Assumption that moved directly to labour and delivery ward.
3. Consultations (intrapartum and postpartum)
    a. All maternal consultations, with the exception of pain consultations resulting in the use of medications for epidural, spinal or general, took place with an obstetrician
    b. Even if two consultations with obstetricians were reported, consultations were only billed once (as per RMA input). Assumption: multiple obstetric consultations were with the same obstetrician. Where intrapartum and immediate postpartum consultation with an obstetrician occurred, the postpartum was viewed as an extension of

the intrapartum period and only one Fee for Service Charge for consultation was calculated.

c. Time of consultation will be similar between groups
d. Obstetricians were NOT in attendance at delivery when 'consultation (rather than transfer of care) was marked on the tracking sheet
e. All consultations took place in a hospital setting
f. Using the midpoint rather than real time (for admission to labour and labour to delivery) will have the same effect on both cohorts

4. Transfers of care during intrapartum (for mother) assumptions:
    a. Costing transfers of care include: physician consultation fee, delivery fee, average nursing care cost and daily obstetric postpartum visit while mother in hospital
5. Length of time from admission to delivery and delivery to discharge assumptions
    a. Using the midpoint for both admission to delivery and delivery to discharge will have the same impact on both cohorts
6. 3rd and 4th degree tears repaired by obstetrician assumptions:
    a. OHIP charge plus a visit
7. Infant ICU assumptions: all term infants were admitted to level B ICU care
8. Readmission assumptions:
    a. Readmission to postpartum unit (i.e. not to the emergency department)

9. Infant resuscitation assumptions:
    a. Physician involvement when: i) meconium noted; ii) PPV and chest compressions indicated for hospital birth
10. OCCI assumptions
    a. The normal charges for care for each birthing modality can be defined by the greatest number of cases
11. Other assumptions:
    a. Hospital utilization for OBs and midwives are the same
    b. When c-section or bleeding > 1000 ml reported, assumption Transfer of Care in labour and daily obstetric postpartum visit until discharge
    c. cost of midwifery care to assume that midwives are practicing within their full scope. Although this is not currently the case (i.e. some midwives transfer care due to epidurals and/or oxytocin augmentations), midwives are trained to manage these scenarios and theoretically should be utilizing their complete skill set.

Table 15: *Resource utilizations for consultations, FFS & procedures: cost, assumptions, & description*

Service (cost is for service from provider ONLY. All costs are calculate for M-F 0:700-17:00). Based on 2010 fee schedule	**Cost**	**Assumption**	**Procedure code & description**
ANESTHESIA			
Anesthesia – consult	N/A	a. No differentiation between midwifery & OB consult b. No charge for consult, just intervention (personal correspondence)	N/A
Anesthesia – labour analgesia	Unit fee = $14.65/15 min (6+12 = 18 units x 14.65) = $263.70	Unit fee based on 2010 fee schedule Assumption = maximum amount of time for anesthesia maintenance used.	P014C – introduction of catheter for labour analgesia (6 units) P016C- maintenance of obstetrical anesthesia – time units, 1 unit per ½ hour, maximum 12 units

Anesthesia – spinal epidural	(+ $50) = $313.70		E111A is added to P014C for a flat rate charge
Anesthesia –cesarean	7 time units + 8 time units = 15 time units = $ 219.75	For c-section can use epidural, spinal or GA and will get paid same (personal correspondence) Time = 1.5 hrs (based on 828 EECV2 women from 68 centres in 21 countries who had a c-section.(Hutton et al., 2011) Note: OR time 'may' have included other procedures in addition to CS e.g. hysterectomy, tubal ligation, intraoperative damage to bowel, ureter, bladder requiring repair…)	P018 – 7 units + time (1^{st} hr = 4 units, 2^{nd} hr = 8 units) 1.28 hrs (paid rate for 1.5 hrs – rounded up) = 8 time units
Anesthesia repeat consultation	$47.10	May be billed as an assessment (i.e. not repeat consultation) – personal correspondence	A013 – specific assessment
Aesthesia operative delivery or breech	6 units + 2 time units =8 units = 14.65 x 8= $117.20	Assumption that anesthetist is present for operative delivery	P020 – 6 units + time fee (need approximate time to calculate) (operative or assisted breech)
Anesthesia – repair of third degree tear	6 units + 2 time units = 8 units = 117.20	Assumption that anesthetist is present	P027 + time fee (need approximate time to calculate)
Anesthesia – repair of fourth degree tear	6 units + 2 time units = 8 units = 117.20	Assumption that anesthetist is present	P028 + time fee (need approximate time to calculate)

OBSTETRICS			
OB consultation	$86.60 (MRA) or $165 (MRSA)	90% of midwifery requested assessments are billed as MRA 10% of midwifery requested assessments are billed as MRSA (N=5, 90 MRAs and 9 MRSAs. Personal correspondence with RMA rep)	
OB oxytocin	N/A or $67.75 $67.75	When OBs bill MRA/MRSA, they do not typically bill for oxytocin as well (personal correspondence with RMA) Assumption OBs will bill when able, therefore use code P023	P023 – oxytocin infusion for induction or augmentation of labour
OB vaginal delivery	$ 462.85	No sole delivery premium	P006 – vaginal delivery
OB Operative delivery	$ 496.00	No sole delivery premium	P020 – operative delivery, i.e. mid-cavity extraction or assisted breech delivery
OB Caesarean section	$535.80	Straightforward c-section. Does not include costs for tubal interruption or hysterectomy	P018 – cesarean section
Assist for caesarean section	6 units (6 x 14.65) = $87.90 + time fee (8 units) = $205.10		P018 + time fee (1.5hrs)

Attendance of obstetric consultant(s) at delivery	$211.20	Physicians only in attendance for vaginal deliveries when TOC took place	P010
Assisted Breech delivery	$496.00		P020 – operative delivery, i.e. mid-cavity extraction or assisted breech delivery
OB manual removal of retained placenta	$54.50	Assumption. Only took place when charted in database.	P029
OB Repair of third degree tear	$82.15	Assumption: when birth was in hospital or transferred to hospital during birth or immediate postpartum an OB repaired the 3rd degree tear	P027 – repair of third degree tear or episiotomy extension, must include repair of perianal sphincter and perineum
OB repair of fourth degree tear	$97.15	Assumption: as above	P028 – repair of fourth degree tear or episiotomy extension, must include repair of rectal mucosa, perianal sphincter and perineum.
OB postpartum haemorrhage	$ 93.80	Assumption: if more than 1000ml noted for vaginal delivery or if specifically charted for c-section	Z774 – postpartum haemorrhage – exploration of vagina and cervix, uterine curettage
OB postnatal care in hospital and/or home	$55.15	Assumption: all women who were transferred to obstetrical care received pp obstetrical care. All women who were readmitted to hospital pp, received pp obstetrical care	

Pediatrics			
Consultation	$167.00		A265
Attendance at maternal delivery	$63.45		H267 = $63.45 (includes an assessment of the newborn) "This service is not eligible for payment if any other service is rendered by the same physician at the time of delivery unless the newborn is sick in which case a medical specific assessment (C263) is payable in addition to attendance at maternal delivery if rendered."
Neonatal care – Level B	1st day = $245.65 2nd day onwards = $122.80/day		G610 G611 (intensive care including monitoring (invasive or non-invasive), oxygen administration and intravenous therapy, but without ventilatory support)

Midwifery			
Midwifery intrapartum	$995.94		Based on information from BC College of Midwives. Fee divided into % based on workload analysis. 33% of total for intrapartum & 33% of total for postpartum. In Ontario 6 levels. Took mean from highest & lowest level ($750.42 & added 1/3 of operational fee - $245.52). Total operational fee per bcc= $744 (2010-2011) irrespective of which of the 6 fee levels midwife is billing at