

THE BIRTHING REVIEW PROJECT

Application of the Robson Classification of Cesarean Sections
In Focus: Robson Groups 1 & 2



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Introduction

Mirroring the national and provincial trends, intervention-intensive births are increasing in hospitals in the Greater Toronto Area (GTA). The cesarean section rate across all hospitals in the GTA increased from 26.7% in 2003-04 to 29.5% in 2008-09[1]. Wide variation exists across the region and across levels of care, with cesarean section rates ranging from 21.4% to 37.8% [1].

Induction rates in the GTA have hovered around 22% for the past four years. Similar to the cesarean section rate, however, substantial variation occurs. For example induction rates for women at 37-39 weeks gestation increased by 2.7% from 2003-04 to 2007-08 [1]. At level I facilities, the induction rate has increased by approximately 5% over the past five years.

In 2003-04, the rate of fetal surveillance using “*auscultation only*” was 11.6%. In contrast, the rate of fetal surveillance using “*auscultation only*” in 2007-08 was 6.5% [1]. At the same time, the rates of fetal surveillance using “*electronic fetal monitoring only*” have been increasing.

“High-tech” birthing is a term that has emerged to describe the phenomenon whereby interventions such as induction of labour, electronic fetal monitoring, amniotomy, and cesarean sections have become commonplace [2]. In response to what the World Health Organization has called “the rapid expansion in the development and use of a range of practices designed to start, augment, accelerate, regulate or monitor the physiological process of labour” [3], many professional associations and organizations have developed recommendations and policies on normal childbirth [3-5].

Most notably, the Joint Policy Statement on Normal Childbirth [4] was released in 2008. This policy statement designed to “support best practice” and “promote, protect, and support normal birth” was reviewed and approved by the Society of Obstetricians and Gynaecologists (SOGC); the Association of Women’s Health, Obstetric and Neonatal Nurses of Canada (AWHONN); the Canadian Association of Midwives (CAM); the College of Family Physicians of Canada (CFPC); and the Society of Rural Physicians of Canada (SRPC).

Among the recommendations in the aforementioned policy statement is the development of interdisciplinary committees to implement standardized unit policies on normal childbirth and all aspects of maternity care. Essential to such policy development, however, is a background understanding of the factors that are contributing to the rising intervention rates.

In an effort to better understand such factors and the implications for the GTA healthcare system, the Child Health Network initiated the Birthing Review Project. The aims of this project were to 1) analyze local determinants of variations in cesarean section and induction rates, 2) inform implementation of continuous quality improvement (CQI) strategies in maternity care settings in the GTA where possible and 3) advocate for appropriate resources to meet the needs of the evolving maternal/newborn population in the GTA.

The purpose of this project is NOT to recommend target rates for cesarean sections, inductions, or any other type of intervention. The purpose of the project is to understand the determinants of rising intervention rates in the GTA, generate discussion about the appropriateness of such interventions, and to generate awareness about the implications for the healthcare system. Joseph et al. made the following recommendation in 2003 and it speaks to the emphasis of this study

“Calls for reducing primary cesarean delivery rates and especially target-driven restrictions on primary cesarean delivery should be tempered by an understanding of temporal changes in maternal characteristics and the rationale behind changes in obstetric practice.”

Literature Review

A literature review was conducted in order to explore if and how maternal characteristics and obstetric practice are changing over time. One of the key questions then is as follows: Is the maternal risk profile changing? If so, can the changes account for increases in cesarean section and induction rates? Unfortunately, the literature is inconsistent in this area.

An examination of trends in the United States from 1991-2002 [6] and from 1989-2006 [7] lead researchers in both studies to the same conclusion: the medical risk profile of mothers do not seem to account for the increasing cesarean section rate. Similarly, in a recent report published by the British Columbia Perinatal Health Program [8], the authors conclude that the cesarean birth rate in British Columbia is rising faster than medical or demographic conditions would justify. In addition, a rapid increase in cesarean delivery in low risk women who had no medical indications has been documented in the literature [7].

Other studies however have concluded that the increasing cesarean section rates may be attributed to maternal risk profiles. A Scottish study looking at data from 1980-2005 showed that a substantial proportion of the increase in rate of emergency primary cesarean section delivery could be attributed to the trend in delaying of first childbirth [9]. An analysis of births in Nova Scotia between 1988 and 2000 lead the researchers to conclude that increases in the primary cesarean delivery rate were a consequence of changes in maternal characteristics [10]. These researchers also noted that changes in obstetric practice (as a result of the changing risk profile of mothers) have also contributed to the increased rates.

The aforementioned studies group several maternal characteristics and indicators of health status into one composite “maternal health profile”. These characteristics can also be explored individually in terms of their potential to influence the cesarean section and induction rates. Literature pertaining to maternal age, BMI, and diabetes are discussed below.

Maternal Characteristics & Health Status

Maternal Age

In Canada, the average age of women giving birth rose from 27.0 years in 1986 to 29.3 years in 2006 [11] Ontario's mean maternal age rose from 29.3 in 1995 to 30.0 years in 2006 [12] [11]. 21% of women giving birth in Ontario between April 2006 and March 2007 were over 35 years of age [13]. The mean age of women giving birth in the GTA in 2007/08 was 30.7 years of age [1].

The impact of this shifting demographic remains uncertain, but increased maternal age has been associated with an increased cesarean section delivery rate [7][14][15]. A recent study found that the likelihood of cesarean birth increased by about 5% for each additional year after age 35. Some have argued that the association between age and cesarean sections is explained by a biological effect [9] (i.e. aging is associated with impairment of myometrial contractility) whereas others posit that the association is a reflection of practice related changes. For example, studies have found that the higher cesarean section rate for older women is at least partially explained by a higher rate of induction, particularly elective induction [15]. In addition, cesarean delivery for the diagnosis of failure to progress and fetal distress occurs more frequently in older patients and older women are less likely to undergo a trial of labor [15]. Thus, when considering the association between maternal age and cesarean delivery, an awareness of the numerous potential confounding variables is important.

Maternal BMI

In 2008, 17.2% of Canadians aged 18 or older, (approximately 4.2 million adults), reported a height and weight that classified them as obese; from 2003 to 2008, obesity among women rose from 14.5% to 16.2% [16]. The credibility of such self reported data is always subject to scrutiny and may actually underrepresent the prevalence of obesity. Data from the 2004 Canadian Community Health Survey: Nutrition (CCHS) [17], which directly measured respondents' height and weight, showed that 23.1 % of Canadian aged 18 or older (or an estimated 5.5 million adults) were obese. Not surprisingly, increases in maternal pre-pregnancy weights have also been described in the literature. The percentage of Nova Scotia mothers weighing more than 90 kg dramatically rose from 4.1% in 1988 to 10.7% in 2001 [18].

The link between obesity and cesarean sections has been well documented in the literature [19-25]. Even among low-risk women managed by nurse-midwives, the risk of cesarean section delivery appears higher for obese women than for women of normal weight [22]. The relationship between obesity and cesarean sections is complicated by the fact that obese women are also at risk for developing pre-eclampsia, and gestational and insulin-dependent diabetes mellitus, as well as delivering large for gestational age and macrosomic infants [25] [26]. A number of studies, however, found that maternal obesity and weight gain are independent risk factors for cesarean delivery. [21, 25, 27]. Excessive weight gain during pregnancy has been found to be an independent risk factor for cesarean section delivery even when birth weight is normal [28].

Maternal Diabetes

The prevalence of diabetes in Ontario has been increasing; in 2005 the rate had exceeded the global rate that was predicted for 2030 [29]. 1.6% of Ontario mothers who gave birth in 2006/2007 had diabetes and 4.3% had gestational diabetes [13]. Between 2000 and 2005, rates of gestational diabetes in British Columbia rose from 6.0 % to 7.0% and rates of pre-existing diabetes rose from 0.3% to 0.4% [8].

Numerous studies have linked gestational diabetes with an increased risk of cesarean section delivery, including a large retrospective study conducted in Alberta [30]. A Toronto study comparing pregnancy outcomes between women with both types of diabetes found a higher rate of caesarean sections in the chronic diabetic group [21]. Both gestational and chronic diabetes have been identified as independent risk factors for primary caesarean deliveries [25]. A recent Swedish study [31] found an 8-fold increased risk for fetal macrosomia in Type 1 diabetic pregnancies.

Several causal pathways have been posited to explain how diabetes and excess weight may affect pregnancy and birth outcomes:

- 1) through their contribution to the development of pre-eclampsia, which can trigger preterm delivery of a low birth-weight baby, often by cesarean section [25]
- 2) through the increased risk of a macrosomic infant, which can result in dystocia and an elevated cesarean section delivery rate [25]

Obstetric Factors

Other possible explanations for the increase in intervention rates, aside from changing maternal characteristics, are changing obstetric factors and changing obstetric practice. Relevant literature pertaining to obstetric factors and obstetric practice is outlined below.

Large for Gestational Age

Large for gestational age refers to a fetus/baby above the 90th percentile of mean weight for gestation. The percentage of large for gestational age (LGA) babies born in Canada increased from 8% in 1978 to 11.5% in 1995 [32]. This increase has been associated with increases in maternal BMI, gestational weight gain, and a decrease in smoking during pregnancy. Similarly, the results of a population-based study in New South Wales from 1990-2005 [33] demonstrate an increasing trend in the proportion of babies born LGA. The authors point out that high birthweight is a concern due to risks to the infant (i.e. shoulder dystocia, brachial plexus injury) and/or to the mother (i.e. higher rates of cesarean section, fourth degree perineal lacerations, prolonged hospital stay, and postpartum hemorrhage).

Other researchers, however, have observed that the LGA definition used affects results. For example analysis of a 1999-2003 regional perinatal dataset from western New York showed an increase in LGA infants over the 5-year period using one LGA definition (i.e. 2 standard deviations above the mean birthweight for gestational age and based upon Swedish weight distributions), but did not find an increase when they used a different definition (i.e. infants above the 90th percentile based on the U.S. weight distributions) [34].

Non-progressive labor / Dystocia

According to Lowe, “The primary indication for cesarean section in nulliparous women is the clinical diagnoses that fall under the rubric of dystocia” [35]. Research evidence suggests that this phenomenon is complex and multifactorial [35].

In an Ottawa-Carleton study of primiparous women with singleton vertex births, 30.1% were given a diagnosis of dystocia [36]. Reflecting on the fact that a third of women in their study were diagnosed with dystocia prompted the authors to wonder, “whether the criteria used to define ‘normal’ adequately reflect actual variations in labour patterns among women” [36]. This question has also been posed by other researchers [37, 38].

More recently, a multi-center cohort study focusing on low-risk nulliparous women in term spontaneous labor with singleton fetus in cephalic presentation found a 37% cumulative incidence of dystocia [39]. In this study, 61% of the diagnoses for dystocia were given in the second stage of labor. Also of interest, the women with dystocia who were treated by augmentation had more cesarean deliveries and their infants were more often given low one-minute Apgar scores compared with women who delivered without a diagnosis of dystocia [39].

Whether the incidence of dystocia is increasing or whether physicians are labeling dystocia inappropriately is a question raised in the literature [36]. A recent study [40] examined the extent to which the Society of Obstetricians and Gynecologists of Canada (SOGC) guidelines on dystocia are being followed. The researchers concluded that many women have cesarean section for dystocia performed without fulfilling SOGC guidelines. The study also found, however, that increased cesarean section rates could not be adequately explained by increased guideline violations.

A recent multi-centre population based cohort study [41] explored risk factors for dystocia (defined by explicit criteria) in nulliparous women in term spontaneous labour with a singleton infant in cephalic presentation. The following characteristics were associated with dystocia: dilation of cervix <4cm, tense cervix, thick lower segment, fetal head above the inter-spinal diameter, and poor head-to-cervix contact. The strongest risk indicator, however, was use of epidural analgesia. 71% of women treated with epidural analgesia were diagnosed with dystocia. A recent Swedish study [42] investigating risk factors and delivery outcomes for dystocia also found that epidural analgesia was a major independent risk factor for dystocia.

The relationship between epidural analgesia and dystocia, however, has not been consistently documented in the literature, nor has the relationship between epidural analgesia and cesarean sections. A 2002 systematic review of the literature [43] examining unintended maternal, fetal, and neonatal effects of epidural analgesia used for pain relief in labor by low-risk women summarized much of the evidence as “equivocal”. In a 2005 Cochrane Database Systematic Review [44], the authors conclude that “epidural analgesia had no statistically significant impact on the risk of cesarean section”.

Oxytocin Use

Although oxytocin use for induction or augmentation is commonplace, it is not without controversy (i.e. issues arise around inappropriate usage and excessive uterine activity)[45]. Oxytocin has been added to the Institute for Safe Medication Practices (ISMP) list of high alert medications. The connection between oxytocin administration and cesarean sections is unclear. Recent research, however, suggests that a uniform approach to oxytocin administration can potentially reduce primary cesarean section rates[46].

Changes in Obstetric Practice

Changes in obstetric practices (i.e. reductions in midpelvic forceps use, labor induction) have been linked to increases in cesarean section rates [10]. What remains unclear is whether these changes have occurred as a consequence of changes in the maternal risk profile or if other factors have motivated the changes.

The connection between labour induction and cesarean births has been explored by many researchers, but continues to be debated in the literature. Parity, indication for induction, and gestational age are potential modifiers of this relationship. Primiparous women who are electively induced appear to have an increased risk of cesarean section delivery [47]. According to Shields et al. [37], “Retrospective and cohort data indicate that elective induction results in a two to threefold increased risk of cesarean section delivery in nulliparous women with an unripe cervix despite the use of cervical ripening agents”[48, 49].

Elective inductions have the potential to jumpstart a cascade of interventions; in a common scenario, the induced woman is confined to bed, connected to an intravenous line, the subject of continuous fetal monitoring, and more likely to experience artificial rupture of membranes[50].

As reported in The British Columbia Reproductive Care Program’s *Obstetric Guideline 7*, “rates of cesarean section rates were generally consistently higher in the induced group versus those who had spontaneous labour with expectant management, with the greatest difference in rates apparent in the nulliparous group”[51].

A recent systematic review, however, comparing the benefits and harms of elective induction and expectant management of pregnancy revealed that elective induction of labor at 41 weeks of gestation



and beyond was associated with a *decreased risk* of cesarean section [52]. Thus, consideration of gestational age is important when discussing elective induction and the risk of cesarean section.

Background – Preliminary Work

A small Child Health Network (CHN)¹ working group from the CHN Maternal Newborn Services Task Force was interested in exploring inductions and cesarean sections and decided to review GTA level data using the Robson Classification system; this work provided the impetus for the current birthing review project.

Data for the preliminary work and the birthing review project was extracted from the Niday Perinatal Database² – a web-based database that currently captures approximately 100% of births in the province of Ontario. Information from the history, assessment, care and outcomes of mothers and newborns is entered into the Niday database by one of the following processes:

1. Data is entered directly to the web-based database by the nurse or midwife caring for the mother and baby.
2. A registered nurse or midwife enters information into the unit log-book, a data worksheet or the patient’s chart and a data entry clerk transfers the information into the Niday database.
3. Data is extracted from either the patient care documentation of the electronic health record or an existing program database and uploaded to the data repository.

¹ See Appendix A for further information on the Child Health Network

² As part of BORN Ontario (formerly the Ontario Perinatal Surveillance System), the Niday database is currently being integrated into a maternal/newborn information system. Integration of the Niday databases with the Fetal Alert Network, Ontario Midwifery Program, Newborn Screening Program and the Maternal Serum Screening Program, will reduce the duplication of data capture, enhance data quality, and will ultimately result in improved decision making ability.

Robson Classification System

The Robson Classification of Cesarean Sections [53] provided the framework for the preliminary work and the current birthing review project. The Robson system of classification categorizes women into ten totally inclusive, mutually exclusive, clinically relevant groups according to parity, number of births, obstetrics history, gestation, presentation and type of labour. The ten subgroups are as follows:

1. Nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks gestation in spontaneous labour
2. Nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks gestation who either had labour induced or were delivered by cesarean section before labour
3. Multiparous women, without a previous uterine scar, with a single cephalic pregnancy at greater than or equal to 37 weeks
4. Multiparous women, without a previous uterine scar, with a single cephalic pregnancy at greater than or equal to 37 weeks gestation who either had labour induced or were delivered by cesarean section
5. All multiparous women, with at least one previous uterine scar and a single cephalic pregnancy at greater than or equal to 37 weeks
6. All nulliparous women with a single breech pregnancy
7. All multiparous women with a single breech pregnancy, including women with previous uterine scars
8. All women with multiple pregnancies, including women with previous uterine scars
9. All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars
10. All women with a single cephalic pregnancy at less than or equal to 36 weeks gestation, including women with previous scars

The Robson Classification system is an objective and robust classification system that is simple and easy to implement [54].

Preliminary Results for All Hospital Sites in the GTA
Table 1 – Robson Classification – Aggregate GTA Hospital Data 2004-05 - 2007-08³

Gp	Group Description	2004-05			2007-08		
		Relative size of Gp	C/S rate	Contribution to C/S rate	Relative size of Gp	C/S rate	Contribution to C/S rate
1	Nulliparous women with a single cephalic pregnancy at greater than or equal to 37 weeks gestation in spontaneous labour	28.2%	16.4%	4.6%	23.5%	15.1%	3.6%
2	Nulliparous women with a single cephalic pregnancy at greater than or equal to 37 weeks gestation who either had labour induced or were delivered by cesarean section before labour	10.3%	41.3%	4.2%	11.3%	38.9%	4.4%
3	Multiparous women, without a previous uterine scar with a single cephalic pregnancy at greater than or equal 37 weeks in spontaneous labour	28.7%	4.5%	1.3%	22.6%	2.9%	0.7%
4	Multiparous women, without a previous uterine scar with a single cephalic pregnancy at greater than or equal to 37 weeks gestation who had labour induced or were delivered by cesarean section	7.9%	16.6%	1.3%	8.2%	13.4%	1.1%
5	All multiparous women with at least one previous uterine scar and a single cephalic pregnancy at greater than or equal to 37 weeks gestation	9.2%	86.0%	7.9%	9.2%	85.2%	7.8%
6	All nulliparous women with a single breech pregnancy	1.8%	96.6%	1.8%	1.8%	97.1%	1.8%
7	All multiparous women with a single breech pregnancy including women with previous uterine scars	1.3%	94.2%	1.3%	1.5%	94.5%	1.4%
8	All women with multiple pregnancies including women with previous uterine scars	1.6%	60.5%	1.0%	1.7%	62.5%	1.1%
9	All women with a single pregnancy with a transverse or oblique lie including women with previous uterine scars	0.4%	82.0%	0.3%	0.5%	93.0%	0.4%
10	All women with a single cephalic pregnancy at less than or equal to 36 weeks gestation including women with previous scars	5.4%	28.8%	1.5%	4.7%	29.1%	1.4%

³ Note: The 16 sites included in this report had less than 5% of data missing in the fields relevant to the classification system (i.e. parity, number of births, obstetric history, gestation, presentation, and labour type). Although small, the amount of missing data does result in minor discrepancies.

As can be seen in Table 1:

- The relative size of Group 1 (nulliparous women with a single cephalic pregnancy at greater than or equal to 37 weeks gestation in spontaneous labour) has decreased from 28.2% in 2004-05 to 23.5% in 2007-08
- The relative size of Group 2 (nulliparous women with a single cephalic pregnancy at greater than or equal to 37 weeks gestation who had labour induced or cesarean section) increased from 10.3% in 2004-05 to 11.3% in 2007-08
- Group 1's contribution to the cesarean section rate is decreasing while Group 2's contribution is increasing. The percentage contribution of each group to the overall cesarean section rate is important as this calculation takes into account not only the cesarean section rate in each group, but also the relative size of that group in the obstetric population [53]
- Women in Group 5 (multiparous women with at least one previous uterine scar and a single cephalic pregnancy at greater than or equal to 37 weeks gestation) have the greatest contribution to the overall cesarean section rate.

This analysis prompted several questions:

- What impact will the increase in the relative size of Group 2 (and the fact that the women in this group are twice as likely to have a cesarean section) have on the GTA healthcare system?
- Will an 'echo effect' be evident? (I.e. more primary cesarean sections leading to more repeat cesarean sections)?
- Is the system adequately resourced to handle the increase in cesarean section deliveries⁴?

⁴ According to a 2004 Canadian Institute of Health Information report (based on 2002-03 data), the average cost of cesarean delivery (\$4600) is 60% higher than that of a vaginal delivery (\$2800). Additional supply and labor costs, added lengths of stay in hospital, and increased neonatal and maternal morbidity add to healthcare expenditures⁴⁷. Wilson, B.L., *Assessing the effects of age, gestation, socioeconomic status, and ethnicity on labor inductions*. J Nurs Scholarsh, 2007. **39**(3): p. 208-13..

Birthing Review Project – Participants & Results

To build on the preliminary work already completed, a Birthing Review Working Group (comprised of CHN members with administrative and clinical expertise) was formed to conduct additional analysis to help understand intervention rates. Terms of reference for the group were drafted and can be found in Appendix B.

Participants

Of the 22 GTA sites, 16 sites⁵ (representing each level of care and a cross section of the GTA) were able to participate in the analysis. Six sites were ineligible due to the amount of missing data in one of the necessary fields (i.e. parity, number of births, obstetrics history, gestation, presentation and type of labour).

Initial Analysis

As in the preliminary work, the relative size, C/S rate, and contribution to the C/S rate were calculated and are shown in Table 2.

Note: Robson group 2 can be further sub-divided into 2A and 2B. Similarly Robson Group 4 can be sub-divided into 4A and 4B:

- **Group 2** = Nulliparous, single cephalic pregnancy ≥ 37 weeks, labour induced **OR** had cesarean before labour
- **Group 2A** = Nulliparous, single cephalic pregnancy ≥ 37 weeks, **LABOUR INDUCED**
- **Group 2B** = Nulliparous, single cephalic pregnancy ≥ 37 weeks, **CESAREAN SECTION BEFORE LABOUR**
- **Group 4** = Multiparous, single cephalic pregnancy ≥ 37 weeks gestation, labour induced **OR** had cesarean section before labour
- **Group 4A** = Multiparous, single cephalic pregnancy ≥ 37 weeks gestation, **LABOUR INDUCED**
- **Group 4B** = Multiparous, single cephalic pregnancy ≥ 37 weeks gestation, **CESAREAN SECTION BEFORE LABOUR**

⁵ See Appendix C for a list of the hospitals

Table 2 - Robson Classification – Aggregate Data – 16 Hospital Sites 2004-05 - 2008-09⁶

Data from 16 hospital sites		2004-05			2008-09		
Gp	Group Description	Relative size of Gp	C/S rate	Contribution to C/S rate	Relative size of Gp	C/S rate	Contribution to C/S rate
1	Nulliparous women with a single cephalic pregnancy at > or = to 37 weeks gestation in spontaneous labour	29.2%	17.1%	5.0%	25.6%	16.6%	4.2%
2	Nulliparous women with a single cephalic pregnancy at > or = to 37 weeks gestation who either had labour induced or were delivered by cesarean section before labour	10.4%	42.5%	4.4%	12.5%	40.8%	5.1%
2A	Nulliparous women with a single cephalic pregnancy at > or = to 37 weeks gestation who had labour induced only	9.1%	34.2%	3.1%	11.1%	33.4%	3.7%
3	Multiparous women, without a previous uterine scar with a single cephalic pregnancy > or = to 37 weeks in spontaneous labour	29.0%	4.5%	1.3%	25.4%	3.0%	0.8%
4	Multiparous women, without a previous uterine scar with a single cephalic pregnancy > or = to 37 weeks gestation who had labour induced or were delivered by cesarean section	7.7%	17.8%	1.4%	9.0%	13.0%	1.2%
4A	Multiparous women, without a previous uterine scar with a single cephalic pregnancy at > or = to 37 weeks gestation who had labour induced only	6.8%	7.0%	0.5%	8.3%	6.4%	0.5%
5	All multiparous women with at least one previous uterine scar and a single cephalic pregnancy at > or = to 37 weeks gestation	9.4%	86.0%	8.0%	11.7%	86.1%	10.1%
6	All nulliparous women with a single breech pregnancy	2.1%	96.5%	2.1%	2.3%	98.2%	2.2%
7	All multiparous women with a single breech pregnancy including women with previous uterine scars	1.4%	94.3%	1.4%	1.8%	95.7%	1.7%
8	All women with multiple pregnancies including women with previous uterine scars	1.8%	62.3%	1.1%	2.0%	62.1%	1.2%
9	All women with a single pregnancy with a transverse or oblique lie including women with previous uterine scars	0.4%	79.7%	0.4%	0.3%	77.9%	0.2%
10	All women with a single cephalic pregnancy at less than or equal to 36 weeks gestation including women with previous scars	5.6%	28.9%	1.6%	5.5%	31.1%	1.7%

⁶ Note: The 16 sites included in this report had less than 5% of data missing in the fields relevant to the classification system (i.e. parity, number of births, obstetric history, gestation, presentation, and labour type). Although small, the amount of missing data does result in minor discrepancies.

Table 2 – Relative Size, C/S Rate, and Overall Contribution to the C/S rate – 16 Hospital Sites

- The relative size of Group 1 (nulliparous women with a single cephalic pregnancy at greater than or equal to 37 weeks gestation in spontaneous labour) has decreased from 29.2% in 2004-05 to 25.6% in 2008-09
- The relative size of Group 2 (nulliparous women with a single cephalic pregnancy at greater than or equal to 37 weeks gestation who had labour induced or cesarean section) increased from 10.4% in 2004-05 to 12.5% in 2008-09
- The relative size of Group 2A (nulliparous women with a single cephalic pregnancy at greater than or equal to 37 weeks gestation who had labour induced) increased from 9.1% in 2004-05 to 11.1% in 2008-09
- Group 1's contribution to the cesarean section rate is decreasing (from 5.0% in 2004-05 to 4.2% in 2008-09) while Group 2A's contribution is increasing (from 3.1% in 2004-05 to 3.7% in 2008-09).
- Groups 3 and 4 combined (the multiparous women) make up 36.7% of pregnancies in 2004-05 (36.7% in 2008-09) but contribute little to the overall cesarean section rate (2.7% in 2004-05 and 2.0% in 2008-09).
- Women in Group 5 (multiparous women with at least one previous uterine scar and a single cephalic pregnancy at greater than or equal to 37 weeks gestation) have the greatest contribution to the overall cesarean section rate (8.0% in 2004-05 and 10.1% in 2008-09).

Additional Analysis

The initial grouping of women according to Robson's classification system provided useful general information (re: relative size, contribution to the overall cesarean section rate). As noted by Robson, however, the ten groups are only intended to give an *initial overview* of cesarean section rates (which can be compared with rates in other units or in the same unit over time).

Subsequent to the initial comparison, additional analysis of the groups was needed to explore the potential reasons for the differences in cesarean section rates. The Working Group decided to prioritize analysis for nulliparous women: Groups 1 and 2.

Group 1 is interesting to explore further - not because the cesarean rate is particularly high - but because the large relative size of the group (larger than all other groups except Group 3) means that small differences in the rate translates into a large number of cesarean sections [53]. In addition, according to Robson:

“The intrapartum care of the spontaneously laboring, single, cephalic nulliparous patient at term is a key indicator of obstetric care in the delivery ward” [55].



Thus, Groups 1 and 2 were explored further with respect to:

- maternal characteristics and health status
- obstetric factors
- neonatal outcomes.

Data was extracted from the Niday Perinatal Database in Microsoft Excel spreadsheet format. The data file included all birth records from the 16 participating hospitals in the fiscal years 2004/05 to 2008/09. Derived variables were created and analyzed using SPSS statistical software.

Table 3 shows the total number of women giving birth at the 16 participating hospital sites by year. Additionally, it shows the number of women in Group 1 and in Group 2 (and subsets 2A and 2B) by year and the combined total of Groups 1 and 2.

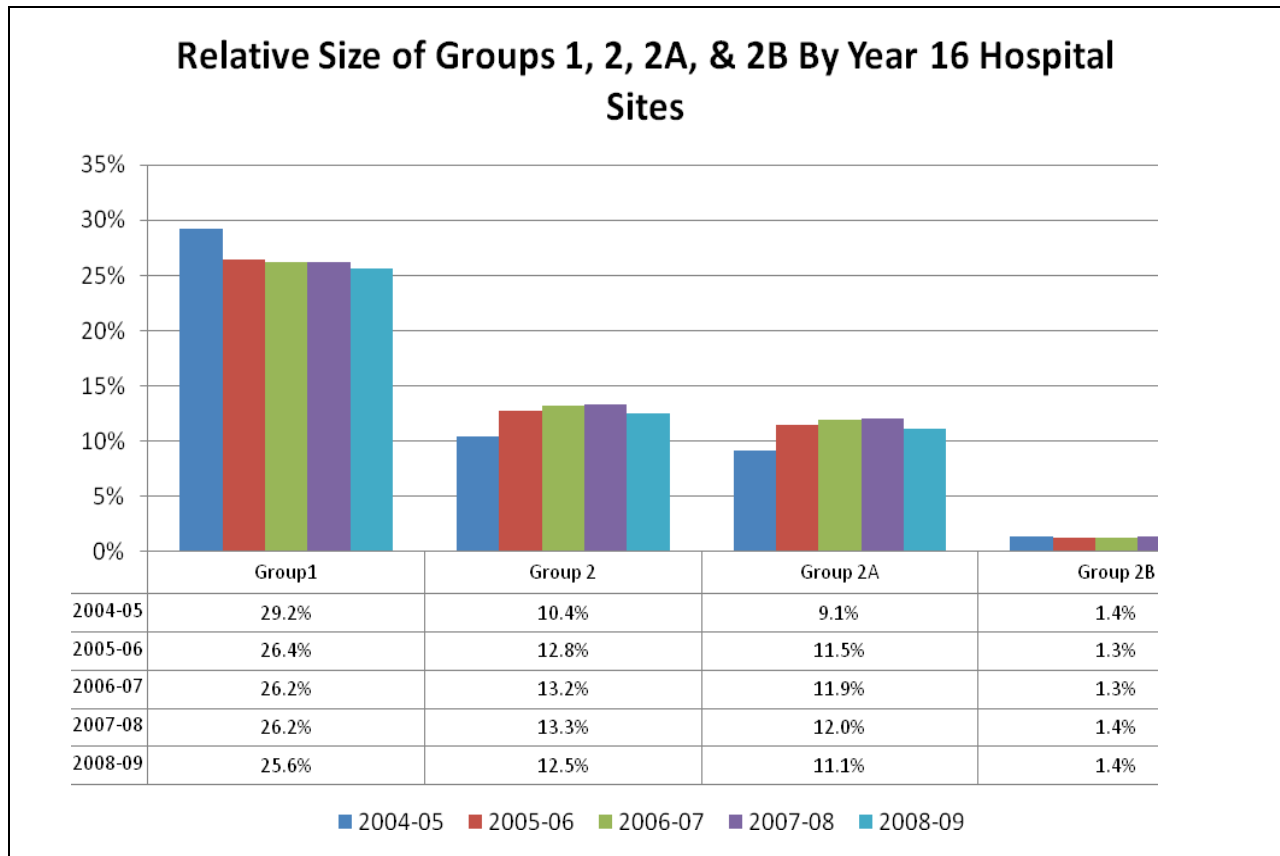
Table 3 – Reference Table – Total Numbers of Women Giving Birth in 16 Hospital Sites by Year

Group sizes – Robson Group 1, 2A, 2B By year – 16 Hospital Sites					
	2004-05	2005-06	2006-07	2007-08	2008-09
Total # of Women Giving Birth- 16 hospital sites	46,501	46,817	47,853	48,899	48,021
# Women Group 1 + Group 2	18,412	18,339	18,879	19,329	18,269
# Women in Group 1	13,556	12,340	12,542	12,812	12,284
# Women in Group 2	4,856	5,999	6,337	6,517	5,985
# Women in Group 2A	4,226	5,370	5,706	5,851	5,318
# Women in Group 2B	630	629	631	666	667

- The total number of women giving birth at the 16 participating hospital sites increased to 48,899 in 2007-08 and then decreased slightly in 2008-09 to 48,021. Despite the decrease in 2008-09, the overall increase in the number of women giving birth at the 16 hospital sites between 2004 and 2009 was 1520.
- The number of women in Group 1 decreased by 1272 between 2004-05 and 2008-09
- The number of women in Group 2 increased by 1129 from 2004-05 to 2008-09. The number of women in Group 2A increased by 1092 from 2004-05 to 2008-09.

Figure 1 illustrates the trend in the relative size of Groups 1, 2, 2A and 2B.

Figure 1 - Relative Size: Groups 1, 2, 2A, 2B By Year



- The relative size of Group 1 decreased by 3.6% over 5 years
- The relative size of Group 2A increased by 2.9% between 2004-05 and 2007-08 and then decreased by 0.9% between 2007-08 and 2008-09
- Group 2B has remained stable.

* Other Robson Groups (Groups 3-10) are not shown here



Table 4 compares the number and percentage of cesarean sections in women in Group 1 and Group 2A, in addition to the overall cesarean section rate by year.

Table 4 – Births by Cesarean Section Delivery -16 Hospital Sites

	2004-05	2005-06	2006-07	2007-08	2008-09
# of C/S - Group 1	2,319	2,049	2,060	2,028	2,036
C/S rate for Group 1	17.1%	16.6%	16.4%	15.8%	16.6%
C/S Rate for all 10 Groups	26.7%	27.4%	28.1%	28.0%	28.5%
C/S contribution for Group 1	5.0%	4.4%	4.3%	4.1%	4.2%
# C/S - Group 2A	1,445	1,801	1,889	1,907	1,775
C/S rate for Group 2A	34.2%	33.5%	33.1%	32.6%	33.4%
C/S Rate for all 10 Groups	26.7%	27.4%	28.1%	28.0%	28.5%
C/S contribution for Group 2A	3.1%	3.8%	3.9%	3.9%	3.7%

- Group 1’s contribution to the overall C/S rate decreased from 5.0% in 2004-05 to 4.2% in 2008-09
- Group 2A’s contribution to the overall C/S rate increased from 3.1% in 2004-05 to 3.7% in 2008-09
- The cesarean section rate for Group 2A has hovered around 33-34% over the past 5 years but the number of women who were induced and subsequently had cesarean sections increased by 23%
- Each year, the cesarean section rate for Group 2A is approximately double that of Group 1.

Note: Percentage contribution to the overall C/S rate = # C/S in a given Robson sub-group / Total # women delivering at the 16 hospitals (i.e. C/S contribution for Group 1 for 2004-05 = 2,319/46,501). This calculation is important because it takes into account the relative size of each group.



Table 4 shows cesarean section data on an aggregate level, but the data can also be analyzed at a hospital specific level. Tables 5-8 show the cesarean section rates for women in **Group 1** at each of the participating hospitals, as well as the relative size⁷ of Group 1. The hospitals are presented in groups by level of care. See Appendix D for descriptions of GTA Levels of Care.

Table 5 – Cesarean Rates in Women in Group 1 at Level 1 Hospitals 2004-2009

Level 1	Rate	Relative Size
HHS - Milton	13.9%	31.4%
HHS - Georgetown	16.1%	23.1%
Lakeridge - Port Perry	22.1%	29.2%
Rouge Valley – Ajax/Pickering	23.5%	23.6%

- Between 2004 and 2009, the average cesarean section rate among the four Level 1 hospitals was 18.9% and the range was 13.9%-23.5%
- Data consideration: because of the relatively small birthing volumes at some Level 1 hospitals, even small decreases or increases can affect percentages.

Table 6 – Cesarean Rates in Women in Group 1 at Level 2 Hospitals 2004-2009

Level 2	Rate	Relative Size
Scarborough - Birchmount	10.3%	26.0%
Trillium	12.8%	29.0%
TEGH	14.8%	28.2%
WOHC - Etobicoke	15.6%	22.6%
St. Joseph's	16.4%	30.0%

- Between 2004 and 2009, the average cesarean section rate among the six Level 2 hospitals was 14.0% and the range was 10.3%-16.4%.

⁷ Relative Size = Number of women in Group 1 at a given hospital / Number of Women delivering at a given hospital

Table 7 – Cesarean Rates in Women in Group 1 at Level 2+ Hospitals 2004-2009

Level 2+	Rate	Relative Size
Credit Valley	11.5%	28.3%
NYGH	16.9%	30.4%
WOHC Brampton	17.3%	25.7%
Rouge Valley - Centenary	19.9%	26.0%
Lakeridge - Oshawa	21.3%	24.3%

- Between 2004 and 2009, the average cesarean section rate among the five Level 2+ hospitals was 17.4% and the range was 11.5%-21.3%.

Table 8 – Cesarean Rates in Women in Group 1 at Level 3 Hospitals 2004-2009

Level 3	Rate	Relative Size
Mount Sinai	19.6%	22.7%
Sunnybrook	22.2%	25.9%

- Between 2004 and 2009, the average cesarean section rate among the two Level 3 hospitals was 20.9% and the range was 19.6%-22.2%.



Tables 9-12 show the cesarean section rates for women in **Group 2A** at each of the participating hospitals, as well as the relative size⁸ of Group 1. The hospitals are also grouped by level of care.

Table 9 – Cesarean Rates in Women in Group 2A at Level 1 Hospitals 2004-2009

Level 1	Rate	Relative Size
HHS - Georgetown	29.0%	13.3%
HHS - Milton	33.6%	13.2%
Rouge Valley – Ajax/Pickering	44.7%	14.2%
Lakeridge - Port Perry	48.8%	13.6%

- Between 2004 and 2009, the average cesarean section rate among the four Level 1 hospitals was 39% and the range was 29.0%-48.8%
- Data consideration: because of the relatively small birthing volumes at some Level 1 hospitals, even small decreases or increases can affect percentages.

Table 10 – Cesarean Rates in Women in Group 2A at Level 2 Hospitals 2004-2009

Level 2	Rate	Relative Size
Scarborough – Birchmount	24.5%	7.6%
Trillium	25.8%	10.6%
TEGH	32.3%	11.0%
WOHC - Etobicoke	29.4%	11.6%
St. Joseph's	34.3%	10.8%

- Between 2004 and 2009, the average cesarean section rate among the five Level 2 hospitals was 29.3% and the range was 24.5%-34.3%.

⁸ Relative Size = Number of women in Group 1 at a given hospital / Number of Women delivering at a given hospital

Table 11 – Cesarean Rates in Women in Group 2A at Level 2+ Hospitals 2004-2009

Level 2+	Rate	Relative Size
Credit Valley	26.1%	9.3%
Rouge Valley – Centenary	34.1%	11.0%
Lakeridge - Oshawa	34.4%	12.7%
NYGH	34.7%	11.6%
WOHC – Brampton	39.0%	10.2%

- Between 2004 and 2009, the average cesarean section rate among the five Level 2+ hospitals was 33.7% and the range was 26.1%-39.0%

Table 12 – Cesarean Rates in Women in Group 2A at Level 3 Hospitals 2004-2009

Level 3	Rate	Relative Size
Mount Sinai	35.0%	11.8%
Sunnybrook	36.4%	13.0%

- Between 2004 and 2009, the average cesarean section rate among the two Level 3 hospitals was 35.7% and the range was 35.0%-36.4%

The issue of premature rupture of membranes (PROM) as an indication for induction was raised with the Birthing Review Workgroup. The suggestion was made to exclude women whose indication for induction was PROM to see if this affected the cesarean section rate. Tables 13-16 compare cesarean section rates in women with and without an indication for induction = PROM. When PROM is taken out as an indication for induction, the cesarean section rate increased at 9 hospitals, decreased at 5 hospitals and remained the same at 2 hospitals.

Table 13 – C/S Rate Comparison in Level 1 Hospitals: Including + Excluding Women with an indication for induction = PROM

Level 1	C/S Rate	C/S Rate (excluding PROM)
HHS - Georgetown	29.0%	27.7%
HHS - Milton	33.6%	33.4%
Rouge Valley – Ajax/Pickering	44.7%	45.2%
Lakeridge - Port Perry	48.8%	49.4%

Table 14 – C/S Rate Comparison in Level 2 Hospitals: Including + Excluding Women with an indication for induction = PROM

Level 2	C/S Rate	C/S Rate (excluding PROM)
Scarborough - Birchmount	24.5%	24.5%
Trillium	25.8%	26.9%
WOHC - Etobicoke	29.4%	29.6%
TEGH	32.3%	31.7%
St. Joseph's	34.3%	35.1%

Table 15 – C/S Rate Comparison in Level 2+ Hospitals: Including and Excluding Women with an indication for induction = PROM

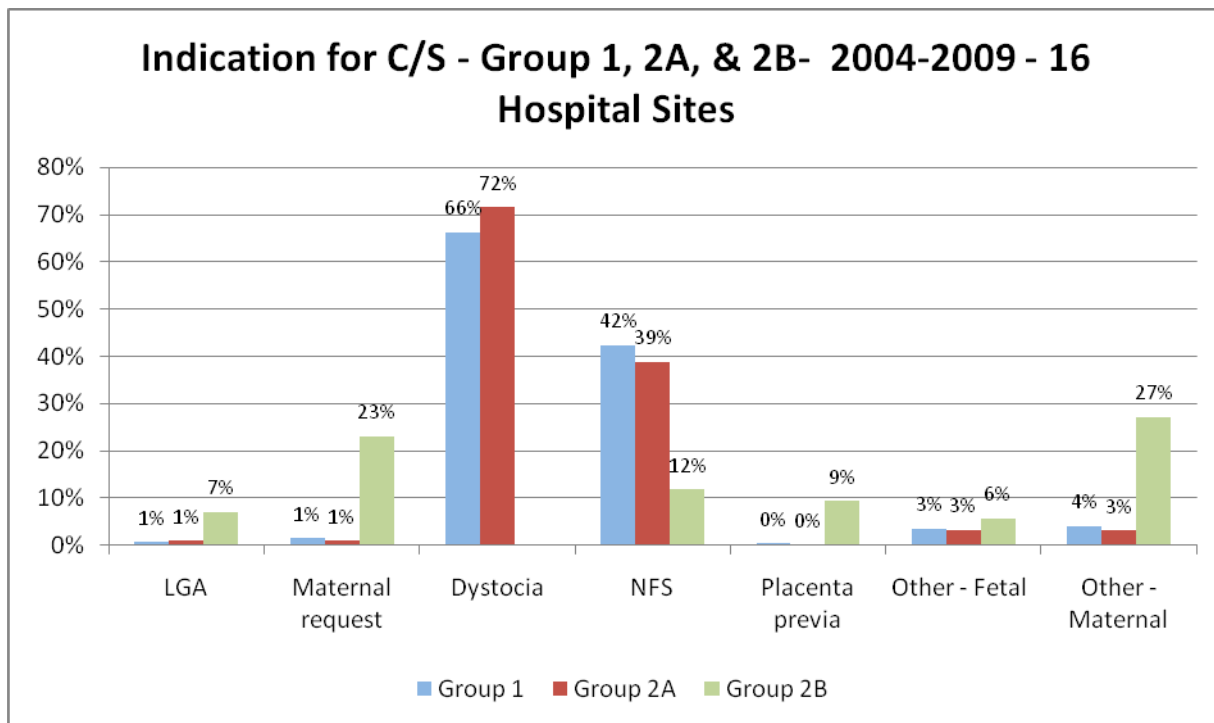
Level 2+	C/S Rate	C/S Rate (excluding PROM)
Credit Valley	26.1%	26.6%
Rouge Valley – Centenary	34.1%	35.1%
Lakeridge - Oshawa	34.4%	34.1%
NYGH	34.7%	36.3%
WOHC – Brampton	39.0%	39.0%

Table 16 – C/S Rate Comparison in Level 3 Hospitals: Including and Excluding Women with an indication for induction = PROM

Level 3	C/S Rate	C/S Rate (excluding PROM)
Mount Sinai	35.0%	35.6%
Sunnybrook	36.4%	36.5%

The distribution of indications for cesarean section is displayed by group in Figure 2. Considerable variation occurs between the groups: Group 1 and Group 2A show similar trends, but Group 2B is quite distinct.

Figure 2 - Indications for Cesarean Sections



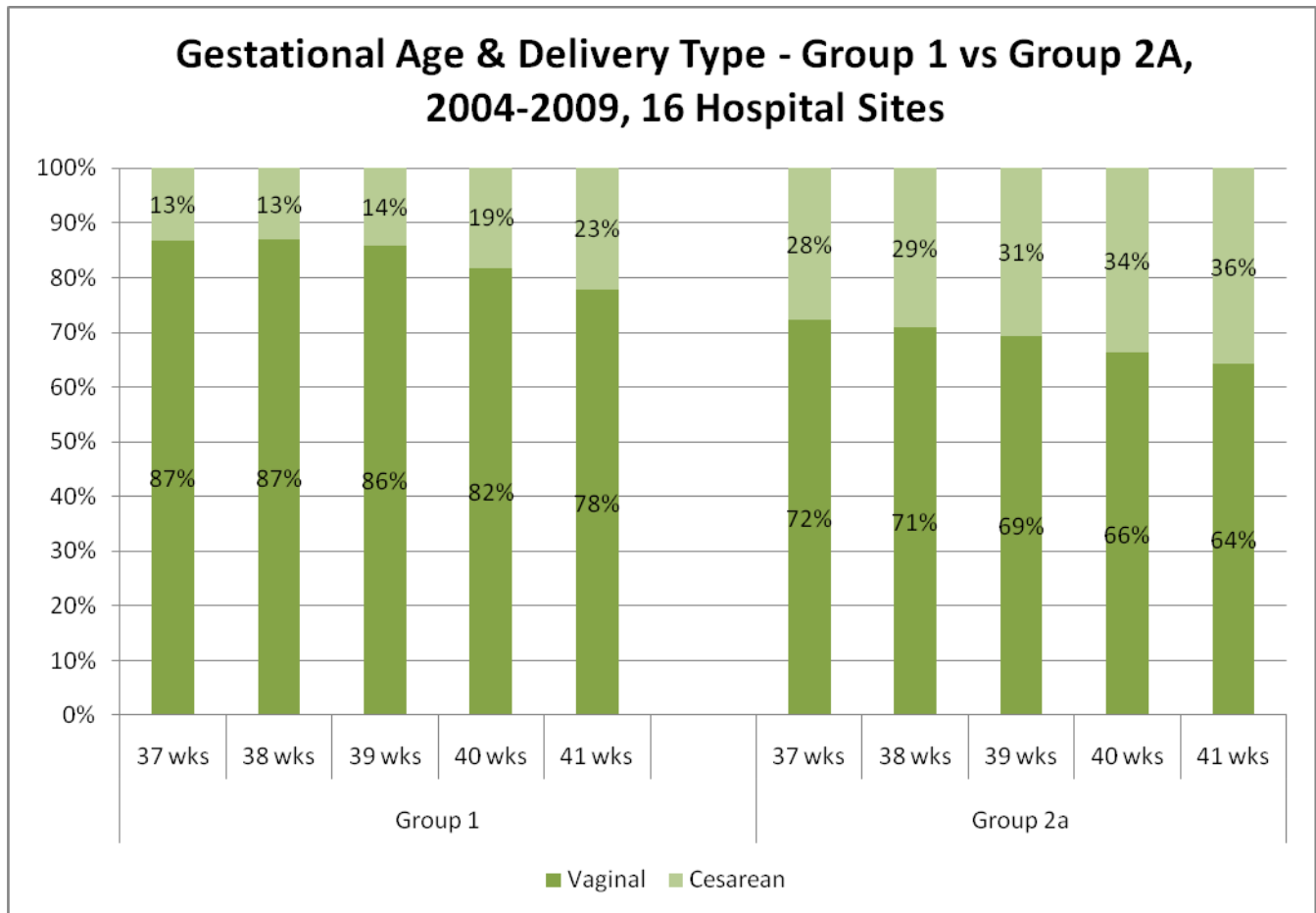
- Of the 7,328 women in Group 2A that had a cesarean section (and had an indication entered), 72% had an indication = dystocia, 39% had an indication = NSF
- Of the 8,029 women in Group 1 that had a cesarean section (and had an indication entered), 66% had an indication = dystocia, 42% had an indication = NFS
- Of the 2,135 women in Group 2B that had a cesarean section (and had an indication entered), 23% had an indication = maternal request
- The indications for cesarean section for Group 2B are more varied than in Group 1 and Group 2A, and the most common indications in Group 2B are maternal request, non-reassuring fetal status and ‘other’ maternal health problems.

Note: included under the category of ‘dystocia’ is non-progressive labour/descent

Note: more than one indication may be selected

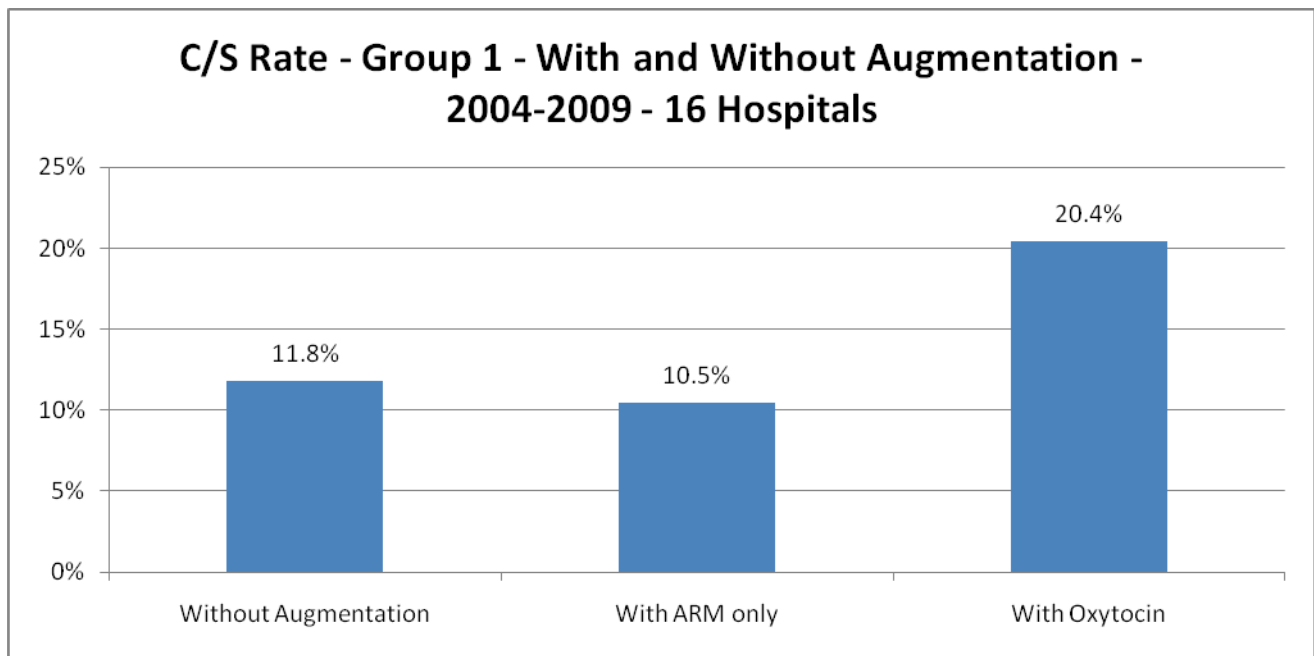
Figure 3 compares the delivery type at various gestational ages for women in Group 1 and Group 2A. At every gestational age (37-41 weeks), women in Group 2A are more likely to have a cesarean section than women in Group 1. With increasing gestational age, the risk of cesarean section appears to increase.

Figure 3 - Gestational Age and Delivery Type



The association between augmentation and cesarean sections is also of interest; Figure 4 compares cesarean section rates among women who were not augmented, women augmented with ARM only and women receiving oxytocin.

Figure 4 - Cesarean Section Rates in Group 1 (With and Without Augmentation)



Tables 17-20 below present cesarean section rates in women with and without augmentation by level of care. The variation within and between levels of care is interesting. At Toronto East General Hospital, women in Group 1 augmented with oxytocin are almost three times as likely to have a cesarean section as those without augmentation. At another level two hospital, Scarborough - Birchmount, however, the cesarean section rates among women augmented with oxytocin and those without augmentation are very similar. What accounts for the difference? Credit Valley Hospital has the lowest cesarean section rates across all three groups of women (i.e. without augmentation, with ARM only, with oxytocin).

Table 17- C/S Rates – Group 1 - With & Without Augmentation – Level 1 - 2004-2009

Level 1	C/S Rates Without Augmentation	With ARM only	With Oxytocin
HHS - Milton	6.7%	8.3%	20.9%
HHS - Georgetown	10.4%	15.0%	20.5%
Lakeridge - Port Perry	17.7%	18.9%	36.7%
Rouge Valley – Ajax/Pickering	21.2%	15.0%	28.7%



Table 18 - C/S Rates – Group 1 - With & Without Augmentation – Level 2 - 2004-2009

Level 2	C/S Rates Without Augmentation	With ARM only	With Oxytocin
Scarborough - Birchmount	10.2%	5.8%	11.8%
Trillium	6.8%	9.3%	17.9%
TEGH	7.5%	9.1%	21.3%
WOHC - Etobicoke	10.3%	10.4%	17.7%
St. Joseph's	12.0%	11.4%	19.9%

Table 19 - C/S Rates – Group 1 - With & Without Augmentation – Level 2+ - 2004-2009

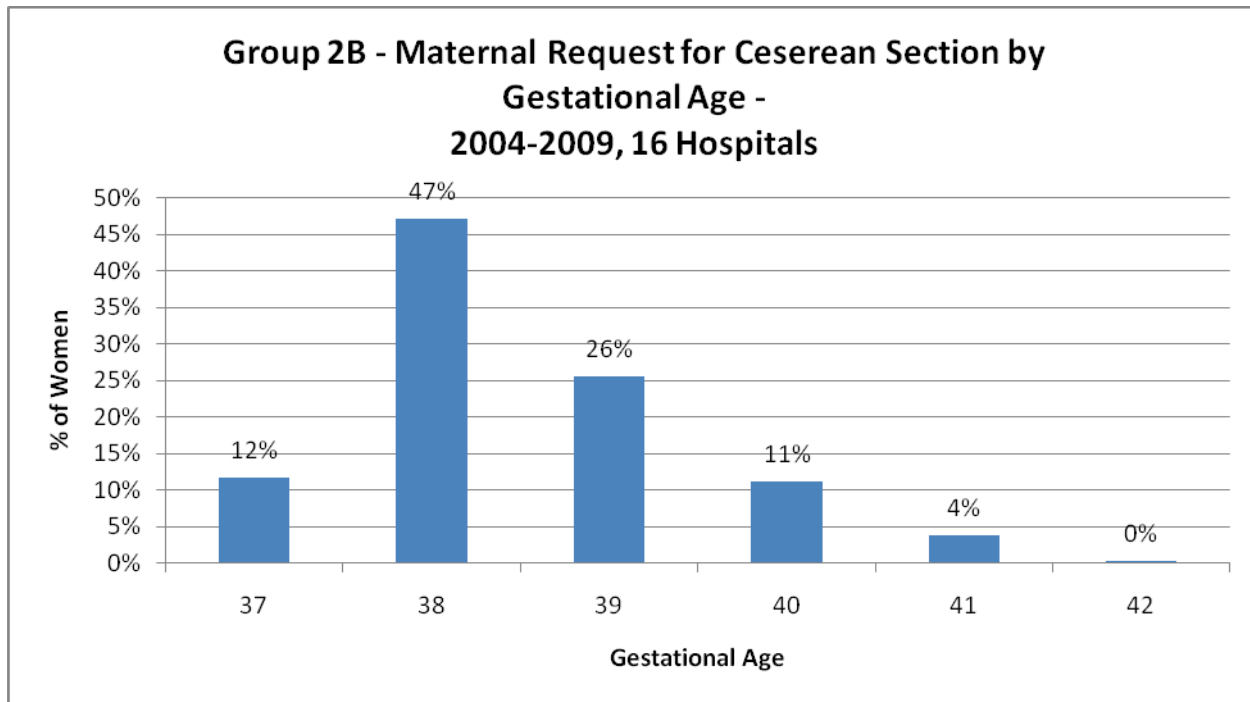
Level 2+	C/S Rates Without Augmentation	With ARM only	With Oxytocin
Credit Valley	6.7%	5.4%	16.4%
NYGH	13.3%	9.6%	18.1%
WOHC Brampton	12.1%	12.2%	20.4%
Rouge Valley - Centenary	19.1%	15.0%	19.5%
Lakeridge - Oshawa	17.1%	14.6%	29.2%

Table 20 - C/S Rates – Group 1 - With & Without Augmentation – Level 3- 2004-2009

Level 3	C/S Rates Without Augmentation	With ARM only	With Oxytocin
Mount Sinai	17.1%	10.0%	22.8%
Sunnybrook	14.2%	13.8%	28.8%

From Figure 2, we saw that Group 2B had the largest percentage of indications for cesarean section attributable to maternal request. Although the number of women in Group 2B who have non-medically indicated cesarean sections is relatively small, it is interesting to examine the distribution across gestational ages (see Figure 5).

Figure 5 – Gestational Age Distribution – Subset of Women in Group 2B

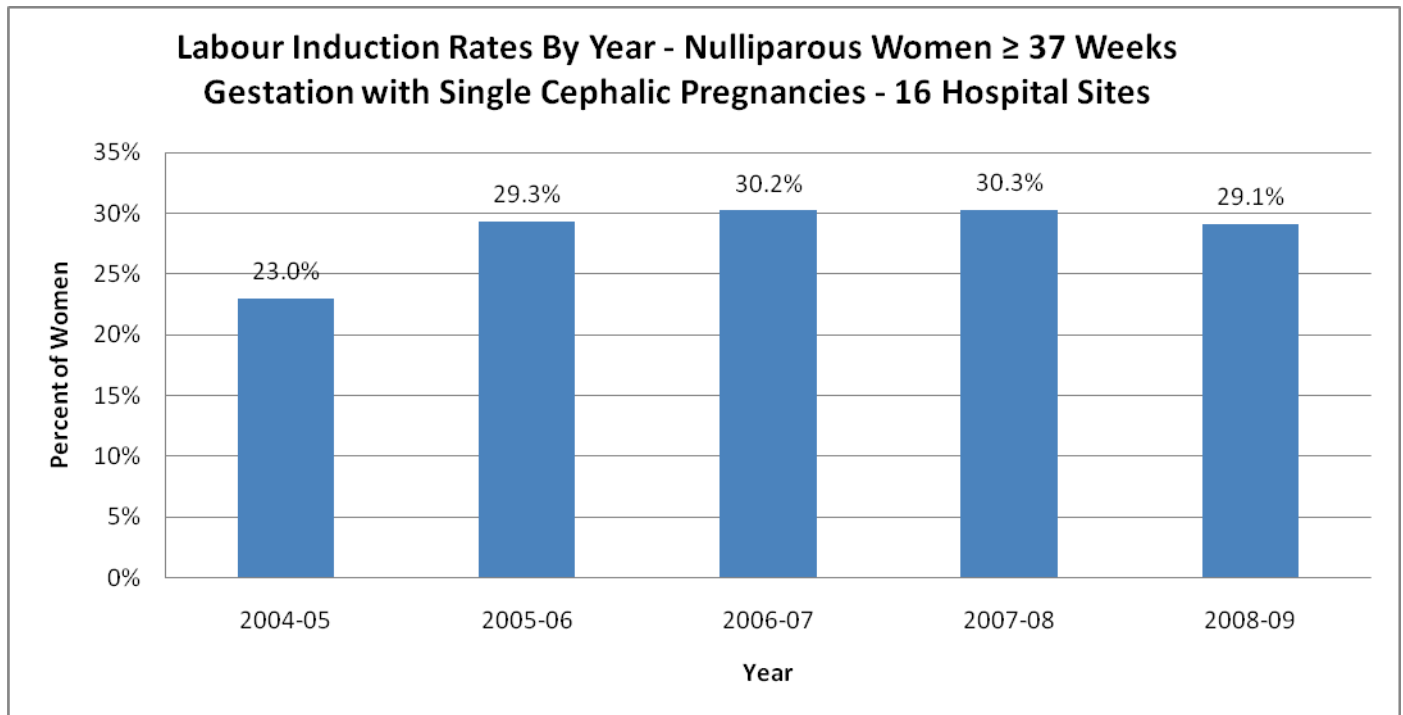


- Of the 534 women in Group 2B who had a *non-medically indicated cesarean section* (i.e. no other indication for cesarean section noted), 47% occurred at 38 weeks.

A Closer Look at Inductions

Given that women in Group 2A are twice as likely to have a cesarean section as women in Group 1, a closer look at inductions is warranted. Figure 6 shows the induction trend among nulliparous women \geq 37 weeks gestation with single cephalic pregnancies over five years.

Figure 6 - Induction Rates – Nulliparous \geq 37 Weeks Gestation (Single Cephalic Pregnancies)⁹



- The largest increase in induction rates was seen between 2004-05 and 2005-06
- Induction rates appear to level off between 2005-06 and 2008-09.

Although the aggregate data is useful in examining an overall trend, presenting site specific data is necessary in order to gain an appreciation for the variation that exists between hospitals in the GTA region. Tables 21-24 highlight induction rates at individual hospital sites (grouped by level of care).

Also shown in Tables 21-24 is the induction rate with an indication for induction = premature rupture of membranes (PROM) **excluded**. When PROM is excluded as an indication, the induction rate at all the hospitals decreased - although some only slightly (i.e. Scarborough Birchmount – 0.4%) and others more substantially (NYGH – 7.5%).

⁹ # inductions per year: 2004-05 = 4,226; 2005-06 = 5,370; 2006-07 = 5,706; 2007-08 = 5,851; 2008-09 = 5,318

Table 21– Induction Rates Among Nulliparous Women ≥ 37 Weeks Gestation with Single Cephalic Pregnancies at Level I Hospitals – 2004-2009

Level 1	Induction Rate	Induction Rate (if PROM is excluded)
HHS - Milton	28.8%	26.5%
Lakeridge - Port Perry	31.3%	26.2%
HHS - Georgetown	35.5%	33.4%
Rouge Valley – Ajax/Pickering	36.5%	33.4%

- Between 2004 and 2009, the average induction rate among the four Level 1 hospitals was 33.0% and the range was 28.8%-36.5% (PROM included)

Table 22 - Induction Rates Among Nulliparous Women ≥ 37 Weeks Gestation with Single Cephalic Pregnancies at Level 2 Hospitals – 2004-2009

Level 2	Induction Rate	Induction Rate (if PROM is excluded)
Scarborough - Birchmount	21.5%	21.1%
St. Joseph’s	25.6%	23.3%
Trillium	26.3%	22.1%
TEGH	27.2%	24.9%
WOHC - Etobicoke	33.0%	31.6%

- Between 2004 and 2009, the average induction rate among the five Level 2 hospitals was 26.7% and the range was 21.5%-33.0% (PROM included)

Table 23- Induction Rates Among Nulliparous Women ≥ 37 Weeks Gestation with Single Cephalic Pregnancies at Level 2+ Hospitals – 2004-2009

Level 2+	Induction Rate	Induction Rate (if PROM is excluded)
Credit Valley	23.9%	22.2%
NYGH	26.4%	18.9%
WOHC Brampton	27.5%	26.3%
Rouge Valley - Centenary	28.9%	27.4%
Lakeridge - Oshawa	33.2%	30.4%

- Between 2004 and 2009, the average induction rate among the five Level 2+ hospitals was 28.0% and the range was 23.9%-33.2% (PROM included)

Table 24 - Induction Rates Among Nulliparous Women ≥ 37 Weeks Gestation with Single Cephalic Pregnancies at Level III Hospitals– 2004-2009

Level 3	Induction Rate	Induction Rate (if PROM is excluded)
Sunnybrook	31.9%	31.2%
Mount Sinai	32.6%	29.7%

- Between 2004 and 2009, the average induction rate among the two Level 3 hospitals was 32.3% and the range was 31.9%-32.6% (PROM included)

In order to try to understand the induction rate (specifically the rise in inductions that occurred between 2004-05 and 2005-06), trends pertaining to the following factors were explored and are presented in Table 25 and Figure 7:

- Maternal health problems (i.e. diabetes, chronic hypertension)
- Obstetrical complications (i.e. gestational diabetes, LGA, pre-eclampsia)
- Maternal age

The rationale for this analysis was as follows: if one or more of these factors showed a similar trend (i.e. an increase between 2004-05 and 2005-06), it may help explain why the induction rate increased. Unfortunately, none of the factors explored parallel the induction trend.

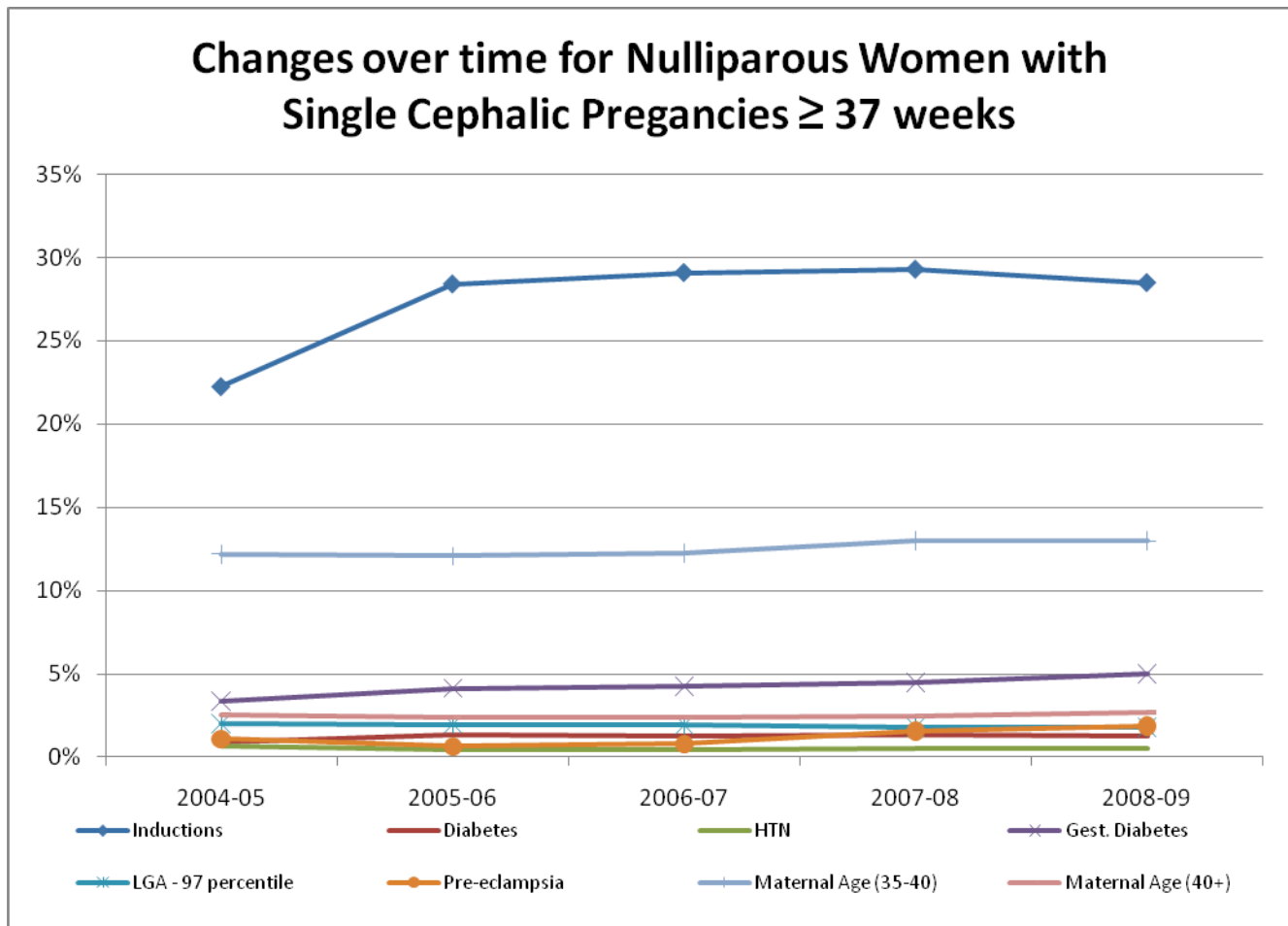


Table 25 – Changes in Selected Maternal Health Problems, Obstetrical Complications and Maternal Age among Nulliparous Women ≥ 37 Weeks Gestation with Single Cephalic Pregnancies

	2004-05	2005-06	2006-07	2007-08	2008-09
<i>Diabetes</i>	*	221 (1.2%)	230 (1.2%)	241 (1.2%)	222 (1.2%)
<i>Chronic HTN</i>	*	71 (0.4%)	77 (0.4%)	100 (0.5%)	90 (0.5%)
<i>Gest. Diabetes</i>	*	692 (3.8%)	772 (4.1%)	852 (4.4%)	895 (4.9%)
<i>LGA - 97th percentile (calculated)</i>	376 (2.0%)	364 (2.0%)	370 (2.0%)	347 (1.8%)	337 (1.8%)
<i>Pre-eclampsia</i>	*	110 (0.6%)	146 (0.8%)	303 (1.6%)	342 (1.9%)
<i>Maternal Age (35-40)</i>	2,270 (12.3%)	2,235 (12.2%)	2,343 (12.4%)	2,529 (13.1%)	2,413 (13.2%)
<i>Maternal Age (40+)</i>	471 (2.6%)	452 (2.5%)	440 (2.3%)	478 (2.5%)	490 (2.7%)

* In 2004-05 maternal health problems and obstetrical complication were new data elements and data capture was less than optimal; thus they are excluded from this analysis.

Figure 7 - Nulliparous Women ≥37 Weeks Gestation (Single Cephalic Pregnancies) Changes Over Time 2004-2009



- Between 2004-05 and 2008-09 the percentage of women who had induced labour increased 6.1% (from 23.0% to 29.1%)
- Between 2005-06 and 2008-09: the diabetes rate remained constant at 1.2%; the chronic hypertension rate has remained fairly constant at 0.4%-0.5%; the gestational diabetes rate increased from 3.8% to 4.9%; the preeclampsia rate increased from 0.6% to 1.9%
- Between 2004-05 and 2008-09: the LGA rate 97th percentile decreased from 2.0% to 1.8%
- Between 2004-05 and 2008-09 the percentage of women in the 35-40 age group increased from 12.3% to 13.2% and the percentage of women in the 40+ age group increased from 2.6% to 2.7%.

LGA was of particular interest as a perception existed that LGA has been increasing over recent years. The data does not appear to support this notion. In order to examine this finding further, LGA was compared across groups and across years and the results are shown in Table 26. The only group showing a modest increase in LGA is Group 2B (i.e. LGA – 95th percentile and LGA-97th percentile).

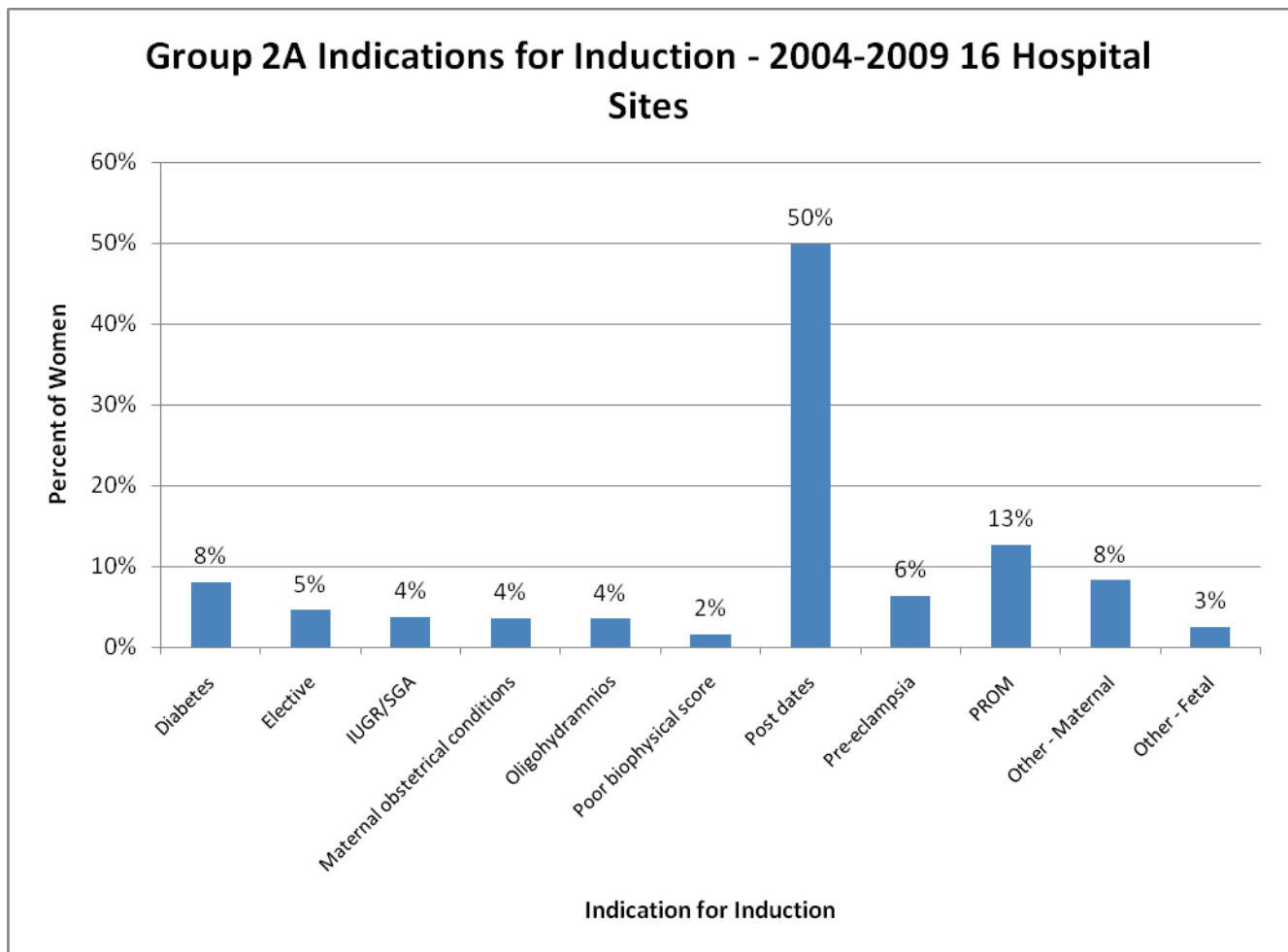
Table 26 – Large for Gestational Age Babies Born to Nulliparous Women 2004-2009

Rate of LGA babies born to Nulliparous Women ≥37 Weeks Gestation (Single Cephalic Pregnancies) 2004-2009 - 16 hospital sites						
		2004-05	2005-06	2006-07	2007-08	2008-09
LGA -90th Percentile	Group 1	6.2%	5.6%	5.9%	6.0%	5.5%
	Group 2	10.6%	9.4%	8.8%	8.4%	9.3%
	Group 2A	9.9%	8.9%	8.3%	7.7%	8.6%
	Group 2B	15.7%	13.4%	13.3%	14.6%	14.6%
LGA -95th Percentile	Group 1	2.9%	2.5%	2.6%	2.5%	2.4%
	Group 2	5.3%	4.8%	4.5%	4.5%	4.6%
	Group 2A	4.8%	4.5%	4.0%	3.8%	4.0%
	Group 2B	8.9%	7.7%	8.5%	10.1%	9.3%
LGA -97th Percentile	Group 1	1.6%	1.5%	1.6%	1.3%	1.4%
	Group 2	3.2%	3.0%	2.7%	2.7%	2.8%
	Group 2A	2.8%	2.7%	2.4%	2.2%	2.2%
	Group 2B	6.0%	5.7%	6.1%	7.2%	7.5%

The previous tables (21-26) and figures (6-7) examined all nulliparous women ≥ 37 weeks gestation with single cephalic pregnancies with respect to induction rates and selected maternal health problems and obstetrical complications.

The next section narrows the focus to women in Group 2A – those women who are induced. Figure 8 shows the indications for inductions.

Figure 8 - Group 2A - Indications for Induction¹⁰



- Of the 21,221 women who were induced (and had an indication for induction entered), 10,590 (50%) were coded as postdates
- 22% of those women coded as post dates were actually less than 41 weeks gestation.

¹⁰ N=21,221

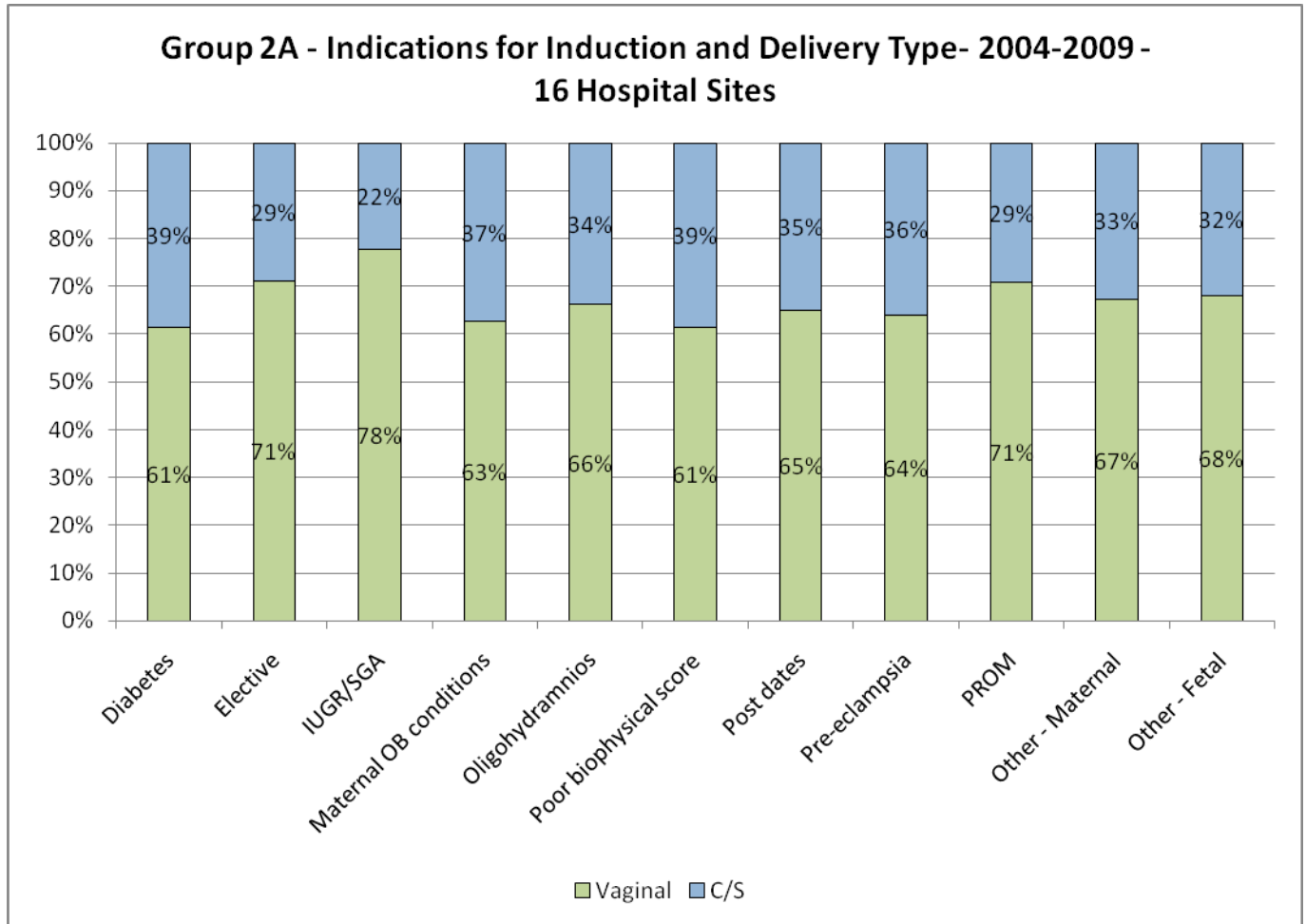
Diabetes=1,705; Elective=973; IUGR=796; Maternal OB conditions=755; Oligohydramnios=749; Poor biophysical score=351; Post-dates=10,590; Pre-eclampsia=1,339; PROM=2,681; Other maternal=1,759; Other fetal=538

Table 27 and Figure 9 also show data pertaining to indications for induction, but they add additional information (i.e. delivery type). For example Table 27 shows that approximately 39% of the women in Group 2A whose indication for induction was diabetes delivered by cesarean section.

Table 27 - Indication for Induction and Cesarean section Rate 2004-2009 - 16 Hospital Sites

Indication for Induction	# Women	# Women delivering by c/s	C/S Rate
Diabetes	1705	658	38.6%
IUGR/SGA	796	178	22.4%
LGA	213	141	66.2%
Maternal obstetrical conditions	755	283	37.5%
Non-reactive NST	191	105	55.0%
Oligohydramnios	749	254	33.9%
Poor biophysical score	351	135	38.5%
Post dates	10590	3722	35.1%
Pre-eclampsia	1339	483	36.1%
Pre-existing maternal medical conditions	231	99	42.9%
PROM	2681	787	29.4%
Other - Maternal	1759	572	32.5%
Other - Fetal	538	173	32.2%

Figure 9 – Indications for Induction and Delivery Type





Women in Group 2A can be further subdivided into those that had medically-indicated inductions and those that had non-medically indicated inductions. Women who had non-medically indicated inductions include women whose indication for induction was either coded “elective” or “post dates” (but the gestational age was less than 41 weeks).

Women who had *non-medically indicated inductions* are a valuable comparator to women in Group 1 because they are a similar group of women (i.e. the main difference between the two being labour type – spontaneous vs. induced). Table 28 presents the number of women with non-medically indicated induction (as compared to all women in Group 2A) by year as well as the cesarean section rate within this group.

Table 28 - Subset of Group 2A Women who had Non-medically Indicated Inductions, By Year – 16 hospital sites

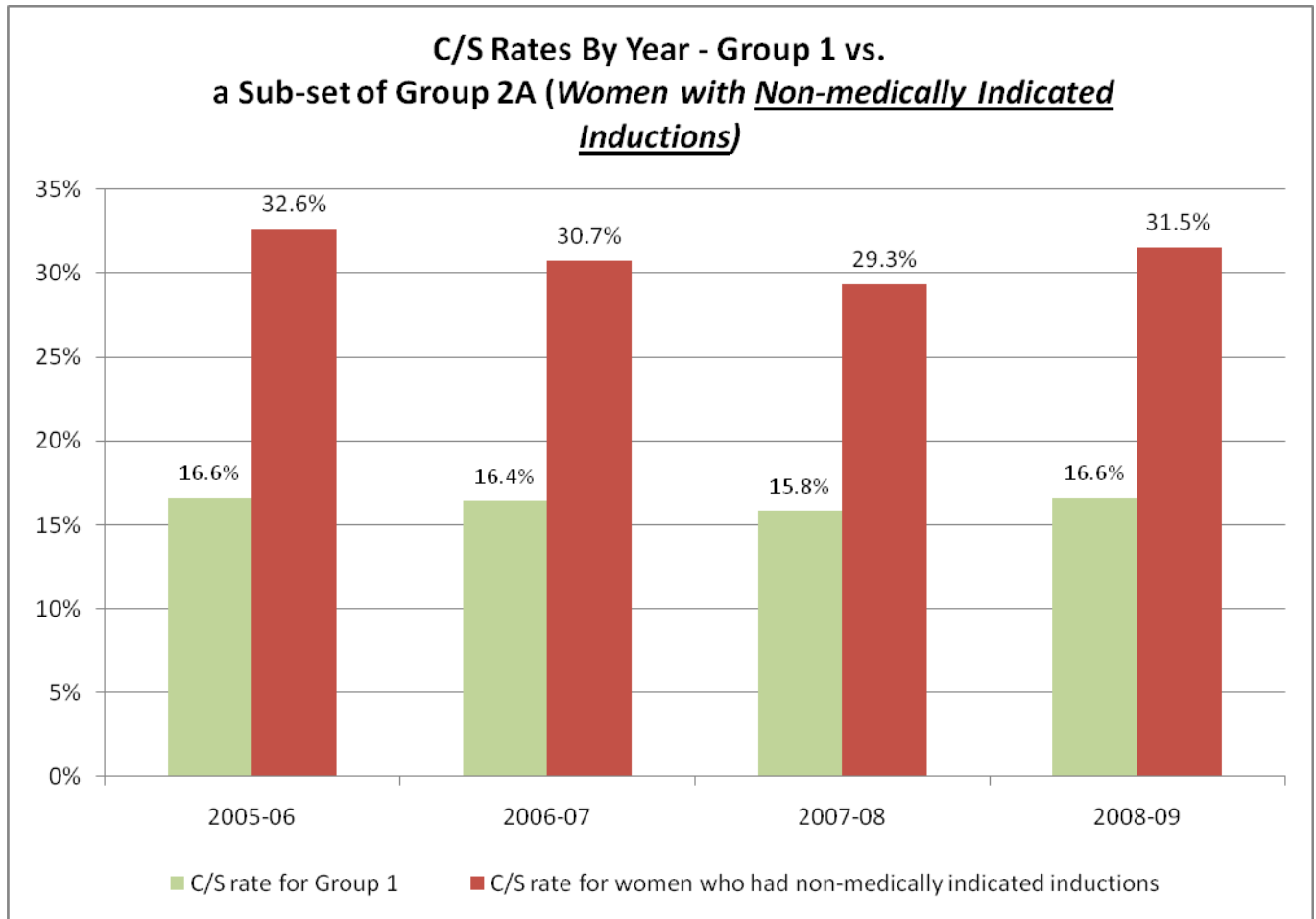
	2004-05	2005-06	2006-07	2007-08	2008-09
# Women in Group 2A	4,226	5,370	5,706	5,851	5,318
# Women with non-medically indicated inductions	*	755	765	850	683
% of Women in 2A who had non-medically indicated inductions	*	14.1%	13.4%	14.5%	12.8%
# Women who had non-medically indicated inductions and delivered by C/S	*	246	235	249	215
C/S rate for women who had non-medically indicated inductions	*	32.6%	30.7%	29.3%	31.5%

- Of the nulliparous women ≥ 37 weeks with single cephalic pregnancies who were induced at the 16 hospital sites between 2004 and 2009, 13.7% were not medically indicated.
- The average cesarean section rate among these women was 31%

*Note: * ‘Indication for induction’ was a new data element in 2004-05 and had less than optimal data capture, thus 2004-05 data pertaining to indication has been excluded.*

Figure 10 illustrates the difference in the cesarean section rate between women in Group 1 and the subset of women from Group 2A who had non-medically indicated inductions.

Figure 10 - Cesarean Section Rates in Group 1 vs. Women with Non-medically Indicated Inductions by Year

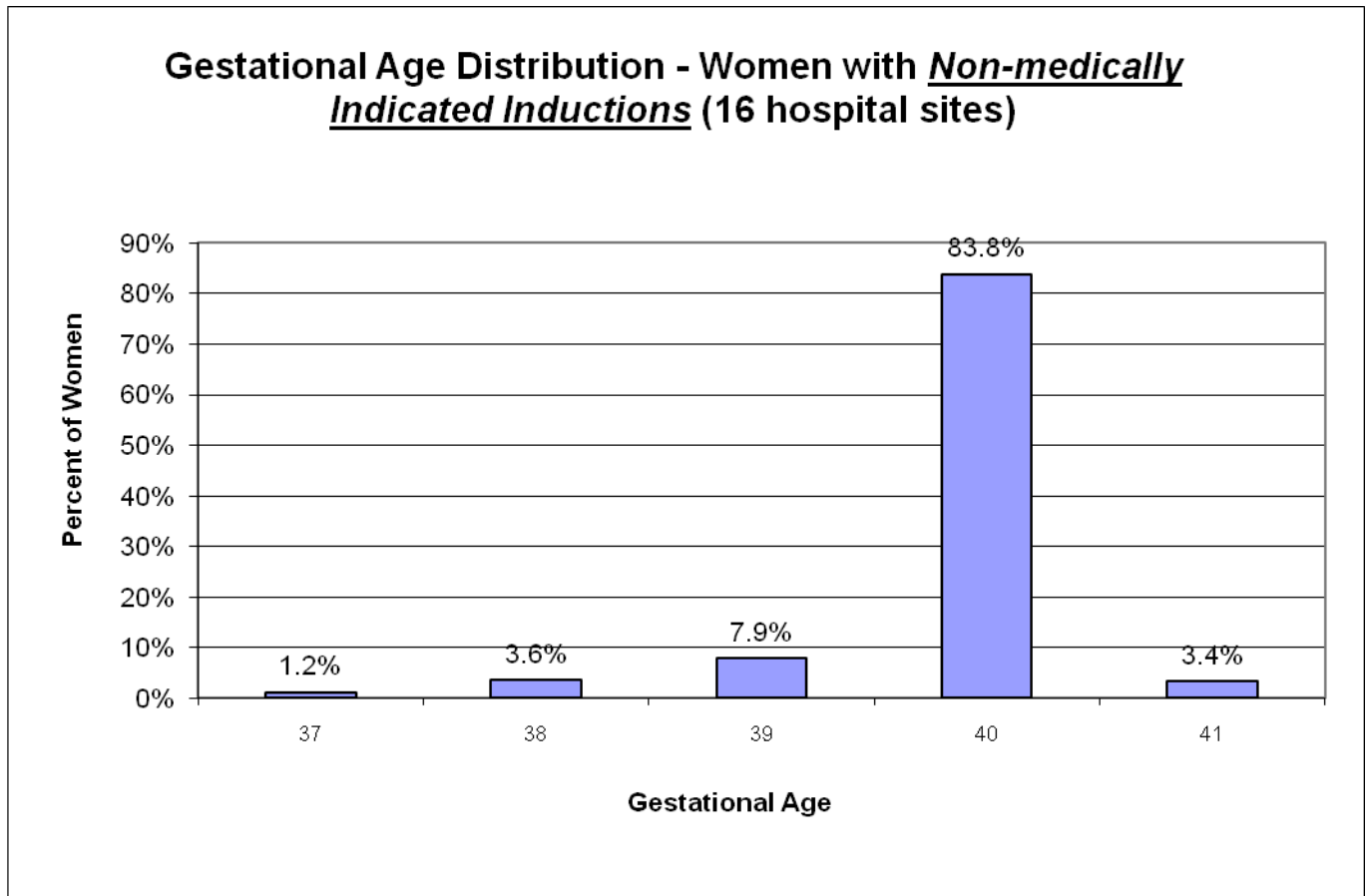


- Every year between 2004 and 2009, the cesarean section rate in women in with non-medically indicated inductions is almost double that of women in Group 1

Key question: what accounts for the difference in cesarean section rates between these two groups?

Also of interest is the gestational age distribution of women who had non-medically indicated inductions (depicted in Figure 11). When are most of these women giving birth?

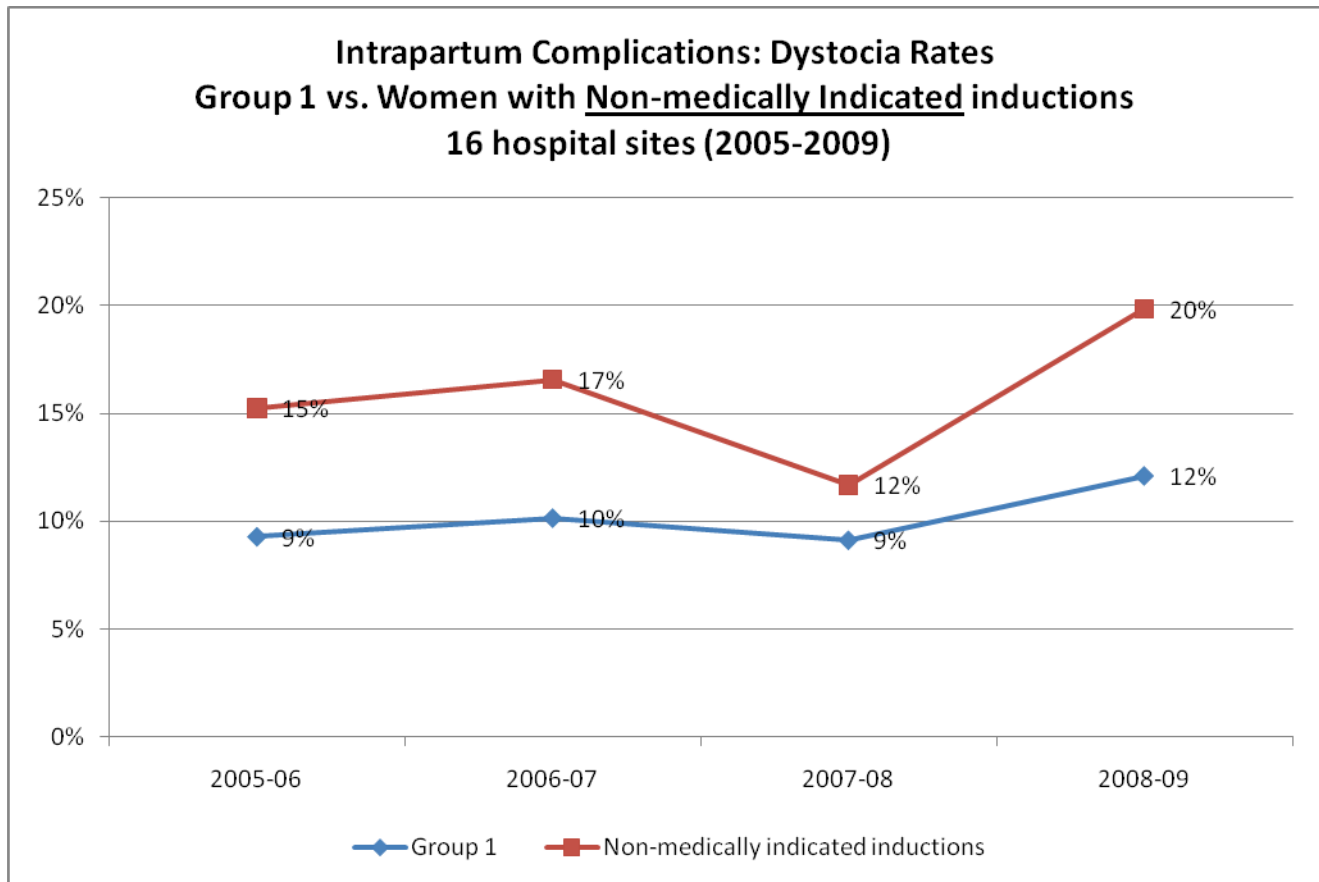
Figure 11 - Non-medically Indicated Inductions and Gestational Age



- Of the 3,053 women who had a non-medically indicated induction, 83.8% occurred at 40 weeks gestation
- Of those induced at 40 weeks (non-medical indication), 32% had a cesarean section.

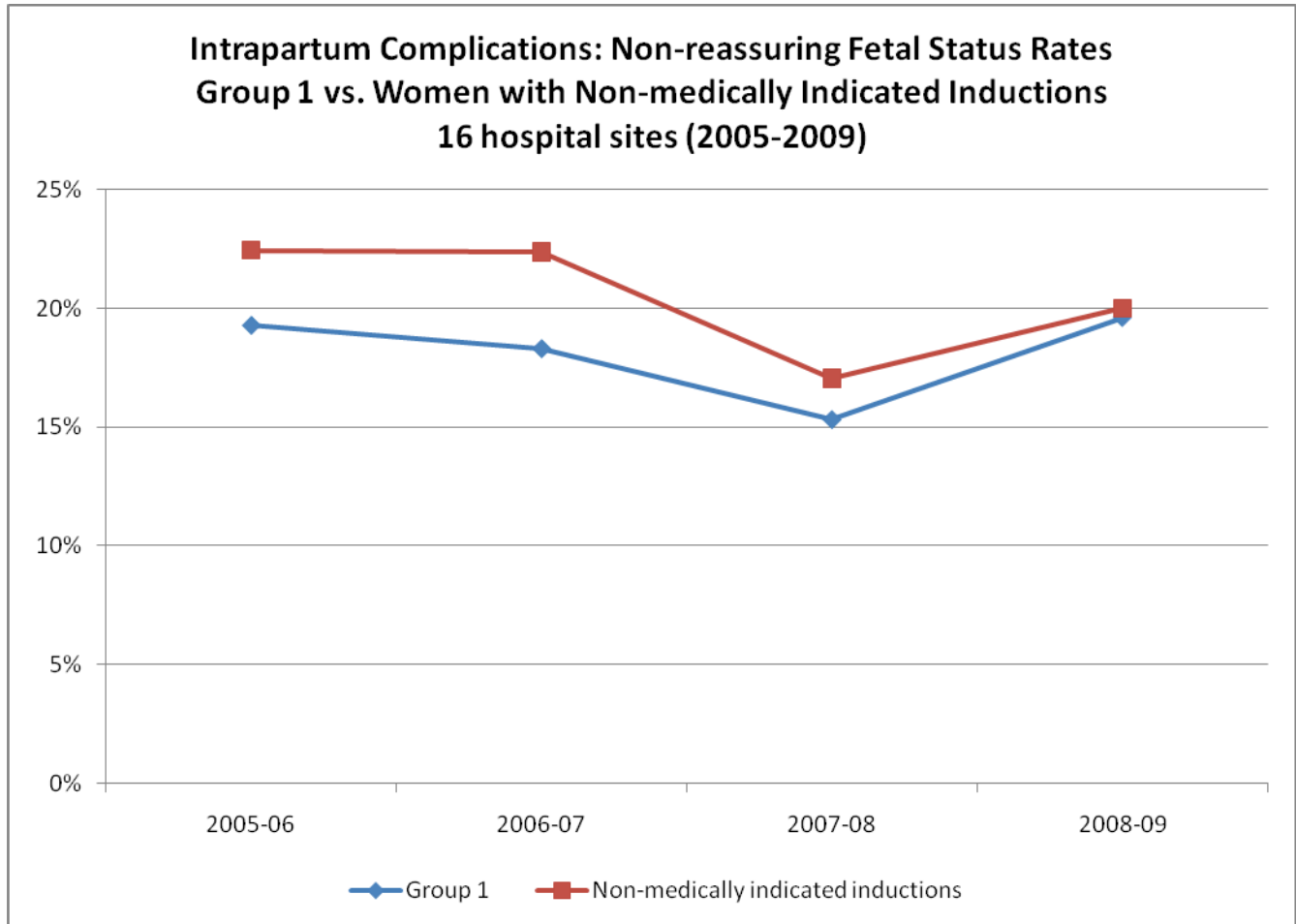
When trying to account for the difference in cesarean section rates between women in Group 1 and women with non-medically indicated inductions, intrapartum complications need to be considered. For example, do women with non-medically indicated inductions have higher rates of dystocia and/or non-reassuring fetal status than women in Group 1? Figures 12 and 13 provide some insight into this question.

Figure 12 – Comparing Dystocia Rates in Women with *Non-medically Indicated Inductions* and Women in Group 1



- On average, 10% of women in Group 1 were diagnosed with dystocia as compared to 16% of women who had *non-medically indicated* inductions
- Rates of dystocia are lower in women in Group 1 than in women with *non-medically indicated* inductions even though they are considered similar groups of women
- In both groups, rates of dystocia have increased between 2005-06 and 2008-09.

Figure 13- Comparing Rates of Non-reassuring Fetal Status in Women with Non-medically Indicated Inductions and Women in Group 1

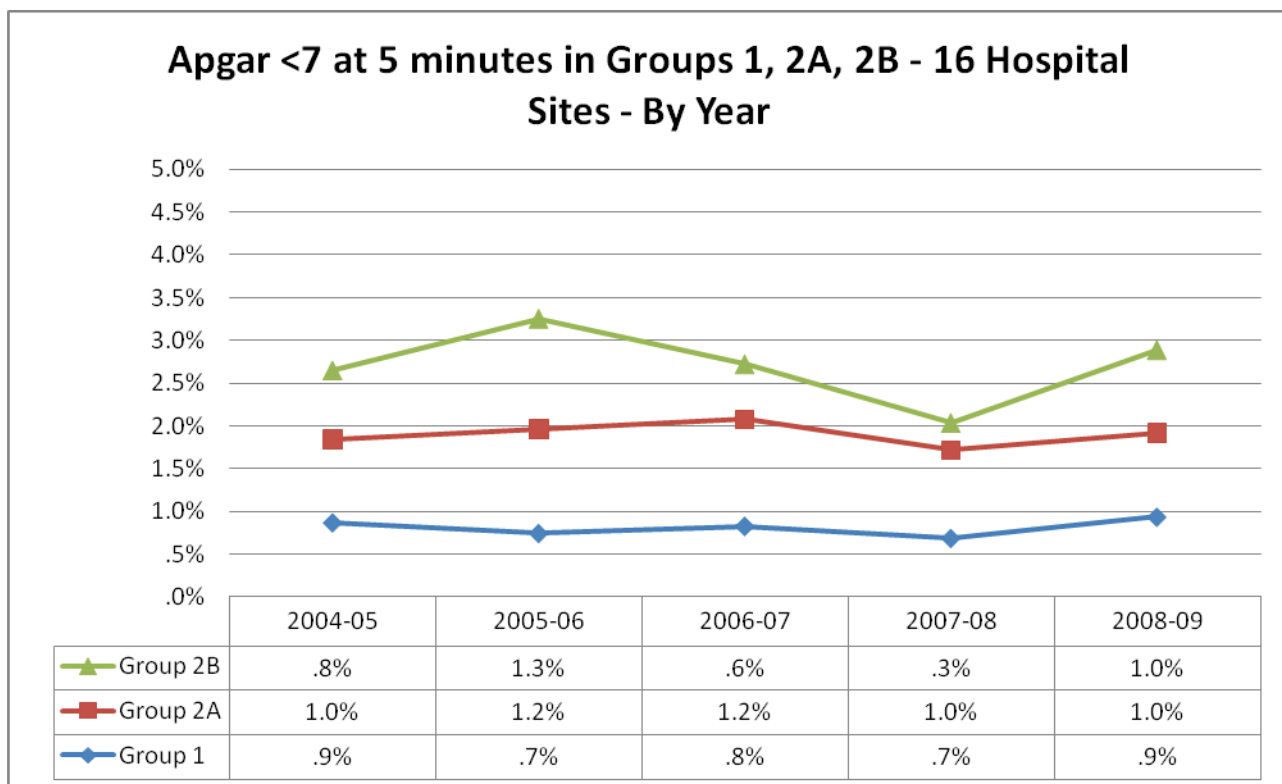


- On average, 18% of women in Group 1 were diagnosed with non-reassuring fetal status compared with 20% of women with *non-medically indicated* inductions
- Rates of non-reassuring fetal status are higher in women with *non-medically indicated* inductions than in women in Group 1 even though they are considered a similar groups of women

Neonatal Outcomes

Understanding how various birthing practices (i.e. induction, augmentation, cesarean sections) affect neonatal outcomes is important. Unfortunately, analysis pertaining to neonatal outcomes was limited due to insufficient data capture and sub-optimal data quality for most fields pertaining to outcomes. Knowing the admission rate to the neonatal intensive care unit (NICU) or special care nursery (SCN) would be very helpful, but the data for this field was not of sufficient quality to be analyzed. The quality of the Apgar score data, however, was good; thus the working group decided to use an Apgar score of <7 at five minutes as a proxy for admission to NICU/SCN. Figure 14 shows the results of this query.

Figure 14 – Apgar Score <7 at 5 Minutes By Group By Year



- Overall, the number of babies with Apgar <7 at 5 minutes is small (i.e. the total number of babies born to women in Group 1 at the 16 hospital sites from 2004-2009 with an Apgar <7 at 5 minutes was 517; the number in Group 2A is 289 and the number in Group 2B is 25). Thus the results must be interpreted with caution.
- A larger percentage of babies born to women in Group 2A have Apgar scores <7 at 5 minutes compared to babies born to women in Group 1
- The percentage of babies with Apgar scores <7 at 5 minutes in Group 2B varies more from year to year than in Group 1 or Group 2A

Discussion

Cesarean Sections

The fact that the cesarean section rate is almost twice as high in Group 2A as it is in Group 1 is consistent with the literature and with findings of the B.C. Perinatal Health Program (i.e. increased risk of cesarean section in nulliparous women with induction of labor). Interestingly, the rate of cesarean sections is also twice as high in women in non-medically indicated inductions compared to women in Group 1. In the first comparison, Group 1 with Group 2A, one could speculate that the underlying medical condition that necessitates an induction may also affect the need for a cesarean section. In the second comparison (i.e. Group 1 with women with non-medically indicated inductions), however, the two groups of women should be quite similar except for the fact that one group is induced and one has spontaneous labor. The relationship is not confounded by underlying medical conditions and yet the cesarean rate for the induced group is much higher.

Also of interest are the induction and cesarean section rates at individual hospitals. For example, Credit Valley Hospital has one of the lowest induction rates (23.9%) among the 16 hospitals and also has low cesarean section rates in Group 1 (11.5%) and Group 2A (26.1%). The same can be said of the Scarborough Hospital – Birchmount site. This lends support to the notion that induction rates affect the cesarean section rate.

The question then remains, what is it about induced labour that increases a woman's risk for cesarean section? Does the 'cascade of interventions' theory hold true? What can be done at a network level or individual hospital level to explore this issue in further detail?

The wide variation in cesarean section rates (10%-23%) among the 16 participating hospitals for Group 1 is noteworthy. With a fairly homogenous group of women (nulliparous women \geq 37 weeks gestation with single cephalic pregnancies in spontaneous labour) one would expect the rates to be more similar. The variation in cesarean sections rates (24%-48%) among the participating hospitals for women in Group 2A (nulliparous women \geq 37 weeks gestation with single cephalic pregnancies who are induced) also raises some questions. What factors account for the differences in rates? Is this level of variation acceptable?

In addition to the variation in rates across hospitals, the timing of cesarean sections has also been called into question. 47% of the women in Group 2B who had a non-medically indicated cesarean section had the section at 38 weeks gestation. Questions arising include the following: What is the rationale for performing non-medically indicated cesarean sections at 38 weeks gestation? What are the implications for women and their babies? Does the timing of elective cesarean sections affect neonatal outcomes? Unfortunately, the quality of neonatal outcome data is not of sufficient quality to be analyzed at present, but this would be an interesting area to explore further once data capture and quality for neonatal outcome fields have improved.



When indications for cesarean sections were explored, dystocia and non-reassuring fetal status were by far the most common indicators in Group 1 and Group 2A. In Group 2B, the indications varied more and “maternal request” and “other maternal health problems” were the most commonly selected indications. The relatively large percentage (27%) of women whose indication for cesarean section was “other maternal health problems” in Group 2B is problematic because of the lack of specificity. What is being included in this category?

Women in Group 1 who are augmented with oxytocin have higher cesarean section rates (20.4%) than those who undergo ARM (10.5%) or no augmentation (11.8%). This finding warrants further exploration and/or discussion. In an effort to better understand this issue, the Birthing Review Work Group is recommending the CHN survey GTA hospitals regarding oxytocin management. Interestingly, the Hospital Corporation of America attributes a statistically significant decrease in the primary cesarean section rate to the system wide adoption of a check-list based approach to oxytocin administration [45].

Inductions

Induction rates among nulliparous women ≥ 37 weeks gestation with single cephalic pregnancies increased by about 6% between 2004-05 and 2005-06 and have since remained fairly stable at 29-30%. In an attempt to explain the 6% increase in induction rates, maternal health characteristics (i.e. age, health problems (i.e. diabetes, chronic hypertension) and obstetrical complications (i.e. gestational diabetes, LGA, pre-eclampsia) were explored. A concomitant jump in one of these factors might help explain the increased induction rate, but we did not find a parallel trend in any of these factors. Thus we are left to conclude that other unanalyzed factors have contributed to the rise in induction rates.

Considerable variation in induction rates (21%-36%) also exists across the 16 hospitals. Differences in induction policies and protocols at each hospital may explain the difference in rates. Understanding more about such policies and protocols would be beneficial. For example: Are all hospitals using similar induction criteria? Are the indications compelling, consented, and documented? (as recommended by MORE OB) How does prioritization occur? How many hospitals use the Bishop Score and what effect does this have?

In this review, the most common indications for induction for nulliparous women ≥ 37 weeks gestation with single cephalic pregnancies was for post date pregnancies (50%), followed by PROM (13%), diabetes (8%) and ‘other maternal’. Of particular note, however, is the fact that 22% of the women whose indication for induction was post date pregnancy were actually less than 41 weeks gestation. Similar findings were reported in the BC Cesarean Birth Task Force Report: the most common primary indication for induction in 2005 was post-date pregnancies and 32.5% of post-date inductions were undertaken before 41 completed weeks gestation. The practice of labeling women as post dates when they do not meet the criteria for post dates makes it difficult to get an accurate picture of the criteria being used. Do these inductions actually fall into the category of ‘elective’? If so, the number of women induced for post-dates is overinflated and the number of women with elective inductions is underestimated.



Also of note, is the 8% of women whose indication for induction was ‘other maternal’. Although this menu option needs to be in place to account for a small number of indications that are not represented among the other choices, it appears to be over utilized. As a vague ‘catch-all’ it is not very helpful. Users should be encouraged to be specific in their entry for this field.

With respect to women with non-medically indicated inductions, the gestational age at which the induction takes place is of interest. In this review, over 83% of nulliparous women ≥ 37 weeks gestation with single cephalic pregnancies who had non-medically indicated inductions were induced at 40 weeks gestation (rather than 41 weeks). The next question that arises is whether the timing of non-medically indicated inductions has any effect on neonatal outcomes. Again, the issue of sub-optimal data capture and quality relating to neonatal outcomes precludes analysis of this sort at present, but highlights how valuable this data will be.

Neonatal Outcomes

Unfortunately, neonatal outcomes analysis was limited due to insufficient data capture and sub-optimal data quality for relevant fields. Improved data capture and quality would afford opportunities to explore intervention rates and Apgar scores, cord blood gases, resuscitation, infant feeding etc.

Because information pertaining to discharge and transfers was not well captured (i.e. we could not look at the number of babies admitted to NICU or special care nursery), a decision was made by the Birthing Review Working Group to use an Apgar score of <7 at 5 minutes as a proxy for admission to the NICU. Although the numbers were small, it was interesting to note that a larger percentage of babies born to women in Group 2A had Apgar scores of <7 at 5 minutes.

Birthing Review Work Group Recommendations

1. Improve data entry for specific fields:
 - Cord gases, Infant Discharge/Transfer data
 - Indication for Induction – need more accurate coding re: elective inductions
 - Indications for C/S - the number of responses coded as ‘other-maternal’ needs to be decreased
2. Initiate collection of BMI data
3. Initiate collection of Bishop score
4. Encourage adherence to SOGC clinical practice guidelines for fetal health surveillance.
5. Survey member hospitals to gather more information re: induction policies and practices and oxytocin management.



APPENDIX A

Background: About the CHN

The Child Health Network for the Greater Toronto Area (CHN) operates in Canada’s largest and most diverse metropolitan area. In 2008/09, more than 73,000 babies were born in the region, representing approximately half of the province’s total births [56]. The number of annual births in the GTA represents about one and a half times more than the annual total number of births occurring in the provinces of British Columbia or Alberta [56]. The significance of birth volumes occurring within the GTA is reflected in the fact that approximately 20% of all births in Canada occur in the region.

Established in 1999, the CHN is a partnership of hospital and community providers committed to establishing a more coordinated system of health care delivery for mothers, newborns, children and youth. The CHN facilitates and supports development of a regional maternal/newborn and children’s health services system. Members of the Network collaborate to share knowledge and coordinate services throughout the region with a focus on strengthening access to quality care and enhancing continuity and consistency of care across the region. The vision, mission and core values guiding the work of the Network are outlined below:

VISION	MISSION	CORE VALUES
<i>A sustainable and responsive maternal, newborn and child healthcare system achieved through better integration and interaction between hospitals, community care access centres, and other partners.</i>	<i>To provide leadership in strengthening the regional maternal, newborn and child healthcare system by facilitating partnerships across the care continuum and supporting changes in care delivery through quality improvement and knowledge transfer.</i>	<p><i>Family-Centered Care: Enhancement of quality, family-centered care across the Network that is predicated on advancing consistent use of leading practices and standards identified in the CHN’s Family-Centered Care document.</i></p> <p><i>Collaboration: Strengthening partnerships, interaction, and linkages across the Network and with other service providers to facilitate timely and appropriate access to maternal and child health services, resulting in a collaborative system of care.</i></p> <p><i>Evidence-Based Practice & Advice: Building on ongoing efforts to enhance quality improvement initiatives and knowledge transfer are critical elements in all of the CHN’s work.</i></p>

· In this report, the term “region” refers to the region that is covered by the CHN membership. This term is distinguished from the term “LHIN region” which refers to one of the five Local Health Integration Networks that include members of the CHN within their geographic boundaries.



The strategic goals guiding the work of the Network in advancing the vision and mission include:

- Align and influence Ontario’s health transformation agenda.
- Influence implementation of an integrated system.
- Enhance opportunities for collaboration and participation.
- Improve knowledge transfer and evidence based practice across the Network.
- Strengthen measurement and evaluation of system performance.

Collectively, Network members have the critical mass required to bring about significant change that would be difficult for any single organization to achieve. It does this by pooling member resources, expertise, and ideas to generate “new” solutions to current challenges, and lobbying government to make the changes necessary to improve service delivery, patient outcomes, research and education.

APPENDIX B

Best Practices in Birthing - Terms of Reference

Purpose

The purpose of the Birthing Review Working Group is to work collaboratively to provide advice and content expertise in the review of Niday Perinatal data related to populations, practices and outcomes and to support the project as described in the Charter.

Membership

The Committee is comprised of:

Chairperson – The group will be co-chaired by two individuals from CHN member hospitals

Members - An inter-professional group will be convened:

- Representing regions within the GTA
- Representing various levels of care from within the CHN GTA hospitals.
- Representing clinical, administrative and/or educational perspectives

The Working Group may increase its membership as the project evolves and new stakeholders or key players are identified.

Accountabilities

The Working Group is accountable to the Project Sponsor and will report to and make recommendations to the Maternal Newborn Services Task Force of the Child Health Network. Working Group members should expect to actively participate in discussions, analyses and in the development of recommendations.

Objectives and Work plan

The objectives of the Working Group will be to support the development of a strategy to monitor, evaluate and better understand the drivers for inductions and cesarean sections. The Working Group will:

- Review data from the Niday Perinatal Database
- Identify drivers and examine outcomes
- Make recommendations for strategies related to Quality Improvement
- Develop set of standard queries using the Niday Perinatal Database to evaluate underlying drivers, practices and outcomes

Meetings

The Working Group will meet 4-6 times in 2009 or as required, to ensure sustained progress, focus and to ensure milestones and deliverables are achieved. The first meeting will be face-to-face with subsequent meetings by teleconference. An Agenda and Record of Decisions from each meeting will be developed and provided to Working Group members and to the Project Sponsor.

APPENDIX C

Participating Hospitals

1. Credit Valley Hospital
2. Halton Healthcare Services (Georgetown site)
3. Halton Healthcare Services (Milton site)
4. Lakeridge Health Corporation (Oshawa site)
5. Lakeridge Health Corporation (Port Perry site)
6. Mount Sinai Hospital
7. North York General Hospital
8. Rouge Valley Health System (Ajax/Pickering site)
9. Rouge Valley Health System (Centenary site)
10. St. Joseph's Health Centre
11. Sunnybrook Health Sciences Centre
12. The Scarborough Hospital (Birchmount site)
13. Toronto East General Hospital
14. Trillium Health Centre
15. William Osler Health Centre (Brampton site)
16. William Osler Health Centre (Etobicoke site)

APPENDIX D

Level of Care Designations for Maternal and Newborn Services in the CHN Model		
LEVEL OF CARE	DESCRIPTION	SCOPE OF SERVICES
Level I	These centres meet the needs of women with healthy pregnancies. This level of care is provided by all hospitals with obstetric services.	<p><i>MATERNAL</i></p> <ul style="list-style-type: none"> ▪ Care for healthy mothers and newborns of a gestational age of 36 weeks or older and/or neonates >2.5 kg. ▪ Care for mothers with transient conditions that are expected to resolve. <p><i>NEWBORN</i></p> <ul style="list-style-type: none"> ▪ Care for the healthy newborn of 36 weeks gestation or older, and/or ≥2.5 kg. ▪ Observation and management of transient conditions (e.g., hypothermia, hypoglycaemia responding to enteral feeds, respiratory distress with reducing or no oxygen requirement, hyperbilirubinemia). ▪ Ability to provide care of infants with conditions that are expected to resolve within a short period of time regardless of place of birth. ▪ Stabilization, initiation and maintenance of assisted ventilation pending transfer.
Level II	These centres manage the care of mothers and newborns at low to moderate risk.	<p><i>MATERNAL</i></p> <ul style="list-style-type: none"> ▪ Ability to provide all services, treatments and resources offered within a Level I maternal and newborn centre. ▪ Ability to manage medical/obstetrical conditions arising from pregnancies >32 weeks gestation, 7 days/week, 24 hours/day. ▪ Availability of maternal intensive care 24 hours/day including provision of ventilation. <p><i>NEWBORN</i></p> <ul style="list-style-type: none"> ▪ Ability to provide all services, treatments and resources offered within a Level I maternal and newborn centre Initial and ongoing care of stable newborns ≥32 weeks gestational age. ▪ Collaboration with Level II and Level II+ maternal and newborn centres concerning long-term follow-up of infants at risk for neurodevelopmental delay.



Level of Care Designations for Maternal and Newborn Services in the CHN Model

LEVEL OF CARE	DESCRIPTION	SCOPE OF SERVICES
<p>Level II+</p>	<p>These centres manage moderate risk obstetrical and medical problems, and carry out fetal diagnostic testing. They all manage moderately ill newborns with medical problems that are expected to resolve rapidly, including short-term assisted ventilation (48 hours) and parenteral nutrition. These centres have functional capabilities provided by Level I and Level II centres.</p>	<p><i>MATERNAL</i></p> <ul style="list-style-type: none"> ▪ Ability to provide care for pregnancies consistent with Level II maternal and newborn centres operating at a maximum level, in addition to pregnancies of >32 weeks gestation, 7 days/week, 24 hours/day. ▪ Recommendation for future system wide implementation would enable Level II+ facilities to care for pregnancies at 30 & 31 weeks gestation. <p><i>NEWBORN</i></p> <ul style="list-style-type: none"> ▪ Ability to provide all services, treatments and resources offered within a Level I or Level II maternal and newborn centre. ▪ Resuscitation and stabilization of all neonates born in hospital, or transferred in from home births, as outlined in the <i>National Guidelines for Neonatal Resuscitation (2000)</i>. ▪ Appropriate consultation with medical staff when unanticipated or anticipated obstetrical or neonatal problems occur. ▪ Coordination and management of neonatal follow-up for at-risk infants (as described in CHN document - <i>Proposal for a CHN-GTA Regionalized Neonatal Follow-Up Program</i>) ▪ Neonatal specialists available to provide care and/or consultation for the following: <ul style="list-style-type: none"> ▪ Level II neonatologists to consult with tertiary centres on the management of ventilated infants. ▪ Level III neonatologists to provide ongoing communication to paediatricians regarding all infants receiving assisted ventilation and unable to be transferred to a tertiary NICU due to capacity constraints. ▪ Collaboration with Level II and Level III maternal and newborn centres for the provision of long-term follow-up of infants at risk for neurodevelopmental delay. ▪ Initial and ongoing care for stable infants ≥ 32 weeks gestational age. ▪ Care for moderately ill newborns who have problems that are expected to resolve rapidly, including those transferred from a Level I or Level II maternal and newborn centre. ▪ Initiation and maintenance of short-term (up to 48 hours) ventilation with mandatory consultation with a neonatologist.



Level of Care Designations for Maternal and Newborn Services in the CHN Model

LEVEL OF CARE	DESCRIPTION	SCOPE OF SERVICES
<p>Level III</p>	<p>These centres provide subspecialty care for high-risk pregnancies, care for unwell, unstable newborns, care for mothers with severe medical complications</p> <p>care for infants with anticipated complicated antenatal genetic or fetal anomalies that require immediate medical or surgical interventions.</p> <p>These centres have functional capabilities provided by Level I, Level II and Level II+ centres.</p>	<p><i>MATERNAL</i></p> <ul style="list-style-type: none"> ▪ Ability to provide all services, treatments and resources offered within Level I, Level II and advanced Level II maternal and newborn centres. ▪ Ability to manage all high-risk pregnancies including those complicated by a diagnosis of congenital malformations or other disorders that may require special diagnostic or therapeutic procedures, paediatric subspecialty consultation, or surgical or medical care or consultation not available in the referring facility. ▪ Ability to perform the full range of non-invasive and invasive procedures/treatments required for maternal tertiary intrapartum antenatal care and birth, including intensive care. <p><i>NEWBORN</i></p> <ul style="list-style-type: none"> ▪ Ability to perform all treatments available in Level I, Level II and advanced Level II maternal and newborn centre, in addition to the following: ▪ Resuscitation, stabilization and ongoing care of all neonates born in tertiary facilities. ▪ Care for neonates who are beyond the scope of the practice, resources and/or expertise of the referring hospital personnel. ▪ Neonatal surgery according to the guidelines of the CHN Surgical Services Task Force.^{11, 12} ▪ Coordination of services for genetic counselling, bereavement and palliative care. ▪ Intensive care monitoring. ▪ Ventilation including high frequency oscillation, high frequency jet ventilation and nitric oxide. ▪ Management of infants with complex organ failure. ▪ Care of infants with major congenital anomalies. ▪ Intensive, rapid or specialized investigations. ▪ Coordination of long-term follow-up for infants at highest risk for neurodevelopmental delay and those enrolled in research studies. ▪ Multiples >twins + <34 weeks gestation.

¹¹ Child Health Network for the Greater Toronto Area. (October 1998). *Surgical services task force report*. Toronto.

¹² All complex neonatal surgery will be performed at The Hospital for Sick Children.

APPENDIX E

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