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Intrapartum Water Immersion: The Relationship Between Timing of Immersion and the Incidence of Dystocia

By

Merry Little

A thesis submitted in conformity with the requirements for the degree of Master of Science
Graduate Department of Nursing Science
University of Toronto

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ABSTRACT

Intrapartum Water Immersion: The Relationship Between Timing of Immersion and the Incidence of Dystocia

Master of Science (1998)
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In a retrospective chart review, the relationship between timing of intrapartum water immersion and dystocia was explored. Two retrospective cohorts of nulliparous women were formed; the cervical dilatation of one group was less than five centimeters on immersion, while the second was five centimeters or greater when the tub was used.

Immersion of women with less than five centimeters of cervical dilatation was associated with increased use of analgesic medication, higher rates of intrapartum transfer to the labour and delivery unit, and increased need for oxytocin augmentation of labour. However, there was no difference between the groups in the diagnosis of dystocia nor in the rate of cesarean section. The study provided base-line data that could be used to determine the sample size for a randomised, controlled trial on early versus late water immersion in labour.
ACKNOWLEDGEMENTS

There are several people to whom I am grateful for making this study possible.

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CHAPTER I

Background

Over the centuries, water immersion has been used in religious rituals, for medical therapy, for hygienic purposes and for pure pleasure. Water was, and continues to be, a central symbol in many religions. In ancient times, supernatural healing powers were attributed to the waters of the Nile, the Euphrates, and the Ganges (Adler, 1993). In Greek and Roman times, water baths expanded from the realm of healing and religion to become a central feature of their cultural and social system (Adler, 1993). The bath houses of Rome were palatial and many had libraries, lounges, and gymnasia (Vihervuori, 1972). After the fall of the Roman empire, bathing had periods of both popularity and notoriety. During the Middle Ages, there was a period when other healing arts, such as blood letting and leeching also took place in the baths, leading to extremely unsanitary conditions. That, coupled with the laxity of morals that accompanied the use of common bathing facilities by both men and women, led to the spread of diseases such as syphilis, plague, and leprosy (Adler, 1993). Thus, throughout history, bathing has been associated alternately with healing and piety, and disease and debauchery.

During the 1980's, interest in the work of Tjarkovsky (Sidenbladh, 1982), Leboyer (1993), and Odent (1983) has increasingly brought water into the domain of childbirth. Hospitals are installing tubs and whirlpool baths to provide comfort in
labour and as a place to give birth. Both the House of Commons Health Committee in the United Kingdom (McCandlish, & Renfrew, 1993) and the Society of Obstetricians and Gynecologists of Canada (Chaddick et al., 1995) have recommended that all units providing obstetrical care make hydrotherapy available to labouring women. A recent survey of obstetrical units in England and Wales reported that "labor or birth in water, or both, had occurred in all provider units" (Alderdice et al., 1995). Water immersion is available in at least eight birthing units in and around Toronto.

The literature based on observation reports that water immersion during labour shortens labour and decreases labour pain. However, in a systematic review of the randomised, controlled trials comparing immersion with no immersion during labour, Nikodem (1998) found "no clear benefits or adverse effects" (p. 5). It is important to note that only three trials (Cammu, Clasen, Van Wettere and Derde, 1994; Rush, Burlock, Lambert, Loosley-Millman, Hutchison, & Enkin, 1996; Schorn, McAllister, & Blanco, 1993) were included in the meta-analysis and that, because of small sample sizes in two of the studies (Cammu et al., 1994; Schorn et al., 1993), only one study (Rush et al., 1996) contributed significantly to the outcomes.

A contentious issue is that of timing of immersion. Many authors (Aderhold & Perry, 1991; Balaskas & Gordon, 1990; Burns & Greenish, 1993; Church, 1989;
Gradert, Hertel, Lenstrup, Bach, Christensen & Roseno, 1987; Lenstrup, Schantz, Berget, Feder, Roseno & Hertel, 1987; Schorn et al., 1993) recommend withholding the use of water immersion until the woman has achieved five centimetres of cervical dilatation, stating their belief that earlier immersion would slow labour. However, this hypothesis has not been adequately addressed in the literature.

The pain and stress of labour is associated with the release of epinephrine, a catecholamine that decreases uterine contractility (Lederman, Lederman, Work & McCann, 1978). Catecholamine release may be mitigated by the relaxation and possible pain relief provided by the use of a warm water bath (Simkin, 1989). If this is the case, relaxation in a warm bath in early labour, prior to five centimeters, might actually speed the process of labour by allowing it to proceed unimpeded by an epinephrine induced decrease in uterine contractility.

Conversely, if immersion at less than five centimetres of dilatation slows labour, the woman may be diagnosed with "failure to progress," or uterine dystocia. This diagnosis: (a) often leads to a cascade of interventions including, amniotomy, intravenous administration of oxytocin, fetal monitoring, and epidural anaesthetic; (b) makes the most significant contribution to the risk of cesarean section (Cammu & Van Eeckhout, 1996; Fraser et al., 1995; Lopez-Zeno, Peaceman, Adashek, & Socol, 1992) and; (c) in the setting of alternative birth centres, frequently means transfer of the woman out of her chosen place of birth, a move that may be both
disruptive and disappointing.

As the use of water immersion increases, it is necessary to evaluate all the risks and benefits associated with this form of therapy, including the possible consequences of the timing of immersion. A retrospective chart review of available data would contribute to the foundational work for a randomised, controlled trial (RCT) that would address the issue of early versus late immersion.

Problem Statement and Purpose of the Proposed Research

There is inadequate scientific evidence to support the recommendation that water immersion be withheld until a labouring woman has achieved five centimeters of cervical dilatation. The purpose of this study was to examine the use of water immersion during early and active labour by a sample of nulliparous women labouring in in-hospital birth centres, to determine if early immersion was associated with a higher incidence of dystocia and other outcomes, including the use of analgesic medications, oxytocin augmentation, and cesarean section. The study provided baseline data that could be used to determine the sample size for a randomised, controlled trial on early versus late immersion.
CHAPTER 2

Literature Review

The literature was reviewed in the following areas: (a) descriptions of the use of water immersion, (b) beliefs about the use of water immersion, (c) the effects of water immersion on pain, length of labour, use of oxytocin, and cesarean section, (d) the criteria for use of water immersion, particularly cervical dilatation, (e) the timing of immersion and, (f) the relationship of pain and anxiety to progress in labour.

Water Immersion

A review of the literature on the use of water immersion in labour revealed anecdotal reports, opinion papers, descriptive and randomized controlled trials, and a review of the research. The anecdotal and opinion reports will be discussed first, followed by a discussion of the experimental studies.

Descriptive Literature.

The anecdotal and opinion articles either: (a) described the use of water immersion in a particular unit (Aderhold & Perry, 1991; Church, 1989; Milner, 1988, Odent, 1983), at a particular birth (Blair-Myers, 1989; Coghill, 1992; Clarke, 1989), or in a particular practice (Jackson, Corsaro, Niles, Stange & Haber, 1989); or (b) presented opinions as the efficacy of water immersion (Daniels, 1989; Jepson, 1989; Newton, 1992). Two books (Balaskas & Gordon, 1990; Lichy & Herzberg, 1993), have been written as guides to labour and birth in water. The anecdotal
literature is overwhelmingly positive about the efficacy of water immersion to provide relaxation, relieve pain, and shorten labour. Several authors (Balaskas & Gordon, 1990; Church, 1989; Milner, 1988; Odent, 1983) recommend withholding water use until four to five centimeters of cervical dilatation is achieved. However, the opinions about the efficiency of water immersion and the recommendation for timing of use voiced by these authors are based upon the authors general observations rather than scientific investigation. In addition, to provide support for these beliefs about the efficiency of water immersion, these authors cite work that is also anecdotal (Odent, 1983) or solely theoretical (Leboyer, 1976, Sidenbladh, 1982), thus not based upon evidence.

While the authors of the above articles present the benefits of water immersion, others recommend caution before water immersion is adopted for wide scale use (McCandlish & Renfrew, 1993; Newton, 1992; Zimmerman, Huch & Huch 1993). These authors raise questions about the safety of water immersion both for labour and birth and advise that further research is needed to fully elucidate the risks and benefits. However, only Zimmerman et al. (1993) addressed the issue of timing of immersion suggesting that immersion after five centimeters might deprive the woman of the apparent benefits of water immersion.

In summary, anecdotal reports and opinions of the use of water immersion for labour and birth vary from enthusiastic endorsement to recommendations for
caution. Authors of the early articles recommending this form of therapy cited work
that is mainly theoretical. Consequently, these articles provided little empirical
support for the use of water as a means of providing relaxation, pain relief and
speeding the labour process or for withholding bath use until the achievement of five
centimeters of dilatation.

Empirical Research

The effect of water immersion on pain. Three RCT's (Cammu et al., 1994; Rush
et al., 1996; Schorn et al., 1993) and one prospective, non-randomized study
(Lenstrup et al., 1987) examined pain relief in relation to the use of water
immersion. Cammu et al. (1994) used a visual analogue scale (VAS) to assess pain
intensity prior to, during and immediately after bathing in a group of 54 nulliparous
women randomized to the bath and in a control group of 56 nulliparous women who
did not bathe. They found that during the first twenty five minutes of tub use, the
pain scores of the experimental group decreased while the scores of the control
group increased. This difference in pain scores between the two groups, from Time 1
to Time 2, was statistically significant. Similarly, while there was an increase in pain
scores from Time 1 to Time 3 in both groups, the increase was statistically greater in
the control group. However, pain scores at Time 3, approximately one hour after
randomization, were not statistically different.

Lenstrup et al. (1987), in a non-randomized, cohort, study, also used a VAS to
measure pain in a group of 88 women who chose to use a warm tub bath and a control group of 72 women who declined the use of the tub. In this study, initial pain scores were significantly higher in the group that chose to use the tub. After 30 minutes of bathing, pain scores of the experimental group decreased, while those of the control group increased. Scores at this time period were not statistically different between the groups. Pain intensity rose in both groups and pain scores at approximately two hours after initiation of the study were not statistically different. Thus, like the study of Cammu et al. (1994), Lenstrup et al. (1987) found the bath group experienced a period of decreased pain while in the tub. In both of these studies, there was no difference in the use of analgesic and anaesthetic agents.

Two randomized controlled trials (Rush et al., 1996; Schorn et al., 1993) used the administration of pharmacological pain relief agents as their measure of the possible effect of water immersion on labour pain. Rush et al. (1996) randomly allocated 393 women to an experimental group that used the tub and 392 to a control group that did not use the tub. While opioid use in all women was very low (n = 5), all of the opioid users were in the control group. Epidural use was not different between the groups analyzed as a whole. However, with the removal of 41 women (15 tub, 26 controls) ineligible for the study but inadvertently included, the use of epidural anaesthetic was significantly lower in the tub group. The use of other types of analgesics such as transcutaneous electronic nerve stimulation (TENS), nitrous
oxide, general and spinal anaesthetic was not significantly different.

Shorn et al. (1993) found no difference in the use of analgesics between 45 women randomly allocated to the use of water immersion versus 48 who received standard care. The authors did not report on the type of analgesic used.

Three of the above studies (Cammu et al. 1994; Lenstrup et al., 1987; Rush et al., 1996) asked the women to comment on their use of immersion during labour. Two (Cammu et al., 1994; Rush et al., 1996) reported that women commented on the relaxation and pain relief they experienced in the tub, while the third (Lenstrup et al., 1987) stated that 91% of women who used the tub would do so again during a future labour.

In summary, there appears to be a temporary decrease in pain with the use of water immersion but the effect of immersion on the use of pain relieving medication is inconsistent. Retrospectively, women commented that the bath provided both relaxation and pain relief.

The effect of water immersion on progress in labour. The above trials also examined the effect of tub use on progress in labour. Cammu et al. (1994) found a significant change in Bishop Score (a score that examines several characteristics of the cervix) in the bath group but no significant difference in dilatation measured in centimeters per hour. Lenstrup et al. (1987), on the other hand, found that the bath group dilated at a rate significantly greater while in the bath. However, in both
studies, the overall length of labour was not significantly different. Similarly, Rush et al. (1996) and Schorn et al. (1993), although they did not compare rates of cervical dilatation between the groups, found no significant difference in length of labour between their bath and standard care groups.

Oxytocin to augment labour was used less often in the bath group in all of the above studies, but the difference did not reach statistical significance in any of the trials. The difference in oxytocin use between the groups ranged from 0.55% (Rush et al., 1996) to 16% (Cammu et al., 1994).

Cesarean sections were performed more often in the bath group in all four of the studies, but, like oxytocin, the rate did not reach statistical significance. The difference in cesarean section rates between the groups ranged from 0.1% (Cammu et al., 1994) to 4.4% (Schorn et al., 1993).

In summary, while one study (Cammu et al., 1994) found a difference in the state of the cervix with immersion and a second (Lenstrup et al., 1987) reported a difference in the rate of cervical dilatation while the women used the tub, no study demonstrated a decrease in the overall length of labour with tub use during labour, lower rates of oxytocin augmentation or decreased cesarean section deliveries with the use of water immersion. The characteristics of the included studies are presented in Table 1.
Table 1

Characteristics of the Included Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Method</th>
<th>Intervention</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cammu et al. 1994</td>
<td>Low risk nulliparous, ≥ 37 weeks, spontaneous labour, 3 to 5 cm dilatation, Ruptured membranes, Clear liquor, Singleton fetus, Cephalic presentation</td>
<td>Randomized by opaque, sealed envelope. On inclusion, Bishop score and visual analogue (VAS) pain score obtained (T₁). Pain was evaluated at 25 (T₂) and 50 to 60 (T₃) minutes after randomization Bishop score evaluated 50 - 60 minutes after randomization</td>
<td>Immersion offered to women randomized to experimental group (57, 3 refused and were not included in analysis, n = 54) Control group received conventional care (n = 56)</td>
<td>Bath group experienced decrease in pain while in tub, T₁ - T₂ (p &lt; 0.001) Bath group had greater increase in Bishop score over period of immersion (p = 0.003) No statistical difference in epidural use, oxytocin use, duration of labour, or cesarean section rate</td>
</tr>
<tr>
<td>Lenstrup et al. 1987</td>
<td>Uncomplicated pregnancy, 38 to 42 weeks, Cephalic presentation, Estimated fetal Weight 2500 to 4000g, Normal cardiotocograph for 30 minutes prior to study, Cervical dilatation 5 cm, No signs of skin infection</td>
<td>Prospective, non-randomized trial VAS pain score obtained on inclusion, after 30 minutes, and after the bath in the experimental group; on inclusion, after 30 minutes, and after 2 hours in the control group Vaginal examination performed on inclusion, one and two hours later in both groups</td>
<td>Experimental group were women who chose to bathe (n = 88), Control group were those who declined (n = 72)</td>
<td>Bath group experienced decrease in pain while in tub (p &lt; 0.05) Greater cervical dilatation in the bath group during the period of immersion (p &lt; 0.05) No significant difference in oxytocin use, analgesic use, vacuum extractions, cesarean section rates, or duration of labour</td>
</tr>
</tbody>
</table>
### Table 1 (continued)

**Characteristics of the Included Studies**

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Method</th>
<th>Intervention</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rush et al. 1996</td>
<td>&gt; 37 weeks, Afebrile, In active labour (&gt;3 cm)</td>
<td>Randomized by opaque, sealed envelope. Multiparous and nulliparous women randomized separately.</td>
<td>Immersion offered to women randomized to experimental group (n = 393), control group received conventional care (n = 392)</td>
<td>Fewer epidural and/or opioid analgesics, vacuum and/or forceps deliveries in experimental group when 41 ineligible women removed from data analysis. No difference in use of oxytocin, diagnosis of dystocia, or cesarean sections. Women found the tub reduced pain and was relaxing</td>
</tr>
<tr>
<td>Schorn et al. 1993</td>
<td>36 to 41 weeks, Without major obstetrical or medical complications, 4 to 7 cms, Intact membranes, Normal fetal heart rate pattern</td>
<td>Randomized by computer generated code. Cervical dilatation, along with other vital signs and contraction frequency, was assessed at inclusion and one hour later.</td>
<td>The experimental group used water immersion (n = 45). The control group used all other methods of pain relief except water immersion. (n = 48)</td>
<td>There were no differences between the groups in rate of cervical dilatation over the study period, in use of analgesics, oxytocin requirements, duration of labour, or cesarean section rates</td>
</tr>
</tbody>
</table>

A preliminary understanding of the effects of water immersion on labour pain and progress are presented in Table 1. Several elements of bias limit the
interpretation of the results. The sample size in two of the studies (Cammu et al., 1994; Lenstrup et al., 1987) was small and of insufficient power to detect a difference in several of the outcomes. Selection bias was introduced in several of the studies as: (a) the groups were non-randomized in one study (Lenstrup et al, 1987); (b) the authors (Cammu et al., 1994) did not include three women who were included in the bath group but refused to use the bath; (c) the randomization process was compromised in one study (Schorn, et al., 1993) resulting in a significantly higher number of primiparous women in the bath group; and (d) 46% of women randomized to the bath group in one trial (Rush et al., 1996) did not actually use the bath.

Settings differed making comparison of results difficult. Schorn et al. (1993) conducted their study in a birth centre where there is usually an effort to minimize interventions. In contrast, the study by Cammu et al. (1994) took place in a hospital with a policy of active management of labour, a policy that tends to result in high rates of artificial rupture of membranes, and oxytocin use.

In all of the studies control and tub groups were compared in terms of length labour. However, the parameters to define length of labour were not discussed by any of the authors. Length of labour is particularly difficult to define because there is no clear delineation between latent and active labour. As many women experience periods of regular uterine contractions off and on prior to the onset of progressive
contractions, determination of the onset of labour is inexact.

Only two studies used a measure to assess pain. It has been demonstrated that VAS provide both reliable and valid pain measurements of pain intensity (McCormack, Horne & Sheather, 1988; Miller & Ferris, 1993). Nevertheless, they only measure pain intensity. Other pain scales, alone or in combination with the VAS, might have increased the validity of the pain scores.

None of the above trials related the degree of cervical dilatation on immersion to possible outcomes. However, a degree of cervical dilatation at the time of immersion was included in the criteria for entrance to the water in all of the trials. In two of the trials (Lenstrup et al., 1987; Schorn et al., 1993), the participants were five centimeters or greater at immersion while in one (Cammu et al., 1994) they were less than five centimeters. There was no report of immersion dilatation in one trial (Rush et al., 1996). The descriptive studies of Odent (1983), Church (1989), and Burns and Greenish (1993) were not included in the above discussion because either they do not give measures of the use of pain relief medication or length of labour (Church, 1989; Odent, 1983) or because they have not statistically analysed the results of their data (Burns & Greenish, 1993). However, the authors of two of those studies (Church, 1989; Odent, 1983) recommend entering the water after five centimeters of dilatation. Other literature (Aderhold & Perry, 1991; Gradert, Hertel, Lenstrup, Bach, Christensen & Rosenø, 1987; Jackson, Corsaro, Niles, Stange &
Haber, 1989) also alludes to five centimeters as a criterion for immersion. It is important to note that Cammu et al. (1994) reported a trend towards decreased use of oxytocin in the bath group. This is important for two reasons. First, the group was composed of nulliparous women, a group that generally progresses more slowly in labour and has a higher incidence of dystocia. Second, the bath group used immersion at less than five centimeters of dilatation. This does not support the view that women should be discouraged from using the tub before they have reached five centimeters.

In summary, the views expressed in the literature on the use of water immersion during labour vary from fervent support to recommendations for caution. The trials on the use of water immersion have produced conflicting results in many areas. Elements of bias, along with different outcome measures have impeded the development of a clear sense of the effects of immersion during labour. The issue of recommended dilatation on immersion has not been addressed. Further, well controlled trials need to be conducted to expand the body of knowledge regarding the risks and benefits of water immersion use during labour.

The Relationship of Pain and Anxiety to the Progress of Labour

In the following section; (a) the interaction of pain and anxiety in general, (b) labour pain specifically, (c) the effects of pain and anxiety in relation to stress hormones and, (d) stress hormones in relation to pregnancy and labour will be
discussed. A review of the studies of pain and anxiety in relation to progress in labour will then be presented. In conclusion, the above issues will be related to the timing of water immersion use.

Melzack and Casey (1968) have conceptualized the experience of pain as having three dimensions: sensory discriminative, cognitive, and motivational-affective. Thus, pain cannot be described as an unpleasant sensation and emotion as a reaction to that sensation, but as sensation and emotion as integral, co-existing components of the pain experience. The cognitive aspects of pain; anxiety, past experience, cultural mores, the meaning of the situation, distraction, and feelings of control over the pain, can override activity in both the motivational and discriminatory systems (Melzack & Wall, 1996). Consequently, women come to labour with a complex, variable cognition that can influence both the intensity and quality of labour pain.

The pain of labour is variable from woman to woman and within the individual labour (Melzack, Kinch, Dobkin, Lebrun, & Taenzer, 1984). Labour pain generally increases as labour progresses (Brown, Campbell, & Kurtz 1989; Melzack, et al., 1984; Wuitckik, Bakal & Lipshitz, 1989), and can be quite severe (Bacigalupo, Riese, Rosendahl & Saling, 1990; Green, 1993; Melzack et al., 1984; Waldenström, Bergman, & Vasell, 1996). Melzack (1993) reported that 60% of primiparous and 46% of multiparous women rated the pain they experienced as severe or extremely
severe. This rating of labour pain is common across cultures with: (a) Swedish nulliparous women scoring their pain at 6.2 on a 7-point scale with 41% scoring seven, or "worst imaginable" (Waldenström et al., 1996); (b) 87% of Arab women scoring 4 or 5 on a 5-point scale with the verbal anchor at five representing "unbearable pain" (Harrison, 1991), and (c) 49% of nulliparous and 66% of multiparous British women rating the pain as "very" or "unbearably" painful (Green, 1993). For many women, childbirth is probably one of the most painful experiences they will encounter in their lifetime (Brownridge, 1995).

Anxiety is not only associated with the pain experience, but also may accompany the woman’s beliefs about childbirth. Pain and anxiety result in an outpouring of stress hormones from the autonomic nervous system. Stress hormones then can sensitize the woman to the barrage of nociceptive stimuli and also either sensitize or directly activate nociceptors, effectively increasing the pain (Bonica, & Chadwick, 1990). Thus, a circle of unrelieved pain and stress may be established.

Studies of stress hormones during pregnancy and labour reveal that; (a) plasma corticotropin-releasing hormone (CRH) rises during the course of pregnancy (Chan, Smith, Lewin, Brinsmead, Zhang, Cubis, Thornton & Hurt, 1993; Lowe, 1989; McLean, Thompson, Zhang, Brinsmead & Smith, 1994), (b) plasma cortisol rises progressively during pregnancy (Lowe, 1989; McCool, & Susman 1994) to peak in labour (Lowe, 1989; Lederman et al., 1978), (c) endorphin (Furuhashi et al., 1983;
De Punzio et al., 1994; McLean et al., 1994), epinephrine, and norepinephrine rise progressively during labour (Jones & Greiss, 1982; Lederman, et al., 1978; Ohno, Yamashita et al., 1986), and (d) epinephrine levels are positively related to labour pain (Grenman et al., 1986; Shnider et al., 1983).

Progress in labour involves the complex interaction of maternal and fetal factors that, as yet, are not completely understood. Ongoing uterine contractions are under the influence of myogenic, neurogenic, and hormonal systems (Challis & Lye, 1994; Garfield, 1987; Wray, 1993) that must act in concert to result in delivery of the fetus. Brownridge (1995) states that pain and anxiety in labour initiate a stress response. While a complete discussion of the possible effects of this response in labouring women is beyond the scope of this thesis, one consequence of stress is the release of epinephrine, a catecholamine associated with decreased uterine contractility (Lederman, Lederman, Work, & McCann, 1978). A relationship between epinephrine and prolonged labour has been demonstrated (Burns, 1992; Eskes, Stolte, Seelen, Moed, & Vogelsang 1965; Ohno et al., 1986). Thus, pain and anxiety related to labour result in an increase of circulating stress hormones, some of which may, in turn, interfere with the progress of labour. It is recognized that this is a simplistic view and that many other interacting factors may come to light as further research uncovers the physiological and psychological complexities of childbirth.
The Relationship of Pain to Progress in Labour

Researchers have attempted to explore the issue of pain to progress in labour. While pain results in the increased production of epinephrine, there is not a clear relationship between pain and progress in labour.

Melzack et al. (1984) explored this relationship using the McGill Pain Questionnaire (MPQ) to assess pain in 240 women during labour. The MPQ measures the sensory, affective, evaluative, and miscellaneous dimensions of pain and was administered from one to four or more times. They found no significant relationship between length of labour and either the total pain score or any of the MPQ sub-scale scores. The authors, however, did not discuss how length of labour was defined nor did they address the issue of medication use that may influence labour progress. Thus, there may be intervening variables in this study that could have had an effect on the duration of labour.

Melzack et al. (1984) measured pain during the active phase of labour. Wuitchik et al. (1989), however, assessed pain throughout labour, during the latent, active, and transitional phase of labour in 86, 98, and 75 nulliparous women respectively. A significant correlation was found between pain during the latent phase and duration of both the latent ($r = 0.58, p < 0.0001$) and active ($r = 0.50, p < 0.0001$) phase. The authors stated that, as the measure of latent labour pain increased, the efficiency of the latent and active phase decreased. A relationship was not found between pain
measured during the active phase and progress during either the active or transitional phase of labour, suggesting that the timing of measurement may be important. The lack of a significant correlation found by Melzack et al. (1984) may be due to measurement during the active, rather than latent, phase of labour.

Three other studies (Davenport-Slack & Boylan, 1974; Nettelbladt, Fagerström & Uddenberg, 1976; Reading & Cox, 1985) explored length of labour in relation to pain that was assessed retrospectively during the postpartum period (at less than 18 hours, at 1 to 2 days, and at less than 24 hours respectively). Similar to Melzack et al.'s study (1984), no relationship was found.

There are many variables that may influence the relationship between pain and labour progress. These include the frequency of contractions (Lowe, 1989; Melzack et al., 1984), stage of cervical dilatation when pain is measured (Brown, Campbell, & Kurtz, 1989), presence of a support person (Hodnett & Osborn, 1989), the ability to ambulate, or even change position (Melzack, Bélanger, & Lacroix, 1991), the use of epidural analgesia (Thorp, & Breedlove, 1996), women's expectations of labour pain (Green, 1993), and maternal confidence (Lowe, 1989; Wuitchik et al., 1990). Retrospective assessments of pain may be affected by the presence of the baby, the woman's evaluation of the events surrounding the labour experience, and the time interval from labour to the pain assessment. There is no clear understanding of the accuracy of pain scores collected at various times during the postpartum period.
(Waldenström et al., 1996). Because pain and anxiety are interrelated, it is difficult to separate these components of the childbirth experience to assess them individually.

The Relationship of Anxiety to Progress in Labour

Although a consistent relationship between pain and labour progress has not been established, anxiety is related to labour progress. Lederman et al. (1978), in a sample of 32 primiparous women, correlated; (a) biochemical measures of stress, (b) uterine contractility, recorded in Montevideo units (a measure of intrauterine pressure), and (c) anxiety, measured using the Spielberger State-Trait Anxiety Inventory. While there was no direct correlation between anxiety and duration of active or second stage labour, anxiety levels were positively correlated with active labour levels of epinephrine \( r = 0.60 \) and cortisol \( r = 0.59 \). Epinephrine levels were correlated with decreased uterine contractility, \( r = -0.71 \) and longer duration of active labour \( r = 0.60 \). This relationship was maintained with the inclusion of five women who were administered a sedative or tranquillizer in latent labour. The authors concluded that, when medication use was controlled, higher plasma epinephrine levels were associated with decreased uterine contractility and longer active phase labour. The results of this trial must be interpreted with caution. Other variables that may have had an impact on the length of labour include the administration of oxytocin and regional anaesthetic (saddle block, caudal and
epidural anaesthetic), electronic fetal monitoring, and internal intrauterine pressure monitoring. Oxytocin is used as a labour stimulant and it is has been shown that epidural anaesthetic can slow the progress of labour (Thorp & Breedlove, 1996). The use of continuous electronic fetal monitoring and intrauterine pressure monitoring may, in themselves, have resulted in increased anxiety and catecholamine levels.

McCool and Susman (1994), in their study of 38 nulliparous adolescents, also found a relationship between anxiety, cortisol and labour outcomes. Anxiety levels during early pregnancy were positively correlated with total duration of labour ($r = 0.40$). The only significant correlation for cortisol was between levels taken at less than 20 weeks gestation and length of second stage labour ($r = 0.37$). Changes in cortisol and anxiety from the initial measure at less than 20 weeks to the final measure at 32-36 weeks were negatively correlated to duration of labor and poor intrapartal outcomes (as measured by a composite outcome scoring system). These findings suggest that, while a high level of anxiety over time may be related to longer labour and poorer outcomes, an increase in cortisol and anxiety in late pregnancy may be adaptive. The lack of (a) correlation of cortisol to anxiety, (b) correlation of anxiety and cortisol to specific outcomes, (c) intrapartal measures of cortisol and anxiety, and (d) adequate sample size limits the interpretation of the relationship of anxiety to progress in labour in this study.

Wuitchik et al. (1989) used open ended questions to assess anxiety levels in 86
nulliparous women at various times during labour. They demonstrated an increase in the length of latent ($r = 0.31$), active ($r = 0.67$), and second stage ($r = 0.61$) of labour in those women who exhibited "distress-related" thoughts during the latent phase of labour (< 3 centimeters of cervical dilatation). However, a significant relationship was not found between anxiety measured during the active phase and the duration of either the active phase of second stage of labour. The authors summarized by stating that cognitive activity during the latent phase of labour contributes to the efficiency of labour. The authors used a coding system to categorize the thoughts of women as coping- or distress-related. While there was a high degree of inter-rater reliability (0.94) between those coding the data, the authors did not report on the coding system. Thus, from this paper, the validity of the concepts cannot be judged.

Beck, Seigel, Davidson, Kormeier, Breitenstein, and Hall (1980) measured anxiety in early labour in 44 women and found a relationship with duration in labour. Throughout the paper, the authors referred to duration of labour but did not state whether anxiety prolonged or shortened labour and the correlation is reported as a negative ($r = -0.38$). A negative relationship indicates that anxiety, in contrast to Lederman et al. (1978), is related to a decrease in labour duration.

In the above studies, small sample sizes, different measurement tools, administration of the assessment tool at different periods during pregnancy and the intrapartum period, and the presence of possible intervening variables, have limited
the development of an understanding of the relationship between anxiety and progress in labour. However, it is generally accepted that high levels of anxiety have the potential to disrupt the labour process and physiological studies have demonstrated that the stress hormone, epinephrine, interferes with myometrial contraction. The relaxation provided by a warm tub bath, could, in theory, decrease both anxiety and pain, thereby reducing catecholamine production and, as a consequence, support labour progress.

It is beyond the scope of this thesis to review the pharmacological management of labour pain. However, a general overview is presented. Pain is a central component of the childbirth experience and many women approach labour with trepidation (Waldenström et al., 1996). Efforts to ameliorate both pain and the anxiety associated with childbirth have resulted in the development of both pharmacological and alternative pain relief strategies. Opioid analgesics are somewhat lacking in effectiveness in decreasing labour pain (Olofsson, Ekblom, Ekman-Ordeberg, Hjelm, & Irestedt, 1996) and have undesirable side effects for both mother and baby. Epidural anaesthesia is effective in relieving pain for most parturients, nevertheless, this pain relief technique is accompanied by increased risks for longer labour, instrumental vaginal delivery, and cesarean birth (Thorp, & Breedlove, 1996) and is not consistently associated with decreased anxiety levels (Witchik, Bakal, & Lipshitz, 1990a). Alternative methods of pain relief may not
change the intensity of pain but may increase the woman's ability to cope with labour pain. However, Folkman and Lazarus (1984) suggest that there is a dynamic relationship between coping and emotion so that helping a women cope with labour pain may decrease anxiety which, in turn, decreases labour pain. Evidence of this is suggested by studies that have found fear and worry associated with increased labour pain (Lowe, 1987; Lederman et al., 1978; Wuitich et al., 1989) and maternal confidence associated with decreased pain (Lowe, 1989; Wuitichik, Hesson, & Bakal, 1990b). Water immersion may decrease labour pain by providing women with a coping mechanism.

In summary, a clear association between the intensity of labour pain and progress in labour has not been demonstrated. Studies have shown a relationship between anxiety and labour efficiency, and this relationship is supported by physiological research. However, intervening variables, accompanied by the difficulty of measuring the unique contribution of pain and anxiety, limit the strength of these studies. While pharmacological analgesics may be effective in reducing labour pain, they are associated with risks for both mother and baby. In an effort to avoid the risks associated with these medications, alternate methods of pain relief, such as water immersion, have been developed. These methods, as coping mechanisms, may reduce anxiety, and in turn, labour pain.

The timing of tub use may be an important aspect of use of water immersion,
but in a direction opposite to that suggested by much of the literature. Rather than delay the onset of efficient contractions, water immersion in early labour, prior to five centimeters, may provide relaxation and a means of coping with the challenge of labour pain, thus intercept the emotional and physiological mechanisms that can impede progress in labour.
CHAPTER 3

Conceptual Framework

The conceptual framework is derived from physiology research and is based on the (a) relationship of anxiety to progress in labour, (b) gate-control theory of pain, (c) possible interaction of positional and (d) hydrostatic effects of immersion on the progress of labour.

**The Effects of Anxiety on Myometrial Contractility**

Epinephrine, a catecholamine released from the adrenal medulla in states of pain and anxiety, is a powerful inhibitor of uterine activity (Arkinstall, & Jones, 1985; Barden, & Stander, 1968; Eskes et al., 1965; Leroy, Ferre, Filliatreau, Cabrol & Breuiller, 1986).

While the exact physiology of uterine contractions is yet to be discerned, Blackburn and Loper (1992) postulate the mechanisms of myometrial contractions as follows: within the myometrial cell, intracellular calcium $[Ca^{2+}]$, binds with calmodulin to form a calcium-calmodulin (Ca-CAM) complex which activates myosin light chain kinase (MLCK). This is the key enzyme responsible for the phosphorylation and dephosphorylation of myosin, a myometrial protein myofilament. With phosphorylation, the heads of the myosin filaments bind with actin, another myometrial protein myofilament. Upon binding, the head of the myosin filament flexes, causing shortening of the actin filament resulting in muscle
Within the uterus, epinephrine stimulates β-adrenergic receptors on the surface of the uterine myometrial cells, activating the production of adenyl cyclase (Blackburn & Loper, 1992). Adenyl cyclase activates the production of cyclic adenosine monophosphate (cAMP) that "in turn activates its own protein kinase, protein kinase A (PKA)" (Challis & Lye, 1994). Protein kinase reduces intracellular calcium levels stopping the cascade that leads to myometrial contraction. Dokhac D'Albis, Janmot, and Harbon (cited in Challis, & Lye, 1994, p. 1007) state "The ability of PKA to inhibit myometrial MLCK activity even in the presence of agonists that increase [Ca^{2+}]; and Ca-CAM may prove a biochemical rationale for the observation that agents that increase intracellular cyclic AMP can inhibit uterine contractions even in the presence of Ca^{2+}-activating agents such as oxytocin and prostaglandins". Thus, reducing the levels of epinephrine, through decreasing the pain and anxiety that may be associated with labour, will help to maintain some of the physiological mechanisms that promote labour progress. Clinical support for this has been demonstrated by Lederman et al. (1978) in their trial that found a relationship both between anxiety in labour and plasma levels of epinephrine (r = 0.6, p < 0.01) and epinephrine and decreased uterine contractility (r = -0.71, p < 0.01).

For centuries water immersion has been associated with relaxation. Warm water
causes muscle relaxation and "exerts a soothing action on the cutaneous nerve endings" (Brown, 1982). The buoyancy of the water lessens the pressure on joints and soft tissues caused by the effects of gravity. Relaxation interferes with the "stress-response", decreasing levels of epinephrine. Thus, water immersion may reverse the physiological effects of epinephrine on the myometrium. This might be especially important in the early stages of labour, before five centimeters of cervical dilatation; a time when anxiety, according to Wuitckik et al. (1989) is most predictive of an increased length of labour.

The Gate Control Theory of Pain

Pain is the "net effect of many interacting and very complex physiologic, biochemical, and psychologic mechanisms that involve activity of most parts of the peripheral and central nervous system" (Bonica, 1990, p. 87) and, as yet, are not completely understood. In a effort to make sense of those factors that inhibit and facilitate the pain experience, Melzack and Wall (1965) developed the Gate Control Theory which addressed the issue of modulation of pain signals by factors that access both ascending and descending neurological pathways. According to this theory, nociceptive stimuli are transmitted along thinly myelinated A-delta and unmyelinated C afferent neurons to the substantia gelatinosa in the dorsal horn of the spinal column. Within the dorsal horn, these afferents release a number of different neurotransmitters, of which substance P is the best known. Stimuli, such as rubbing,
massage, vibration, and the application of innocuous heat and cold, activate low-threshold mechano- and thermal- receptors which transmit their impulses by myelinated thicker, faster transmitting Aα/Aβ neurons. These impulses inhibit the transmission of nociceptive signals to ascending systems at the level of the substantia gelatinosa, either by the production of the neurotransmitter gamma aminobutyric acid, which inhibits the release of the excitatory neurotransmitter substance P, or by the stimulation of inhibitory interneurons within this lamina of the dorsal horn.

Melzack and Wall (1965) also proposed that factors that affect descending pathways could modulate the transmission of pain signals. Subsequent to their hypothesis, work by others has elucidated the presence of endogenous opioid and non-opioid substances that inhibit the transmission of pain. These substances, enkephalins, dynorphins and beta endorphin, are active at many areas within the brain and spinal column. Within the dorsal horn, Mu opiate receptors are found on both at the terminus of the nociceptive afferents and on the dendrites of postsynaptic neurons (Jessell & Kelly, 1991). When these receptors are activated, they inhibit the release of neurotransmitters such as glutamate, substance P, and others by decreasing Ca^{2+} entry into the sensory terminal (Jessell & Kelly, 1991). Thus, nociceptive impulses can be "gated", or inhibited, at the level of the dorsal horn by both ascending systems and descending systems.
Further to the original development of the gate control theory, Melzack and Casey (1968) suggested that there are three major dimensions of the pain experience: the sensory-discriminative, the motivational-affective, and the cognitive-evaluative. These have been presented by Bonica (1990) as follows. Sensory-discriminative information is processed in the ventrobasal thalamus and the somatosensory cortex within the brain. The reticular formation, hypothalamus, medial thalamus and limbic systems are involved in the motivational and affective dimension of pain. Through complex circuitry, these structures are organized to motivate protective action by the organism. Cognitive functions can act selectively on both the sensory processing and motivational systems. Thus, pain is far more than an unpleasant sensation that elicits avoidance behaviour and an emotional response. Rather, pain is a complex interaction of reciprocal systems that can be inhibited or facilitated by biochemical, physiologic, emotional, and cognitive factors.

Warm water immersion may influence both ascending and descending systems affecting all three dimensions of the pain experience. Warmth and hydrostatic pressure may stimulate the low threshold mechano- and thermo-receptors, blocking pain transmission at the level of the substantia gelatinosa. In the case of whirlpool immersion, intense stimulation, such as that provided by the vibrating flow of water from the jets, may excite small diameter C afferents. These afferents are thought to stimulate an ascending system which, in turn activates an inhibitory descending
In this way, water immersion may influence the sensory discriminative dimension of labour pain. Reclining in a warm bath may cause relaxation, both by decreasing pain from contracted muscles and by lessening the level of anxiety, thus influencing the motivational-emotional dimension of the pain experience. The association of warm water with comfort, pain relief and other personal meanings, relates to the cognitive dimension which is dependent upon past experience, cultural beliefs, and other unique personal factors. A positive perception immersion may then initiate descending inhibiting factors that modulate the inputs at the level of the dorsal horn before they activate the sensory or motivational system.

**Positional Effects of Water Immersion**

A dorsal recumbent position during labour is associated with decreased efficiency of uterine contractions (Roberts, 1989) as evidenced by the increased use of drugs to augment labour and artificial rupture of membranes noted in a systematic review of the studies (Nikodem, 1995). A mechanism that may explain these findings involves the interaction of prostaglandins and oxytocin. In an upright position, through the force of gravity, the fetal head exerts pressure enhancing the mechanical stretch of the cervix (Blackburn & Loper, 1992). Cervical stretch results in the release of the prostaglandins PGE$_2$ and PGF$_{2\alpha}$, which increase myometrial sensitivity to oxytocin (Bonica, Miller, & Parmley, 1995). Oxytocin, which is synthesized within the fetal membranes and decidua (Chibbar et al., 1993), and, it
has been argued, released from the hypothalamus in response to stretch of the lower uterine segment and cervix (Bonica et al., 1995; Wray, 1993), stimulates further prostaglandin production (Fuchs & Fuchs, 1996). Thus, a feed-forward mechanism is established that perpetuates the process of labour (Fuchs & Fuchs, 1996.) Increased head-to-cervix pressure is predictive of progress in labour and vaginal delivery (Allman, Genevier, Johnson & Steer, 1996).

Because of the construction of most tubs, the position most often assumed is supine semi-recumbent. This position may affect uterine contractility through decreased pressure applied to the cervix by the vertex. The narrowness of most tubs limits the use of other positions, thus women generally assume a supine semi-recumbent position regardless of their stage of cervical dilatation. However, pressure on the cervix due to an upright position might be a more important stimulatory mechanism in early labour as opposed to later when the feed forward mechanism is well established and more frequent contractions increase cervical pressure. Thus, the semi-recumbent position that accompanies the use of using water immersion in a conventional tub may decrease the effectiveness of uterine contractions when a woman is less than five centimeters dilated, but have little effect of the efficiency of contractions when she is beyond five centimeters and having frequent contractions.

The Hydrostatic Effects of Water Immersion

Hydrostatic pressure experienced during immersion causes a shift of fluid from
the extravascular to intravascular space during water immersion (Katz, Ryder, Cefalo, Carmichael & Goolsby, 1990). This fluid shift may have a diluting effect on circulating oxytocin, consequently decreasing the oxytocin available as stimulus for uterine contraction. Significant diuresis has been noted with shoulder-out immersion with no post-immersion increases in blood volume. Katz et al. (1990) postulate that, as the hydrostatic pressure moves fluid from the tissues to the intravascular space, plasma volume expands stimulating increased renal blood flow and diuresis maintaining homeostasis of the plasma volume. Circulating oxytocin will then be diluted and excreted.

There is no change in circulating oxytocin levels prior to or during active labour (Bonica et al., 1995; Challis & Lye, 1994; Wray, 1993). However, Challis and Lye (1994) note that the number of oxytocin receptors in the myometrium increase dramatically at term making the myometrium more sensitive to oxytocin. Therefore, a dilution-induced small decrease in the level of circulating oxytocin could have the effect of slowing labour.

Conversely: (1) oxytocin is produced by the amnion, chorion and decidua and acts on the myometrium in a paracrine manner. (Chibbar et al., 1993), (2) the physiological effects of oxytocin are more dependent upon the concentration of receptors than circulating levels of the hormone (Challis & Lye, 1994; Wray, 1993), and (3) the metabolic clearance rate of oxytocin during pregnancy is more likely the
result of the presence oxytocinase which degrades oxytocin rather than renal and hepatic function (Thornton, Davison & Baylis, 1990). Consequently, decreased circulating oxytocin might have no effect on the contractility of the uterus. Levels of circulating oxytocin in relation to water immersion and the possible effect of changes in these levels have not been subject to investigation. The theoretical basis of limiting immersion until after five centimeters to decrease the dilutional effects of fluid shifts is subject to question.

In summary, four elements; the relationship of anxiety to labour progress, the Gate Control Theory of pain, the effects of position in the tub, and the hydrostatic effects of water, form the theoretical foundation for this inquiry into the use of water immersion. If water immersion does decrease anxiety through pain reduction and/or relaxation, progress in labour should be noted regardless of the stage of dilatation at immersion. If cervical stretch is diminished due to a reclining position in the tub, or if water immersion does cause dilution of oxytocin, one might observe a prolongation of labour and increased incidence of dystocia, particularly in those women who use immersion before five centimeters when labour may not be well established. This might be particularly evident in the population of primiparous women who have a higher incidence of dystocia.
Research Questions

Among nulliparous women labouring in two in-hospital birth centres and using water immersion:

Research Question 1: What proportion of women used water immersion at (a) less than five centimeters of cervical dilatation, and (b) five centimeters of cervical dilatation or greater?

Research Question 2: What is the incidence of dystocia in women who used water immersion in labour at (a) less than five centimeters of cervical dilatation and (b) five centimeters or greater?

Research Question 3: What is the incidence of other outcomes, including use and type of analgesic medication, use of oxytocin for labour stimulation, type of delivery, and indication for cesarean section, for women who used water immersion at (a) less than five centimeters of cervical dilatation, and (b) five centimeters or greater?

Definitions of Terms

Water Immersion

Water immersion involves immersing the woman to the level of her breasts in a whirlpool tub with the water temperature adjusted to the woman's level of comfort.

Dystocia

A diagnosis of dystocia was defined as: (a) the time from three centimeters of dilatation to full dilatation, as computed from the patient's record, was less than 0.5
centimeters per hour for four hours, and/or (b) intravenous oxytocin was administered for "slow progress", or "failure to progress" as recorded on the chart, and/or (c) cesarean section was performed for "slow progress", "failure to progress", "dystocia of labour", or "cephalopelvic disproportion" (CPD).

Outcomes

In addition to those outcomes taken as a diagnosis of dystocia, as stated above, the outcomes that were measured included: (a) the use and type of pain relieving medication, (b) the type of delivery, and (c) the indication for cesarean section.
CHAPTER 4

Methods

The Design

This was a pilot study to explore aspects of the use of water immersion during labour, and especially the possible connection between early immersion and uterine dystocia. Further, this study enabled the calculation of the sample size needed for a randomized controlled trial. A descriptive, retrospective, cohort design was employed; one cohort used water immersion prior to achieving five centimeters of cervical dilatation, while the second used immersion after five centimeters was reached.

Study Population

The population consisted of all women who registered for care in two in-hospital birth centres from October, 1988, to August, 1996, and for whom medical records were available.

Inclusion Criteria

Nulliparous women admitted to the birth centre with some contractions and who had a tub bath in labour were included in the study. Because cervical dilatation is progressive and usually proceeds at least 0.5 centimetres per hour, it was important to know the cervical dilatation as close to the time of first immersion as possible in order to assign the women to the correct cohort. Therefore, vaginal
examination within one-half hour of immersion was a prerequisite for inclusion.

**Exclusion Criteria**

Nulliparous women having any condition that, had it been diagnosed prior to admission, would have led to a transfer to the labour and delivery unit were excluded from the study. This included women with an undiagnosed breech presentation, twins, and pregnancy induced hypertension. Women whose labours were induced using artificial rupture of membranes or intravenous oxytocin were also excluded as, in one of the birth centres, this would have precluded admission to the centre.

**Estimated Sample Size**

Because the introduction of water immersion to labour care in Canada is relatively recent, two centres were used for data collection in order to obtain an adequate sample size. Data were collected in Centre A from October, 1988 to August, 1996 when data collection was begun. In Centre B, data collection covered the period from November, 1989, when the bath was installed, until May, 1995, when the program changed to a model of single room maternity care. Data were not available in the latter centre for 1992 and two months of 1993 because the log books were missing. While there were differences between the centres (see Table 2), the basic philosophy and many of the practices of the centres were similar. Of those admitted to the centres in labour, approximately 53% in Centre A and 24 % in Centre B used water immersion in labour.
Table 2

Summary Statistics Describing Two In-hospital Birth Centres

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number in program (NIP)</td>
<td>1975</td>
<td>1980</td>
</tr>
<tr>
<td>Nulliparous (%)</td>
<td>46.4</td>
<td>35.9</td>
</tr>
<tr>
<td>Multiparous (%)</td>
<td>54.6</td>
<td>64.1</td>
</tr>
<tr>
<td>Antepartum transfer (%) (APT)</td>
<td>16.5</td>
<td>13</td>
</tr>
<tr>
<td>No. of cases (NIP - APT)</td>
<td>1649</td>
<td>1713</td>
</tr>
<tr>
<td>Water immersion use (%)</td>
<td>52.9</td>
<td>23.7</td>
</tr>
<tr>
<td>Intrapartum transfer (%)</td>
<td>17.6</td>
<td>17</td>
</tr>
<tr>
<td>Failure to progress (%)</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Oxytocin Augmentation (%)</td>
<td>8.8</td>
<td>9.1</td>
</tr>
<tr>
<td>Epidural anesthesia (%)</td>
<td>5.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Cesarean section * (%)</td>
<td>4.9</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Note. * The cesarean section rate of Centre A includes only those women transferred intrapartum while the rate of Centre B includes those of women transferred both antepartum and intrapartum. This is because centre A did not keep statistics on those transferred during the antepartum period.
Using the number of nulliparous women admitted to Centre A in labour and the percentage of those who used the tub, it was possible to approximate the number of women who used the tub in a given year. Statistics available from Centre A did not provide information on the use of immersion by nulliparous women as a separate group. Therefore, the percentage used in estimation of the sample size included all women who used water immersion.

From a one year sample of women who used the whirlpool bath in Centre B, it was found that approximately 66% of women had digital vaginal examinations within one half hour of entering the tub. Using this number and the average of the number of women who used the whirlpool bath in labour over five years, the number of records that could be expected to meet the inclusion criteria was calculated. (see Table 3). It was estimated that approximately 250 records in Centre A would meet the inclusion criteria.
Table 3

**Estimated Number of Records Meeting the Inclusion Criteria in Centre A**

<table>
<thead>
<tr>
<th>Year</th>
<th>89-90</th>
<th>90-91</th>
<th>91-92</th>
<th>92-93</th>
<th>93-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. admitted</td>
<td>98</td>
<td>162</td>
<td>170</td>
<td>167</td>
<td>136</td>
</tr>
<tr>
<td>Bath use no. (%)</td>
<td>59 (60)</td>
<td>86 (53)</td>
<td>88 (52)</td>
<td>82 (49)</td>
<td>64 (46)</td>
</tr>
<tr>
<td>Estimated no. examined within 1/2 hour (66%)</td>
<td>39</td>
<td>57</td>
<td>58</td>
<td>54</td>
<td>42</td>
</tr>
<tr>
<td>Total = 250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Centre B recorded the number of nulliparous women who used water immersion during labour. Again, using 66% as an approximation of the number who were examined within one-half hour of entering the tub, it was possible to estimate the number of records that would meet the inclusion criteria in Centre B. (see Table 4)
Table 4

**Estimated Number of Records Meeting the Inclusion Criteria in Centre B**

<table>
<thead>
<tr>
<th>Year</th>
<th>90-91</th>
<th>91-92</th>
<th>92-93</th>
<th>93-94</th>
<th>94-95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath use</td>
<td>30</td>
<td>38</td>
<td>34</td>
<td>33</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Estimated No. examined within ½ hour (66%)</td>
<td>19</td>
<td>25</td>
<td>22</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>106</td>
</tr>
</tbody>
</table>

Using the numbers obtained from both centres, it was calculated that approximately 356 records would meet the inclusion criteria.

**Sample**

From October, 1988 to August, 1996 in Centre A and November, 1989 to May, 1995 in Centre B, 2393 nulliparous women registered in the birth centre programs. Of these, 1744 (72.9%) maintained low risk status according to the Ontario Antenatal Record and chose to remain in the program, thereby receiving intrapartum care in the centre. Water immersion was used by 1062 (61%), of which 430 were examined within one half hour of immersion; 366 from Centre A and 64 from Centre B. Data were not collected after May of 1995 in Centre B as the centre moved to a model of single room maternity care in which all woman, regardless of risk, used the centre. This, accompanied by the loss of data for 14 months over 1992 to 1993,
partially accounts for the smaller number of women in the sample from Centre B.

Four hundred and ninety one women were not examined within one half hour of immersion and thus did not meet the inclusion criteria. Complete information could not be obtained for 141 women. (See Figure 1 for the derivation of the study sample).
N = 2393  (MD = 19)

Intrapartum Care in BC  Risk Increased  (MD = 32)

1744

Delivered in BC Intrapartum Transfer

1158  586

Used Water Immersion

Yes No  (MD = 18)  * Missing Data

1062  664

Examined within 1/2 hour

Yes No  (MD* = 141)

430  491

Study sample

Chart not found  21
Out for microfilming  29
No record of WI on chart  34
Times unclear  15
No chart number  19
No record of this birth  7
Wrong chart number  7
No partogram  2
No dilatation on WI  2
No time of WI  1
Induction  4

Figure 1. Derivation of the study sample
The Setting

The data were collected from two in-hospital birth centres. The centres were designed to offer low-risk women an alternative to traditional obstetrical care. The philosophy of the centres was one that valued birth as a normal, healthy process and the importance of decision making in collaboration with the woman and her family. Water immersion was one of many alternative pain relief techniques used. Parenteral opioid analgesic and nitrous oxide were available in the centres. However, epidural anaesthesia necessitated transfer of the woman out of the centre to the hospital labour and delivery unit.

Nurses, in collaboration with the woman's physician, provided care in the antepartum, intrapartum, and postpartum periods, including care at home during the first few weeks post birth. There were differences between the centres in the way continuity of care was provided, however, both centres made efforts to insure the presence of a nurse known to the woman for labour and birth.

While the centres were based on a similar philosophy of care and somewhat similar mode of care delivery, there were differences between the centres. Table 5 provides a comparison of the birth centres' rates of selected data collected during the study period, October, 1988, to August, 1996, in Centre A, and November, 1989, to May, 1995, in Centre B.
Table 5

Comparison of the Birth Centres

<table>
<thead>
<tr>
<th>Centre</th>
<th>A</th>
<th></th>
<th>MD</th>
<th>B</th>
<th></th>
<th>MD</th>
<th>(\chi^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parity - multiparous</td>
<td>1834</td>
<td>53.41</td>
<td>1</td>
<td>882</td>
<td>52.66</td>
<td>18</td>
<td>0.25</td>
</tr>
<tr>
<td>Parity - nulliparous</td>
<td>1600</td>
<td>46.59</td>
<td></td>
<td>793</td>
<td>47.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Care in BC*</td>
<td>1155</td>
<td>72.18</td>
<td>0</td>
<td>589</td>
<td>77.33</td>
<td>32</td>
<td>7.25**</td>
</tr>
<tr>
<td>Delivered in BC*</td>
<td>799</td>
<td>69.18</td>
<td>0</td>
<td>359</td>
<td>60.95</td>
<td>0</td>
<td>11.83***</td>
</tr>
<tr>
<td>Intrapartum transfer*</td>
<td>356</td>
<td>30.82</td>
<td>0</td>
<td>230</td>
<td>39.05</td>
<td>0</td>
<td>11.83***</td>
</tr>
<tr>
<td>Water immersion*</td>
<td>855</td>
<td>74.09</td>
<td>1</td>
<td>207</td>
<td>36.19</td>
<td>17</td>
<td>231.96****</td>
</tr>
<tr>
<td>Examined within 1/2 hour</td>
<td>366</td>
<td>48.74</td>
<td>104</td>
<td>64</td>
<td>37.65</td>
<td>37</td>
<td>6.41**</td>
</tr>
</tbody>
</table>

Note. MD = missing data; *Data include only nulliparous women.

\(** p < .01, *** p < .001, **** p < .0001\)

Ethical Considerations

After ethics approval was granted by the Office of Research Services at the University of Toronto, permission to access patient charts was obtained from the Ethics Committees of the participating community hospitals. This involved submitting the request, in writing, along with the proposal and the remarks of the...
Office of Research Services, to the Ethics Committee of the hospital. The request (see Appendices A and B) outlined the intent of the project and guaranteed protection of patient confidentiality and hospital identity.

In the context of this study, the most important issue is the protection of confidential information. To maintain confidentiality, the medical record number, recorded on the Inclusion Criteria Work sheet (see Appendix C), was assigned a code number. Only the code number was used on the Data Collection Sheet (see Appendix D) and the investigator alone retained possession of these forms. On completion of the study, the work sheet and the data collection sheet were placed in a locked file where they will remain for seven years. References to the hospitals involved have been by letter assignment only throughout this document to maintain the anonymity of the hospital.

**Data Collection Methods**

After ethics approval was granted, birth centre logs of basic information on the progress and outcomes of labour were reviewed. An inclusion criteria work sheet (see Appendix C) was used to record information relevant to the study. The medical record number (MRN), a number unique to each patient, was recorded for those who met the following elements of the inclusion criteria: (a) nulliparous, (b) received intrapartum care in the centre, and (c) used water immersion. If elements of the inclusion criteria were missing but the MRN was available, the MRN was recorded
on the work sheet and pertinent data added from the chart.

Upon completion of the work sheets, arrangements were made with Health Records in Centre A to train the investigator in methods of chart acquisition. The hospital was reimbursed for costs incurred. Centre B made the appropriate charts available to the investigator at no cost.

The charts were reviewed by the investigator and, if the final inclusion criterion, vaginal examination within one half hour of tub use, was met, a code number was assigned and recorded on both the work sheet and a data collection sheet (see Appendix D). The study data were then manually abstracted from the chart. The date of admission, along with the number of the computer record for each entry, were recorded on both the work and data collection sheets to allow cross referencing and tracking of each record within the database.

Information from the data collection sheets was entered into a personal computer using Epi Info statistical software (Dean, Dean, Coulombier, Burton, Brendel, Smith, Dicker, Sullivan, & Fagan, 1984).

**Methods of Measurement**

Data collected included both categorical measurements such as parity, intrapartum transfer, use of water immersion, administration of oxytocin, use and type of pharmacological pain relief, type of delivery, and smoking, and continuous measurements such as maternal age, gestation, cervical dilatation, and time of
admission, immersion, achievement of cervical dilatation greater than three centimetres, full dilatation, and delivery.

Data were collected and cross referenced using several sources, including the birth centre log, the Ontario Antenatal Record, patient notes, the partogram, and the labour and delivery summary sheet. To determine if the inclusion criterion of examination within one half hour was met, the nursing notes on the partogram, the partogram graph, and the antepartum nursing notes were reviewed.

On the partogram graph, the hours are divided into 15 minute blocks of time. Therefore, times taken from the partogram were the averaged time using fifteen minute intervals. For example, if the time on the partogram was recorded between 1700 and 1715, the time entered on the data collection sheet was 1707. The following guidelines were used to determine eligibility for inclusion: (a) if there was a specific notation for the examination time, the notes were considered accurate; (b) if the examination was contained in a general note and admission to the water was within the half hour period, the time was taken from either the notes or the partogram; and (c) if the examination was contained in a general note and the half hour inclusion criterion was not met, but was close, the partogram was reviewed, and, if the averaged partogram time and the immersion time were within the half hour period, the chart was included. Charts that were equivocal were discussed with the thesis supervisor and included only if there was agreement that they met the
inclusion criteria. Times for other vaginal examinations were extracted from the chart in a similar manner.

Because birth centre nurses may have conducted the initial intrapartum examination in the woman's home prior to admission, the initial rather than admission dilatation time was recorded. Full dilatation and delivery times were determined from the notes and cross referenced to labour and delivery summary sheet. If there was a discrepancy, the notation on the labour and delivery summary was considered more accurate as these were duplicated and kept in both the infant's and physician's chart. If the notes did not indicate a time for full dilatation, but instead a time for a "rim" or "anterior lip", and the next notation was "pushing", an average of these two times was used.

Medications, both those used for pain relief and to stimulate labour, could be recorded on the partogram notes, the partogram graph, and on the labour and delivery summary. Therefore all three were examined for evidence of medication use. For the purposes of this study, oxytocin use was recorded only if it was used to augment a prolonged labour and not if it was used to induce labour because of prolonged, pre-labour rupture of membranes.

In a similar fashion, the notes, then the partogram graph, and then the labour and delivery summary were used to determine the type of delivery. In the case of a cesarean section, the indication for the surgery was taken from the discharge
summary and cross referenced with the physician's dictated operating room note.

Three elements were considered in the definition of dystocia and pooled to form the variable. These included: (a) use of oxytocin to augment labour, (b) cesarean section for dystocia, failure to progress, or cephalopelvic disproportion, or (c) a rate of cervical dilatation of less than 0.5 centimetres over four hours after three to four centimetres of dilatation (Fraser et al., 1995). If any one of these elements were present, the woman was categorized as having dystocia. Rate of cervical dilatation was calculated using (a) the time at which the woman achieved three centimetres of cervical dilatation or more, (b) cervical dilatation at that time, (c) full dilatation and, (d) the time of full dilatation. As previously stated, use of oxytocin was considered as an indication of dystocia only if administered for slow progress in labour. In the context of this study, the investigator questioned whether the administration of oxytocin in second stage should be included when measuring the variable "dystocia." Five obstetricians, who were unaware of the purpose of the study, were asked their opinion. Four stated that it should be included while one stated that it would depend on other factors. Oxytocin administration in the second stage was therefore included in the pooled variable. A cesarean section was considered to fall into the category of dystocia if the discharge summary or operating room record stated that the surgery was for "failure to progress," "cephalopelvic disproportion," or "dystocia."
**Statistical Methods**

The chi square statistic was computed for comparison of the categorical variables parity, intrapartum transfer, use of water immersion, administration of oxytocin, type and use of pharmacological pain relief, type of delivery, and smoking behaviour. Continuous variables, such as maternal age, gestation, cervical dilatation, and time of (a) admission, (b) immersion, (c) achievement of greater than three centimeters of cervical dilatation, (d) full dilatation, and (e) delivery were analyzed using the Student's t-test and, where the data were skewed or variances heterogeneous, Kruskal-Wallis H was used. The level of statistical significance for all tests was set at $p < .05$.

**Assessment of Reliability**

The reliability of the data was increased by the use of; (a) a consistent data collection form, (b) specific guidelines for data collection, and (d) one data abstractor.

**Part 1: Reliability of Classification of Eligibility/Ineligibility**

Data were available for 922 nulliparous women. Forty-seven charts, representing five percent, were used for data re-abstraction to compute intra-rater reliability of eligibility for inclusion. A computer-generated list of random numbers was used to determine which charts would be reviewed.

Of the 47 charts, 44 were accurate in terms of meeting the inclusion criteria
producing an accuracy rate of 93.6%. Cohen's kappa to test for intra-rater reliability yielded a reliability of .88. One chart was that of a multiparous women and withdrawn from data analysis. A second chart was eliminated because the woman was not examined within one half hour prior to immersion and the data were removed. In a third chart it was determined that the woman had actually been examined within the half hour period. Therefore, the data from this chart were collected and entered into the database.

Part 2: Reliability of Data Abstraction

For every chart, there were six possible entries. If the woman was examined within the criterion period, there were a further 16 entries, equalling a total of 22 possible data entries. The time that the woman was considered less than three centimeters dilated, or greater or equal to three centimeters, was always dependent upon the time of the initial examination, thus only one was considered as a separate entry. For example, if the woman was less than three centimeters at the initial examination, the time of the initial and the "less than three" examination were the same, thus only the “greater or equal to three” time was considered a separate entry.

Twenty-four of the charts provided six entries per chart as those women were not examined within one half hour. Twenty-two women in the group of 46 were examined within one half hour of entering the water, thus provided a total of 22 entries per chart. Using both groups, there were a total of 628 entries. There were 16
discrepancies between the original data and the re-abstracted data, generating an accuracy rate of 97.45%.

Part 3: Reliability of Data Entry

The reliability of data entry was assessed as follows. Data were available for 430 women who met all of the inclusion criteria. Data for five percent (22) of these were re-entered, by the investigator, in a separate file and compared to the original entries. A computer-generated list of random numbers was used to determine which charts would be re-entered.

There were entries that were dependent upon other entries so that, if the first entry was "No", the rest of the entries relating to it were not completed. For example, if "examination at less than three centimeters" was "N", the time relating to that entry was not entered. Similarly, if an original entry was entered incorrectly, dependent entries were also incorrect. Therefore, each record was considered individually in terms of the number of possible entries and all incorrect entries, including dependent ones, were counted. There were 14 errors out of a total of 988 possible entries, generating and accuracy level of 99%. Following the determination of accuracy, all of the records were compared to the data collections sheets and errors corrected to insure precision of data entry.
CHAPTER 5

Results

Research Question 1

Data were collected for 430 nulliparous women who used water immersion and were examined within one half hour of immersion. Of these, 253 (58.8%), Cohort 1, used water immersion at less than five centimetres of cervical dilatation while 177 (41.2%), Cohort 2, were immersed when they had achieved at least five centimetres of cervical dilatation.

The cohorts were not different in terms of age, gestation, or smoking behaviour. However, there was a significant difference in cervical dilatation both at the time of the initial examination and at immersion. Characteristics of the sample by cohort are presented in Table 6. Data on ethnicity were unavailable from the charts and therefore not collected.
Table 6.

Characteristics of the Study Sample

<table>
<thead>
<tr>
<th></th>
<th>Cohort 1 (n = 253)</th>
<th>Cohort 2 (n = 177)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>M</strong></td>
<td><strong>SD</strong></td>
</tr>
<tr>
<td>Age (years)</td>
<td>28.0</td>
<td>4.16</td>
</tr>
<tr>
<td>Gestation (weeks)</td>
<td>39.7</td>
<td>1.14</td>
</tr>
<tr>
<td>Initial dilatation (cm)</td>
<td>2.81</td>
<td>1.09</td>
</tr>
<tr>
<td>Immersion dilatation (cm)</td>
<td>3.22</td>
<td>0.97</td>
</tr>
<tr>
<td>Smoking no. (%)</td>
<td>22 (8.8)</td>
<td></td>
</tr>
</tbody>
</table>

Note. Data were missing for the following: smoking, three in Cohort 1 and one in Cohort 2; initial dilatation, 7 in Cohort 1 and 3 in Cohort 2; immersion dilatation, 4 in Cohort 1.

**** p < .0001

Research Question 2

Labour was considered to be complicated by dystocia when; (a) cervical dilatation, after three centimeters, progressed at less than 0.5 centimeters per hour for four hours, and/or (b) intravenous oxytocin was administered for “slow progress” or “failure to progress”, and/or (c) cesarean section was performed for “slow
progress”, “failure to progress”, or “cephalopelvic disproportion”. In total, 96 women (22%) were considered to have dystocia, 63 (24.9%) in Cohort 1 and 33 (18.6%) in Cohort 2. There was no statistical difference between the cohorts in the incidence of dystocia ($\chi^2 = 2.35, \text{ OR } = 1.45, 95\% \text{ CI } = 0.88 - 2.38$).

The first component of the definition of dystocia investigated was the rate of dilatation. Dilatation in centimeters per hour could be calculated for 411 women, 239 in Cohort 1 and 172 in Cohort 2. Five women were fully dilated at their first examination after they reached three centimetres. In these cases, the time and dilatation at the initial examination were used to determine their rate of dilatation.

The rate of dilatation could not be calculated for 19 women, 14 in Cohort 1 and five in Cohort 2. Thirteen women, nine in Cohort 1 and four in Cohort 2 did not reach full dilatation prior to delivery. Six women reached full dilatation but (a) the time of full dilatation was missing for four, (b) the time of the first examination after three centimetres was missing for one, and (c) cervical dilatation when greater than three was missing for one woman. Of these, five were in Cohort 1 while one was in Cohort 2. In total, Cohort 1 had a mean rate of dilatation of 2.04 centimetres per hour ($\text{SD } = 2.54$) while the rate of Cohort 2 was 1.66 ($\text{SD } = 1.71$). Because of the inability to include in the analysis those who did not reach full dilatation, and because the majority of these were in one cohort, a comparison of dilatation rates was not conducted. Where dilatation per hour could not be calculated, the data were
reviewed to insure that group assignment (dystocia versus no dystocia) was correct.

Oxytocin for augmentation of labour, the second component of the definition of dystocia, was used significantly more often in Cohort 1. Within the sample, oxytocin use was 15.3 percent. Forty-seven women (19%) in Cohort 1 had labour stimulated with oxytocin compared to 19 (11%) in Cohort 2 ($\chi^2 = 4.93$, OR = 1.90, 95% CI = 1.03 - 3.52).

Twenty-eight women, 16 (6.3%) in Cohort 1 and 12 (6.7%) in Cohort 2, had a cesarean section for dystocia, the third component of the definition. The cesarean section rate for dystocia was not significantly different between the groups, ($\chi^2 = 0.04$, OR = 1.08, 95% CI = 0.46 - 2.50).

**Research Question 3**

The overall use of analgesics within the sample was 46.5 percent. There was no difference between the groups in use of nitrous oxide. Cohort 1 used intramuscular opioid analgesic or the combination of nitrous oxide and opioid significantly more often than Cohort 2. Similarly, epidural anaesthetic, alone or in combination with opioid analgesia, was used significantly more by the women in Cohort 1. Three women in Cohort 1 were administered Atarax, a muscle relaxant, and one woman, also in this group, had a general anaesthetic for cesarean section. A pudendal block was administered to one woman in Cohort 2. These were included only in the analysis of "any medication use", a variable created by pooling the use of these along
with the use of nitrous oxide, opioids, and epidural anaesthetic. Oxytocin was not included in "any medication use". Cohort 1 used significantly more medication overall. (see Table 7).

Table 7

Use of Analgesic Medication by Cohort

<table>
<thead>
<tr>
<th>Medication</th>
<th>Cohort 1 (n = 253)</th>
<th>Cohort 2 (n = 177)</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrous oxide</td>
<td>35 (14)</td>
<td>23 (13)</td>
<td>0.06</td>
</tr>
<tr>
<td>Intramuscular opioid(^a)</td>
<td>52 (21)</td>
<td>13 (7)</td>
<td>14.13**</td>
</tr>
<tr>
<td>Epidural anaesthetic</td>
<td>50 (20)</td>
<td>22 (12)</td>
<td>4.01*</td>
</tr>
<tr>
<td>Other(^c)</td>
<td>4 (2)</td>
<td>1(^d)</td>
<td>0.26(^e)</td>
</tr>
<tr>
<td>Any medication use</td>
<td>141 (58)</td>
<td>59 (33)</td>
<td>20.95****</td>
</tr>
</tbody>
</table>

Note. \(^a\) Use of intramuscular opioid with or without nitrous oxide. \(^b\) Use of epidural anaesthetic or without prior nitrous oxide and/or intramuscular opioid. \(^c\) "Other" includes Atarax (3), general anaesthetic (1), and pudendal block (1). \(^d\) Less than 1 percent. \(^e\) Yates Corrected.

\* \( p < .05 \) \* \( p < .01 \) \*\* \( p < .0001 \)
A summary of delivery outcomes is presented in Table 8. One hundred and eight women (25%) were transferred to the labour and delivery unit during the intrapartum period. Although the reason for transfer was not recorded, 25 (23%) received epidural analgesia alone, 19 (18%) received oxytocin stimulation alone and 47 (44%) received had both epidural analgesia and oxytocin augmentation. Three hundred and thirty one women (76.9%) had a spontaneous vaginal delivery. A further 49 were delivered by vacuum extraction and 17 by forceps giving an overall vaginal delivery rate of 92.3 percent. There were 33 cesarean sections performed for a rate of 7.67 percent. A 2 X 2 contingency table using a pool of vaginal plus operative vaginal deliveries labelled "vaginal deliveries" and a pool of all deliveries by cesarean section and analyzed using chi-square failed to demonstrate a statistical difference between the cohorts in overall rates of vaginal delivery or cesarean section ($\chi^2 = 0.02, p = .878$). There were no significant differences between the cohorts in individual indications for cesarean section, or for types of operative vaginal deliveries.

While the use of oxytocin and pain relieving medications reached a level of statistical significance, most of the other outcomes showed non-significant trends, always in favour of Cohort 2.
Table 8.

**Comparison of Obstetrical Outcomes by Cohort**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Group 1</th>
<th>Group 2</th>
<th>$\chi^2$</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrapartum transfer</td>
<td>72 (28%)</td>
<td>36 (20%)</td>
<td>3.64</td>
<td>1.56 (0.96 - 2.54)</td>
</tr>
<tr>
<td>SVD</td>
<td>189 (75%)</td>
<td>142 (80%)</td>
<td>1.79</td>
<td>0.73 (0.44 - 1.19)</td>
</tr>
<tr>
<td>Vacuum</td>
<td>34 (13%)</td>
<td>15 (9%)</td>
<td>2.54</td>
<td>1.68 (0.85 - 3.35)</td>
</tr>
<tr>
<td>Forceps</td>
<td>11 (4%)</td>
<td>6 (3%)</td>
<td>0.25</td>
<td>1.30 (0.43 - 4.02)</td>
</tr>
<tr>
<td>Oxytocin</td>
<td>47 (19%)</td>
<td>19 (11%)</td>
<td>4.93</td>
<td>1.90 (1.03 - 3.52)</td>
</tr>
<tr>
<td>CS dystocia</td>
<td>16 (6%)</td>
<td>9 (5%)</td>
<td>0.29</td>
<td>1.26 (0.51 - 3.17)</td>
</tr>
<tr>
<td>CS fetal distress (FD)</td>
<td>2*</td>
<td>1*</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>CS FD &amp; dystocia</td>
<td>0</td>
<td>3 (2%)</td>
<td>2.22</td>
<td></td>
</tr>
<tr>
<td>CS other</td>
<td>1*</td>
<td>1*</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td><strong>bCS total</strong></td>
<td>19 (7.5%)</td>
<td>14 (7.9%)</td>
<td>0.02</td>
<td>0.95 (0.44 - 2.06)</td>
</tr>
</tbody>
</table>

**Note.** SVD = spontaneous vaginal delivery; CS = cesarean section; *Less than 1%.

*The CS was for chorioamnionitis. The CS was for a brow presentation. Yates corrected $\chi^2$ - the odds ratio could not be computed due to small cell numbers.
CHAPTER 6
Discussion

This study has several limitations. The sample for the study was derived from groups of nulliparous women who chose to deliver in a hospital birth centre. Thus, the findings may not be generalizable to women who; (a) are multiparous, or (b) choose to deliver in other settings including the traditional labour and delivery unit of a community hospital, a tertiary care centre, or free-standing birth centre. The difference in outcomes between Cohorts 1 and 2, if real, may be greater or non-existent in other settings because settings differ in their practices and environments. For example, a trial that examined early versus late immersion in a tertiary care centre (Eriksson et al., 1997) reported oxytocin augmentation rates approximately three times the rate detected in this study.

As a retrospective study that was dependent upon secondary analysis, there was no way to control the quality and accuracy of the data available on the medical records.

The internal validity of the study was affected by the loss of more than half of the nulliparous women who used water immersion because they were not examined within the half hour inclusion period. Their inclusion may have provided a truer reflection of the incidence of dystocia in nulliparous women in a birth centre setting, both in general and as dystocia related to cervical dilatation at the time of
immersion.

A second threat to validity is the interaction of other co-interventions. The presence of others in the room, the use of music and dim lighting, massage while in the tub, and the effects of having the whirlpool jets running may have had interfered with the impact of the use of water immersion alone.

A further limitation to this study is the lack of power to detect a significant difference in the rate of dystocia due to the small sample size. Using the formula for determination of sample size from Fleiss (cited in Dean, 1994) and; (a) the proportions determined by the 2 X 2 tables, (b) an alpha level of .05, and (c) a beta level of .80, a total sample of 1,462 women would be needed to detect a difference that was statistically significant.

The mean age of the women in this study was comparable to others who chose birth centre care (Waldenström & Nilsson, 1994). As uncomplicated pregnancy was a criterion of inclusion in this study and in all four of the trials on water immersion (Cammu et al., 1994; Lenstrup et al., 1987; Rush et al., 1996; Schorn et al., 1993), the mean gestation of 39 weeks is comparable. Approximately 10% of the women were smokers, similar to that of the women who chose to deliver in other birth centres (Rooks, Weatherby, & Ernst, 1992a), possibly indicating that a healthy lifestyle is common to those who choose birth centre care.

Over half of the study sample (58%) used immersion at less than five
centimeters of dilatation. Women in Cohort 1 were admitted to the birth centre with mean cervical dilatation significantly less than women in Cohort 2. While anxiety and pain were not measured at this time, early contact with nursing staff and early admittance could be taken as an indication that these women were either more anxious and/or experiencing significantly more pain than those women who were admitted later in the course of their labour.

Water immersion is used as a non-pharmacological approach to relieving pain. Two studies (Cammu et al., 1994; Lenstrup et al., 1987) found a decrease in pain while women were in the tub. This study did not include actual measures of pain, but like others (Cammu et al., 1994; Lenstrup et al., 1987; Rush et al., 1996; Schorn et al., 1993), used analgesic use as an indirect indicator of pain. Almost half of the women in this study used some form pain relieving medication during the course of their labour. The use of analgesia, particularly opioids, was significantly higher in the group of women who used water immersion before they had reached five centimeters. One explanation for this finding is that opioids are frequently withheld if the woman is progressing rapidly and at a greater stage of cervical dilatation because of concern that the opioid could depress the respiratory efforts of the newborn (Belfrage, Boreus, Hartvig, Irestedt & Raabe, 1981; Hamza, Benalbed, Orhant, Escourrou, Curzi-Dascalova & Gauthier, 1992).

Other studies on the use of water immersion have demonstrated different rates
of analgesia use; however, comparison is difficult due to different medication practices within the institution and the inclusion of both multiparous and nulliparous women in their samples. For example, the only available analgesia offered in the study by Cammu et al. (1994) was epidural analgesic, while a full range of analgesics and anaesthetics were available in the other studies (Lenstrup et al., 1987; Rush et al., 1996; Schorn et al., 1993).

The rate of epidural anaesthesia, alone or in combination with analgesics, in this study was considerably lower than those found by Rush et al. (1996), in a Canadian study that recorded epidural rates and included both nulliparous and multiparous women. The lower rate in this study may reflect: (a) the women's goal to avoid medication use, (b) the need for transfer to the labour and delivery unit for epidural analgesic or, (c) the culture of the participating hospitals regarding the use of analgesia. A further explanation for lower epidural rates may be that the birth centres both valued and staffed to provide 1:1 care during labour. In systematic review of the studies of continuous support, epidural rates are lower when continuous support is provided (Hodnett, 1998).

Epidural anaesthesia was used significantly more often by those women who used immersion at less than five centimeters of dilatation. A possible explanation is that these women may have been experiencing greater pain levels earlier in their labour.
Use of medication, however, may not be a good indication of the pain relief possibly provided by tub use. The warmth of the water, the hydrostatic effect and the tactile stimulation provided by the jets in a whirlpool bath decrease pain by stimulating the inhibitory gate control mechanism. However, Bonica (1990) stated that the response of neurons in the substantia gelatinosa habituate with repeated stimuli, so that, while water immersion may provide substantial pain relief initially, the effect is only temporary. Nevertheless, women can use the tub several times during the course of their labour.

Interventions such as epidural anaesthesia, use of oxytocin, and cesarean section deliveries were not provided in birth centres in which this study took place. Transfer out of the birth centre for epidural anaesthesia or for complications may be both disrupting and disappointing for the labouring woman. Therefore it was important to assess the effect early immersion had on intrapartum transfer rates.

There were more women transferred in the group that used immersion at less than five centimeters dilatation but the level did not reach statistical significance. The rate of intrapartum transfer in this study was approximately twice that noted in a large study of free-standing birth centre care (Rooks, Weatherby, & Ernst, 1992b). The difference might be attributable to the inclusion of multiparous women in the transfer rates reported in the National Birth Centre Study (Rooks et al., 1992b) and/or the greater ease of transfer when the birth centre is located within a hospital.
While the difference between the cohorts was non-significant, early immersion was associated with a two-fold increase in the rate of intrapartum transfer.

A significant (Cammu et al., 1994), and non-significant (Rush et al., 1996; Schorn et al., 1993) decrease in the use of oxytocin augmentation with the use of water immersion has been reported. The low overall rate of augmentation observed in this study offers increased support to the finding that water immersion is accompanied by decreased need for stimulation of labour. Immersion prior to five centimeters, however, was associated with increased need for oxytocin, an outcome that supports the conclusion of Eriksson, Matsson and Ladors (1997). However, the rate of oxytocin administration in their cohort that used immersion prior to five centimeters was three times the rate found in this study, perhaps reflective of the practices within the tertiary care centre in which the study was conducted. The increased need for augmentation in Cohort 1 may be due to increased worry, pain, need for support or other reasons that prompted these women to seek support earlier in the course of their labour than those admitted to the centres later. Because pain and anxiety were not measured, a relationship between these variables and use of oxytocin could not be determined.

The difference in oxytocin rates, 19% in Cohort 1 and 11% in Cohort 2, while statistically significant, may not be significant enough clinically to withhold water immersion in early labour. Trials on active management of labour (Cammu & Van
Eeckhout, 1996; Frigoletto, Lieberman, Lang, Cohen, Barss, Ringer & Datta, 1995; Lopez-Zeno et al., 1992) and early amniotomy (Fraser et al., 1993) have consistently reported rates greater than 40% in nulliparous women. In this study, the rate was much less, even for those who used immersion early. Thus, early immersion may increase the risk compared to late immersion but, in comparison to the 40% considered the standard rate, may provide some benefit for this group of women.

Higher rates of augmentation have been noted with a reclining position in labour. It is unknown if position had an effect on the progress of labour in this study as position in the tub was not recorded. However, in the whirlpool tub, the size of a conventional bath tub, in Birth Centre A, a modified left lateral position was possible, as were hands and knees, and squat positions. Birth Centre B had a large whirlpool tub that could accommodate any position. Because the women may not have consistently assumed a reclining position, it cannot be assumed that the increased need for oxytocin augmentation in Cohort 1 was due to the position in which they laboured.

In comparison with the other studies on water immersion, the cesarean section rate found in this study fell between the rates reported in the trials, lower than that reported by Rush et al. (1996) and Lendstrup et al. (1987) but higher than Schorn et al. (1993) and Cammu et al. (1994). The cesarean section rate was not statistically different in any of the studies on water immersion and, in the context of this study,
was not different between Cohorts 1 and 2, suggesting that water immersion may not affect cesarean section rates. It should be noted, however, that in all of these trials the rates of abdominal operative delivery were much lower than the national rates of approximately 20%. Water immersion may have had an effect by the increased attention that accompanies a novel therapy.

While there were significant differences between the cohorts in the rates of intrapartum transfer, use of pain-relieving medication, and oxytocin augmentation, there was no difference in the diagnosis of dystocia. The failure to detect a difference in this study may be due to the inadequate sample size. It is important to note that the women in Cohort 1 were admitted to the hospital at a much earlier stage of labour in terms of cervical dilatation. The reasons for early admittance were not recorded. However, it may be that these women were very anxious and having severe pain, perhaps an indication that their labour was already complicated.

Wuitchik et al. (1989) noted that the pain and anxiety experienced during in the latent phase of labour was most predictive of both length of labour and adverse outcomes. In Cohort 1, 27% of women used the tub when they were less than three centimeters dilated, which, by definition, indicates that they were in the latent phase. That these women were admitted so early in their labour may indicate that they were among the most anxious. However, there were no differences in the use of epidural analgesia, oxytocin, cesarean section, or dystocia between this group and those who
used immersion at three to five centimeters and at five centimeters or greater. This finding might indicate that the use of a non-pharmacological pain relieving therapy, such as water immersion, may decrease the woman’s anxiety and pain enough to avoid the prolonged labour and complications noted in the study by Wuitchik et al, (1989). It is also important to note that this therapy was accompanied by the presence of supportive nursing staff. It may be that it was the care provided by the staff alone, or along with the use of a warm bath that was responsible for the lack of difference seen in this early group.
CHAPTER 7

Summary

Water immersion is being used increasingly by labouring women. There is little empirical data to support its use as either a method of reducing pain or as a stimulant to labour. Several papers commenting on the use of water immersion have suggested withholding use of the tub until women have achieved five centimeters of cervical dilatation, assuming that early immersion will slow the progress of labour. This study was an examination of the use of water immersion by a group of nulliparous women labouring in two hospital birth centres to determine the outcomes and possible effects of using a warm tub bath before or after five centimeters of dilatation.

While it is generally accepted that the pain and anxiety that accompany labour have the potential to hinder the progress of labour, studies supporting this premise have not been conclusive. However, in accordance with this assumption, use of a therapy that may decrease pain and encourage relaxation should be accompanied by pain relief and progress in labour, as indicated by decreased use of analgesia and oxytocin augmentation.

In this study, the majority of women used the tub prior to achieving five centimeters of cervical dilatation. This group used significantly more analgesia and had higher rates of oxytocin stimulation. Although there were no differences in rate
of dystocia and, a common result of dystocia, cesarean section, the study lacked the power to detect a significant difference. There are a number of possible explanations for these findings. First, the use of analgesia may not be a good measure of pain relief provided by immersion. Pain relief may be provided by accessing the gate-control system, but this mechanism is known to habituate. Second, pain intensity is only one dimension of the pain experience. Each woman brings to the labour experience a wealth of values and past experiences which may influence the way she views childbirth and responds to pain. These other dimensions, perhaps not responsive to analgesia, may override the effect of immersion. Third, the women who used immersion early in the course of their labour, were admitted to the birth centre at a substantially earlier stage of cervical dilatation. These women may have been more anxious, in considerable pain, or had a labour that was already progressing slowly. Fourth, cervical dilatation is only one measure of the state of the labour. Other measures, not recorded in this study, such as the frequency and duration of the contractions, cervical effacement, and station of the vertex, may have provided a clearer understanding of the effect of early immersion. Fifth, the processes that initiate and sustain parturition are complex and not completely understood. There may be other factors, as yet unknown, that affect labour and are independent of pain, anxiety, or current efforts to control the process itself.

The finding that all of the outcomes favoured Cohort 2 underscores the need for
a randomized controlled trial. This study presents baseline data for such a trial.

Research Implications

This study was not designed, nor did it have the power, to make a clear statement on the use of water immersion, especially as it relates to the timing of immersion. While there was an increase in the number of medical interventions in Cohort 1, the results of this study do not provide support for withholding water immersion in early labour. Further research, in the form of a well designed, randomized controlled trial, would broaden the knowledge base concerning this increasingly popular form of therapy. The following outcomes should be included in such a trial: (a) pain scores; (b) anxiety scores; (c) other measures of labour progress, such as effacement, and frequency and duration of contractions; (d) physiological markers, such as blood levels of epinephrine, norepinephrine, endorphin and endogenous oxytocin; and (e) measures of maternal confidence, satisfaction and sense of control. Further research should question: (a) the efficacy of using whirlpool jets, (b) the effect of water temperature, (c) the effect of various positions in the tub, and (d) the influence of past experience, cultural values, and beliefs about childbirth.

The increased use of analgesia and oxytocin augmentation noted with early immersion may not be due to the use of the tub but, rather to the factors that motivated early admission. A study exploring the outcomes of those women who were both admitted early and who used immersion prior to five centimeters versus
those admitted early but did not use the tub might clarify a relationship between early immersion and the use of these medications.

As the use of water immersion in labour increases it is inevitable that birth into the water will occur. Media reports on water birth have increased attention on using water for birth. In reiteration of the recommendations of others (McCandlish, & Renfrew, 1993; Newton, 1992; Zimmermann et al., 1993), it is imperative that rigorous trials be conducted exploring the risks and benefits of birth into water.

Implications for Nursing

New therapies, both technological and alternative, are being introduced to obstetrics on an ongoing basis. Not all of these have been adequately assessed. Until further studies are conducted and a clear sense of the risks and benefits established, use of water immersion will call for judgement on the part of the nurse. Nurses therefore, need to be cognizant of the evidence around this form of therapy and the physiological mechanisms supporting its use. This knowledge is also important to be able to adequately counsel women on using the tub during labour.

Many women approach labour hoping to avoid the use of analgesia, not only because of the risks associated with their use, but also for personal reasons. Because these medications have significant risks, it is important to be able to offer women methods of managing pain that minimize these risks. As methods that access the gate-control mechanism habituate, it is important that a variety of non-
pharmacological pain relief techniques are available to the labouring woman. Water immersion is only one of these techniques. Nurses, as the "most present" caregivers during labour, are in a position to be able to offer women various forms relief, both pharmacological and non-pharmacological.

Concluding Statement

While trials (Cammu et al., 1994; Lenstrup et al., 1987; Rush et al., 1996; Schorn et al., 1993) have explored the use of a warm tub bath in labour, there is not, as yet, a clear picture of the effects of immersion in terms of its effects on pain and labour progress. A study (Eriksson et al. 1997) that examined the use of water immersion in a tertiary care centre found an increase in dystocia, as indicated by the use of oxytocin augmentation, in a group of women who used immersion prior to five centimeters of cervical dilatation. This study provided the investigator with an opportunity to examine the question of timing of immersion and its relationship the incidence of dystocia and other outcomes in a birth centre setting. Increased rates of both epidural anaesthesia and oxytocin augmentation were noted in the group of women who used a warm water bath early in labour. Further questions regarding the importance of the latent phase of labour have been raised. The results of this study suggest that additional, well designed, trials are needed both to guide the judgements of those who are already using water immersion in labour and before it can be recommended for full use.
References


Date:

Dear (Hospital "A"):

I am a Registered Nurse currently enrolled in the Master of Science program in the Department of Nursing at the University of Toronto. In partial fulfilment of the requirements of the program, I am planning a research project under the supervision of Dr. E. Hodnett, a professor in the Graduate Department. I would like to request permission to collect data at your hospital.

The purpose of the proposed study is to report on the use of water immersion in a sample of nulliparous women labouring at an in-hospital birth centre to help determine which is the best outcome for future study. The ultimate purpose is to provide base-line data for sample size determination for a prospective randomized controlled trial on the use of water immersion in labour.

I hope to collect data from two in-hospital birth centres. This will involve reviewing the medical records of approximately 359 women in your institution. No identifying information will be collected about the patient. To protect confidentiality, the medical record number will be assigned a code number and the master list of medical record and code numbers kept in a locked file for seven years. Your institution will be identified only as "Hospital 'A'" and no identifying information about the hospital will appear in any published reports.

A copy of the research protocol is enclosed. I am prepared to reimburse the hospital for any costs incurred and will plan to collect data at a mutually convenient time.

This study has been approved by a Human Subject Review Committee in the Office of Research Services at the University of Toronto. A report of the committee's comments is enclosed.

Thank you for your consideration of this matter.

Sincerely:

Merry Little  BScN, MSc (C)
Dear Hospital "B":

I am a Registered Nurse currently enrolled in the Master of Science program in the Department of Nursing at the University of Toronto. In partial fulfilment of the requirements of the program, I am planning a research project under the supervision of Dr. E. Hodnett, a professor in the Graduate Department. I would like to request permission to collect data at your hospital.

The purpose of the proposed study is to report on the use of water immersion in a sample of nulliparous women labouring at an in-hospital birth centre to help determine which is the best outcome for future study. The ultimate purpose is to provide base-line data for sample size determination for a prospective randomized controlled trial on the use of water immersion in labour.

I hope to collect data from two in-hospital birth centres. This will involve reviewing the medical records of approximately 163 women in your institution. No identifying information will be collected about the patient. To protect confidentiality, the medical record number will be assigned a code number and the master list of medical record and code numbers kept in a locked file for seven years. Your institution will be identified only as "Hospital 'A'" and no identifying information about the hospital will appear in any published reports.

A copy of the research protocol is enclosed. I am prepared to reimburse the hospital for any costs incurred and will plan to collect data at a mutually convenient time.

This study has been approved by a Human Subject Review Committee in the Office of Research Services at the University of Toronto. A report of the committee's comments is enclosed.

Thank you for your consideration of this matter.

Sincerely:

Merry Little  BScN, MSc (C)
Appendix C

Worksheet - Inclusion Criteria

Birth Centre ________

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<th>Year\Month</th>
<th>Gravida in BC</th>
<th>IP care in BC</th>
<th>Deliver to LD</th>
<th>Used WI</th>
<th>MRN</th>
<th>Examined within 0.5 hr</th>
<th>Code No.</th>
<th>Record No.</th>
<th>Date</th>
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Appendix D

Data Collection Sheet

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- dilation

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<td></td>
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