PREDICTIVE VALIDITY FOR NEONATAL READMISSION OF CANADIAN GUIDELINES FOR DISCHARGE AT LESS THAN 48 HOURS OF AGE

By ELISE C. WEISS

A thesis
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Department of Community Health Sciences
Faculty of Medicine
University of Manitoba
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ABSTRACT

OBJECTIVE: Few studies have examined the validity of Canadian guidelines for early discharge in predicting newborn readmission risk. This study examined both the relationship between newborn discharge status and the 1996 joint Canadian Pediatric Society (CPS) and Society of Obstetricians and Gynecologists of Canada (SOGC) Guidelines for discharge at 48 hours of age and the relationship between discharge decision and the risk of newborn readmission.

METHODS:

Design: A case-control study based on hospital chart reviews.

Setting: Brandon Regional Health Centre (BRHC), Brandon, Manitoba, from October 1, 1993 to September 30, 2001.

Study Population: Records of mother-infant dyads were obtained from the Brandon Regional Health Centre (BRHC) delivery database from October 1, 1993 to September 30, 2001. Newborns readmitted to BRHC within 28 days of life were eligible for the case group. Newborns not readmitted to BRHC within 28 days of life were eligible for the control group. Participants were excluded if: 1) multiple gestation, 2) caesarean birth, 3) intrapartum or postpartum complications requiring ongoing medical treatment or observation, 4) boarder babies, 5) social admission, 6) elective surgery for neonatal

circumcision. Three controls for each readmitted newborn were selected from the BRHC delivery database to be frequency matched by time period of delivery, Regional Health Authority residence and transfer status.

Data collection: Data was obtained from maternal and newborn hospital charts. Predictors of newborn readmission status were 13 CPS / SOGC discharge criteria and hyperbilirubinemia. Potential confounding variables included breastfeeding status at discharge, newborn length of stay, gender, parity, maternal age at delivery, gestational age, birth weight, time period of delivery and early discharge status.

Data analysis: Univariate analyses compared case and control groups on the distribution of explanatory variables. Multivariate logistic regression was used to identify the probability of readmission for each explanatory variable.

RESULTS: Newborns were less likely to be discharged early if they had an abnormal cardiorespiratory status {O.R. 0.11(0.10,0.95); p-value < 0.05}, feeding problems {O.R. 0.17(0.04,0.84); p-value < 0.05}, an abnormal discharge exam {O.R. 0.04(0.01,0.34); p-value < 0.01} including jaundice alone at discharge exam {O.R. 0.27(0.14,0.53); p-value < 0.001}. They were more likely to be discharged early if of greater gestational age {O.R. 1.34(1.12,1.60); p-value < 0.01}. Among the CPS / SOGC criteria, only hyperbilirubinemia and jaundice at discharge exam differed between cases and controls. Readmission was strongly associated with hyperbilirubinemia {adj. O.R. 7.46(1.32,42.05); p-value < 0.05} and jaundice at discharge exam

{adj. O.R. 4.23(2.00,8.94); p-value < 0.001}. This association was observed in the sub-group of infants discharged later than 48 hours following birth (hyperbilirubinemic infants {adj. O.R. 11.68(1.86,73.56); p-value < 0.01} and those with jaundice at discharge exam {adj. O.R. 4.04 (1.87,7.73); p-value < 0.001}) and in the subset of newborns born at 37 weeks or more {[hyperbilirubinemia: O.R. 11.06(1.09,111.84); p-value < 0.05]; [jaundice at discharge exam: O.R. 2.54(1.33,4.87); p-value < 0.01]}. Infants of greater gestational age were less likely to be readmitted {O.R. 0.81(0.70,0.94); p-value <0.01}. Circumcised males were at less risk of readmission than uncircumcised males {O.R. 0.34(0.12,0.97); p-value < 0.05}.

CONCLUSION: Newborns of lower gestational age, with an abnormal cardiorespiratory status, feeding problems, an abnormal discharge exam, including the presence of jaundice alone, were more likely to be kept longer in hospital than their counterparts. A lower gestational age, non-circumcision, hyperbilirubinemia and jaundice at discharge exam were the sole statistically significant predictors of readmission. Non-compliance to existing CPS / SOGC discharge guidelines did not increase the risk of readmission. The results support the need for a critical review of the effective utilization of the guideline discharge criteria and consideration of the inclusion of additional clinical markers of readmission risk.

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CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 THE PROBLEM

Cost-containment strategies have resulted in a continued trend toward shorter lengths of stay for all hospitalizations. As a part of this trend, early postpartum discharge has also become common. The potential effect of these strategies and trends on subsequent outcomes for neonates and their mothers has generated concern over the safety and effectiveness of this practice. Up to 10.9% of newborns require readmission (Norr & Nacion, 1987).

Although previous studies on early discharge provide little evidence to support these concerns, recent critical reviews by Grullon and Grimes (1997), Margolis (1995), and Braveman, Egerter, Pearl, Marchi and Miller (1995) highlight the methodological flaws and limited statistical power of these studies. Recent Canadian data indicate that a reduction in hospital stay after delivery from 4.5 to 2.7 days is associated with increased readmission to hospital, especially for hyperbilirubinemia and dehydration, after which at least two infant deaths occurred (Lee, Perlman, Ballantyne, Elliott & To, 1995). Establishing neonatal feeding could decrease the need for readmission of the baby, since inadequate breast milk intake is associated

with increased neonatal jaundice (Neifert, 1998). The importance of individualized assessment in preparation for early discharge is also emphasized (Bragg, Rosenn, Khoury, Miodovnik & Siddiqi, 1997; Britton, Britton & Beebe, 1994; Lane, Kauls, Ickovics, Naftolin & Feinstein, 1999).

The existence of risk factors for readmission and the importance of individualized assessment justify the need for the development and implementation of clinical practice guidelines for discharge incorporating these risk factors. In 1996, the Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada published criteria for discharge less than 48 hours after birth following the 1995 publication of the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists.

There are numerous publications documenting the success of clinical practice guidelines in reducing length of stay for specific adult conditions (Kong, Belman & Weingarten, 1997; Rich et al, 1996). However, a recent systematic review suggests that the implementation of guidelines does not necessarily lead to an improvement in clinical outcome (Worrall, Chaulk & Freake, 1998). Flores, Lee, Bauchner and Kastner (2000) encourage clinical testing of clinical practice guidelines and advocate for clinical practice guidelines that are not only outcome-based but outcome-justified. McDonagh, White, Singh and Mohide (2002) rated the 1996 CPS/SOGC joint policy statement for early discharge and length of stay for term birth poorly

with respect to rigour of development. Physicians may be reluctant to incorporate the recommendations of a guideline that are not sufficiently evidence-based or outcome-justified.

1.2 RATIONALE AND NEED

Further research is required to answer the question as to whether the CPS/SOGC clinical practice guidelines are outcome-justified. Establishing the predictive validity of the guideline discharge criteria may identify individuals most at risk for readmission who might require either a longer hospital stay or more intensive community follow-up. Identifying other risk factors may provide answers to the following question: What are appropriate eligibility criteria for early discharge?

1.3 SIGNIFICANCE

Clearly the issue of whether implementation of discharge guidelines reduces readmissions is a key concern for policy makers, hospital administrators, consumers and health care providers. Implementation of the CPS/SOGC clinical practice guidelines for discharge at less than 48 hours of age should correctly identify newborns most at risk for readmission and should enable appropriate discharge planning to occur. Prolonging the

infant's birth hospital stay or providing more intensive community follow-up should, in turn, reduce neonatal readmissions.

Evidence- based research on the validity of clinical practice guidelines in predicting the risk of readmission in defined classes of people is needed to inform policy on cost-containment strategies and clinical care both in hospital and in the community for the general population in the vulnerable neonatal period. The burden is to identify cases at risk of readmission, and either to prolong the infants' birth hospital stay appropriately or to provide earlier follow-up.

1.4 THE PURPOSE STATEMENT

The purpose of this case-control study is to establish the predictive validity of the criteria for discharge less than 48 hours after birth developed by the Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada by comparing compliance with the guideline discharge criteria in newborns readmitted within 28 days of life to the Brandon Regional Health Centre between 1993/4 and 2000/1 (cases) and those not readmitted (controls). Compliance to guideline discharge criteria measures agreement between guideline discharge criteria status and discharge status. A range of factors that may influence the decision to discharge mothers from the hospital and, therefore, the eventual health of her infant will be controlled

for.

CHAPTER 2: THEORETICAL FRAMEWORK, HYPOTHESIS AND OBJECTIVES

2.1 THEORETICAL FRAMEWORK

Compliance with the guideline discharge criteria will be compared between newborns readmitted within 28 days of life to the Brandon Regional Health Centre between 1993/4 and 2000/1 (cases) and those not readmitted (controls). **Compliance to guideline discharge criteria** measures agreement between guideline discharge criteria status and discharge status. Guideline discharge criteria status measures "readiness" or eligibility for discharge at 48 hours of age. The guideline discharge criterion is "**met**" when the guideline discharge criteria status is such that the newborn could be discharged early. The guideline discharge criterion is "**not met**" when the guideline discharge criteria status is such that the newborn could not be discharged early. Discharge status measures whether the newborn was actually discharged at less than 48 hours of age or not. **Early discharge** is defined as discharge from hospital at less than 48 hours from birth. Not early discharge is defined as any length of hospital stay 48 hours or more from birth.

Combination of these 2 dichotomous variables produces 4 possible

compliance outcome categories: 2 showing agreement (or compliance) between guideline discharge criteria status and discharge status (met/early discharge, not met/not early discharge) and 2 showing disagreement (or non-compliance) between guideline discharge criteria status and discharge status (met/not early discharge, not met/early discharge).

Compliance overall is achieved when there is agreement between all guideline discharge criteria status and discharge status. **Non-compliance overall** is achieved when 1 or more of the individual criteria show non-compliance.

Compliance is summarized as follows:

Compliance = agreement between guideline discharge criteria status and discharge status.

Compliant if:

- individual criterion met AND newborn discharged early.
- individual criterion not met AND newborn not discharged early.

Non-compliance = disagreement between guideline discharge criteria status and discharge status.

Non-compliant if:

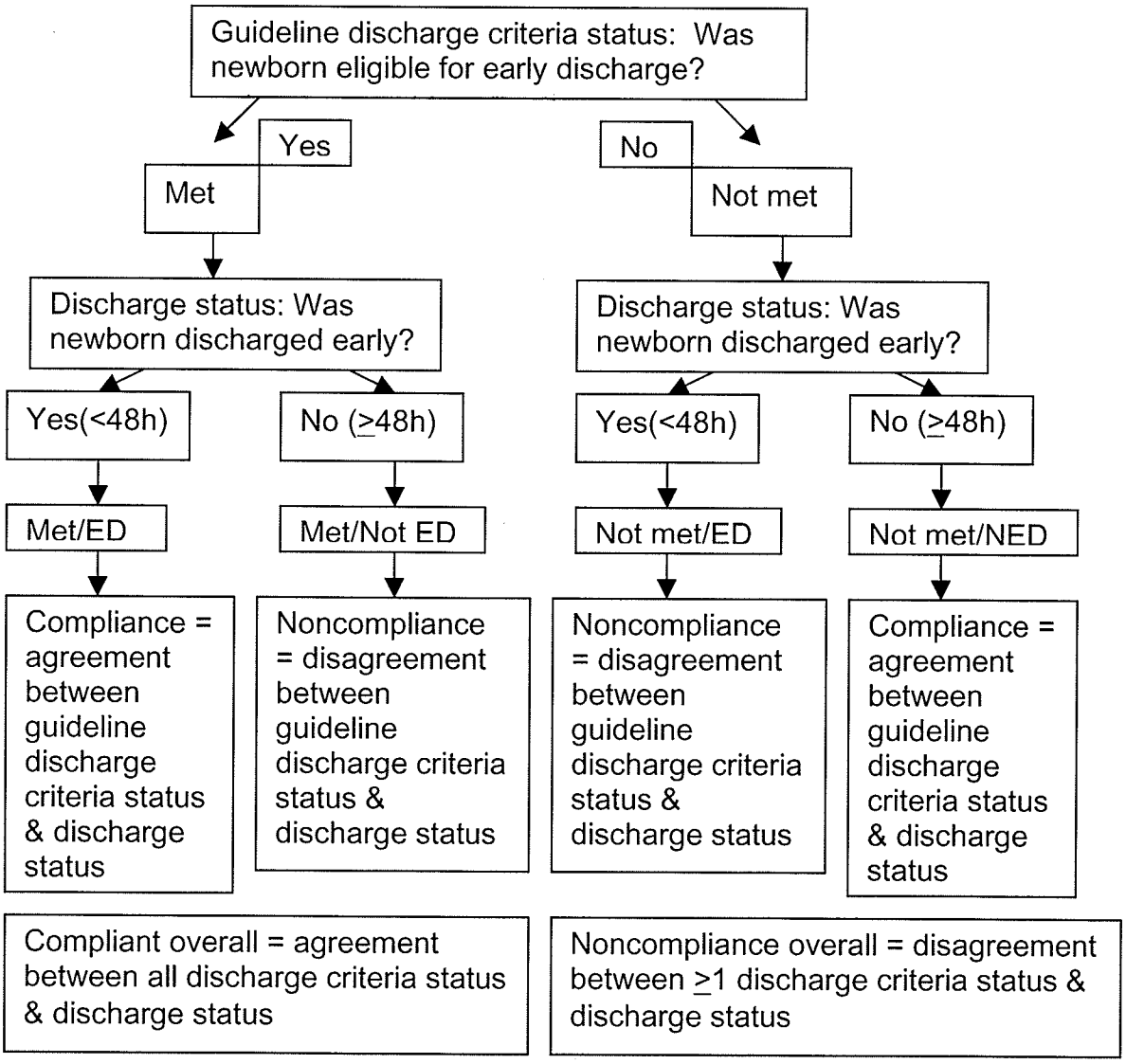
- individual criterion not met AND newborn discharged early.
- individual criterion met AND newborn not discharged early.

Overall compliance = agreement between all guideline discharge criteria status and discharge status.

Overall non-compliance = disagreement between ≥1 guideline discharge criteria status and discharge status.

Figure 1 represents the theoretical framework for the study.

Figure 1. Theoretical framework.



The following model is presented:

Dependent variable:	newborn readmission within 28 days of life
Independent variables:	compliance/non-compliance with 13 guideline discharge criteria, hyperbilirubinemia
Confounding variables:	parity, maternal age at delivery, gender, birth weight, gestational age, breastfeeding, newborn length of stay, date of delivery, early discharge

2.2 HYPOTHESIS

The effectiveness of the guidelines in predicting newborn readmission risk will be evaluated. The following null hypothesis is presented: non-compliance {disagreement between guideline discharge criteria status and discharge status} with guideline discharge criteria is not associated with newborn readmission.

2.3 OBJECTIVES

The objectives of the study are:

Objective 1. To examine the relationship between newborn discharge status and guideline discharge status.

Objective 2. To examine the relationship between discharge decision and risk of readmission

a) if non-compliant overall (unadjusted and adjusted)

b) if non-compliant with individual guideline discharge criteria (unadjusted and adjusted)

c) if guideline discharge criteria status such that the newborn is not eligible for discharge at 48 hours (unadjusted and adjusted).

Where overall non-compliance = disagreement between $\geq$1 guideline discharge criteria status and discharge status.

Where adjusted = controlling for the possible impacts of parity, maternal age at delivery, gender, birth weight, gestational age, breastfeeding, newborn length of stay, time period of delivery and early discharge.

CHAPTER 3. REVIEW OF THE LITERATURE

The literature review section will attempt to critique key issues and controversies regarding previous early postpartum discharge studies. Evidence suggesting that factors other than shorter neonatal stay may contribute to increased readmission rates will be examined. Publications documenting the success of clinical practice guidelines as well as their limitations will be reviewed. Deficiencies and limitations in the existing literature will define the purpose of the present study.

3.1 HISTORICAL FORCES DETERMINING LENGTH OF STAY

Childbirth in the hospital was uncommon prior to the 20th century (Annas, 1995). Promises of greater safety for mother and child, pain relief, convenience for physicians, scientific advances, and steady supply of patients for medical students, caused a shift of home deliveries to hospital settings from 5% in 1900, to 80% in 1945 and to essentially all hospital-planned births in the U.S. by 1960 (Parisi & Meyer, 1995).

Despite a marked decrease in the perinatal mortality rate, childbirth came to be treated as a disease process more than a natural event. Therefore, despite the safety and comfort of hospital-based deliveries, a shift

toward natural childbirth emerged in the 1960s and the 1970s. Coincident with the women's' movement, women wanted more control over the childbirth process, fathers wanted to be present in the delivery room and parents had a strong desire to leave sooner from the hospital to be home with their families. The early discharge programs of the 1970s were developed in response to such consumer demand. (Thilo, Townsend & Merenstein, 1998).

In the early 1980s, the cost of providing in-hospital postpartum care became a driving force behind shortened hospitalization. Hospitals began having a chronic shortage of maternity beds for standard obstetrical practice patterns allowing 7-10 day hospital stays. By the early 1990s, escalating health care costs and changing third-party reimbursement policies in the U.S. began to generate pressure on physicians and hospitals to discharge mothers and babies from the hospital as quickly as possible to save money. This push for "drive-through" deliveries occurred at a time when limited published research was available to evaluate the medical consequences of shorter mother and newborn stays for the general population (Thilo et al, 1998).

Thilo et al (1998) surveyed over 35 neonatologists and pediatricians from 22 countries and determined that the trend toward early newborn discharge is also occurring in many countries other than the U.S. The usual stay was 2-3 days for a vaginal delivery and 7 days for a caesarean delivery, with longer lengths of stay in countries other than the U.S., especially after caesarean section deliveries. Observational data from 1989-1997 confirm a

trend toward earlier hospital postpartum discharge in Canada from 4.0 days to 2.3 days for a vaginal delivery, and 6.7 to 4.5 days for a caesarean delivery (Health Canada. Canadian Perinatal Health Report, 2000). This trend is also observed in Manitoba where the age-adjusted average maternal length of stay (includes labor, delivery and postpartum) between 1994/95 to 1998/99 was 2.7 days for vaginal deliveries and 5.3 days for caesarean deliveries. Maternal length of stay in the Brandon Regional Health Authority was somewhat shorter than the provincial average at approximately 2.6 days for a vaginal delivery and 5.2 days for a caesarean delivery (Manitoba Centre for Health Policy and Evaluation. (Assessing the Health of Children in Manitoba, 2001).

3.2 ISSUES RELATED TO EARLY POSTPARTUM DISCHARGE AND NEWBORN READMISSION

Widespread concern that early discharge practice compromises the safety of both mother and the newborn began to appear as early as 1962. (Avery, Fournier, Jones & Sipovic, 1982; Carty & Bradley, 1990; Charles & Prystowsky, 1995; Hellman, 1962; Yanover, Jones & Miller, 1976). Most of the studies attempted to determine the most appropriate length of stay for newborns without affecting newborn morbidity. Follow-up care after discharge rather than timing of discharge seems to be a growing focus of more recent studies.

Critical reviews of the literature on early postpartum discharge have been done by Grullon and Grimes (1997), Margolis (1995), Braveman et al (1995), Britton et al (1994), Beck (1991), and Norr and Nacion (1987). Collectively, they reviewed published English literature from 1960 to January 1997. Britton et al (1994), Beck (1991) and Norr and Nacion (1987) reported readmission rates for infants ranging from 0 - 11% and concluded that discharge prior to 48 hours was not associated with an increase in maternal or infant rehospitalizations. Their reviews included multiple small centre studies that concluded that early discharge is safe with or without accompanying postpartum discharge programs. Early discharge of high-risk groups such as indigent populations (Cooper et al, 1996; Kotagal et al, 1997), very-low-birth-weight infants (Casiro et al, 1993), and post-caesarean (Strong, Brown, Brown & Curry, 1992) women was also found safe.

However, three recent critical reviews highlight the problems with the scientific literature available supporting early discharge. Braveman et al (1995) reviewed relevant English literature articles published from 1975 through 1994 and critiqued the study designs and the results of 25 papers. Margolis (1995) identified 10 quasi-experimental and 3 experimental studies from 1989 to 1993 through a MEDLINE computer search. Grullon and Grimes (1997) critically examined 5 randomized controlled trials, 10 cohort studies, one case-control report, and 12 case series identified through a MEDLINE search of English language journals from 1966-1997. All three

reviews concur that the studies have similar limitations: (1) With one exception, all reports are from hospitals with well-defined eligibility and follow-up protocols, potentially limiting applicability to the general population. (2) They all have important methodological flaws (lack of appropriate comparison groups, non-random assignment to groups, and variable definition of early discharge), or lack sufficient size and statistical power to assess rare events such as readmission or other morbidity. (3) Most fail to control for confounding factors that could influence hospital discharge timing and subsequent infant health or to address possible interactions. Grullon and Grimes (1997) further state that the current data do not support or condemn the widespread use of early postpartum discharge (Class "C" recommendation).

Since 1997, multiple studies have evaluated "safety" of early discharge by measuring readmission as well as utilization of other health services such as primary care provider visits (emergency room, urgent care, physician offices), home nursing visits, and even mortality data. Maternal satisfaction and breastfeeding continuation rates are other outcome measurements studied. Follow-up care provided for newborns is not always specified. By and large, those studies with follow-up conclude that early discharge is not associated with an increase in neonatal readmissions, death, health services utilization or breastfeeding discontinuation. Most studies that do report increased readmissions, death or outpatient department visits do not specify

whether follow-up care was provided. See Table 1 for a summary of literature reviewed.

Other studies since 1997 specifically evaluated early discharge of high risk groups such as indigent populations (Brumfield et al, 1996), post-caesarean deliveries (Brumfield, Sheffield, Hauth, DuBard & Shannon, 1998) and diabetic or hypertensive women (York et al, 1997) and found the practice safe.

Despite the limitations identified by Braveman et al (1995), Margolis (1995) and Grullon and Grimes (1997), most of the studies conducted since 1997 were also limited in power by small sample size and by limited generalizability.

Two recent population-based studies by Lee et al (1995) and Liu, Clemens, Shay, Davis and Novack (1997) provide convincing evidence not only of an increase in readmission rate during the first weeks of life associated with shorter lengths of stay but also of increased morbidity in cases of hyperbilirubinemia and dehydration. A third population-based study by Edmonson, Stoddard and Owens (1997) identifies risk factors for readmissions due to jaundice, dehydration and sepsis.

Liu et al (1997), in a large, well-designed study published in July 1997, performed a population-based, case-control study using Washington State birth certificate and hospital discharge abstracts from 1991-1994 to assess the risk for newborn rehospitalization within 30 days of life after early

Table 1. Summary of literature review on safety of early postpartum discharge. Medline search 1997-2002.

Author/Year	Study Design	Outcome criteria	Results	Limitations
Safe with community follow-up				
Bragg et al 1997	Retrospective study- fu vs no fu	Rehospitalization	No significant differences in readmission	Small sample size; Limited generalizability
Escobar et al 2001	Randomized controlled trial; Intervention=home visits; Control=hospital-based fu	Health services utilization; Breastfeeding continuation	No significant differences in readmission	Limited generalizability
Gagnon et al 1997	Randomized controlled trial; Montreal	Health services; Hyperbilirubinemia	No significant differences	Small sample size; Limited power
Gagnon et al 2002	Randomized controlled trial; Montreal	Breastfeeding continuation Weight gain	No significant differences	Unblinded; Generalizability
Lieu et al 2000	Randomized controlled trial; Comparison of fu care at discharge <48 hours	Rehospitalization; Urgent clinic visits; Breastfeeding continuation	No significant differences in readmission	Limited power; Not generalizable
Madden et al 2002	Retrospective before and after cohort study	Health services	No significant differences in health services utilization	Limited power; Not generalizable
Mandl et al 1997	Prospective cohort study	Health services	NS readmissions; Increase in ER visits in ED group	Limited generalizability; Small sample size
Mandl et al 2000	Retrospective quasi-experimental study	Health services	No increase in primary care use	Small sample size; Limited generalizability
Meickle et al 1998	Inception cohort study	Rehospitalizations; Outpatient department use	No significant differences in readmission	Small sample size

Table 1. Summary of literature review on safety of early postpartum discharge. Medline search 1997-2002.

Author/Year	Study Design	Outcome criteria	Results	Limitations
Not safe with community follow-up				
Danielson et al 2000	Retrospective cohort study	Readmission	Increased readmission in very early group	Selection bias; FU not recorded
Grupp-Phelan et al 1999	Case-control population based	Readmission	Increased readmission for jaundice in ED group	LOS not in hours; Small sample size
Lane et al 1999	Observational cohort study	Health services	NS readmission; Increased office visits and breastfeeding discontinuation in ED group	Generalizability; FU not recorded
Lock et al 1999	Retrospective before and after cohort study	Readmission	Increased readmission for jaundice in ED group	LOS in days; Readmission to other hospitals included
Millar et al 2000	Retrospective chart review; London, Ontario	Readmission; Health services	Increased emergency room use in early discharge group; NS readmission	Generalizability; FU not recorded

discharge at less than 30 hours of age. The case patients were 2029 newborns rehospitalized in the first month of life, and the control subjects were 8657 randomly selected newborns not rehospitalized and matched to case patients by the year of birth. The overall newborn rehospitalization rate in their study was low (2%). The authors found that although only 17% of newborns in Washington State were discharged early during the study time period, newborns discharged early were more likely to be rehospitalized within 7, 14 and 28 days of discharge than were newborns who were sent home later (O.R.=1.28 @ 7 days, O.R.=1.16 @ 14 days and O.R.=1.12 @ 28 days). Early discharge was also associated with an increased risk of readmission for jaundice, dehydration and sepsis. The follow-up care provided for the early discharge newborns was not specified in this study.

Using comparable methods and data sources as Liu et al (1997), Edmonson et al reported in July 1997 on a study involving a Wisconsin population. The cases were 210 newborns readmitted with feeding-related diagnoses by day 28 of life and the controls were 630 randomly selected newborns not readmitted and matched to case patients. Although odds ratios for readmission were comparable to, but of somewhat lower magnitude than those observed by Liu, they had much wider confidence intervals. Therefore, although they concluded that early discharge following an uncomplicated postpartum hospital stay had little or no effect on the risk of neonatal readmission for feeding-related problems, certain risk factors emerged.

Readmitted newborns were more likely to have been breastfed, firstborn, preterm, or have poorly educated, unmarried mothers. The study lacked the statistical power to detect a significant difference of the magnitude observed.

The third population-based study by Lee et al in 1995 in Ontario demonstrates that a reduction in hospital stay after delivery from 4.5 to 2.7 days is associated with increased readmission to hospital during the first two weeks of life, especially for hyperbilirubinemia and dehydration. An increase in the severity of illness was indicated by higher serum bilirubin and sodium concentrations. Two deaths for hypernatremic dehydration during the study period prompted a coroner's inquest in Ontario. The jury supported the 1996 recommendations of the Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada, particularly the need for follow-up in the home.

Edmonson et al (1997), Lee et al (1995) and Liu et al (1997) provide the most convincing evidence not only of an increased risk for neonatal readmission with shorter lengths of stay, but also of an increase in adverse outcomes such as hyperbilirubinemia and dehydration. Considerable evidence is also presented to suggest that factors other than shorter neonatal stay, such as breastfeeding, being firstborn and preterm, should be considered as possible causes of increased readmission rates. Few studies have been so large or have so skilfully addressed limitations in dealing with potential confounding.

3.3 EFFECTS OF EARLY DISCHARGE ON JAUNDICE

Jaundice is the most common newborn problem, requiring readmission to the hospital in most early discharge studies (Brown et al, 1999; Catz, Hanson, Simpson & Yaffe, 1995; Grupp-Phelan, Taylor, Liu & Davis, 1999; Lee & Perlman, 1996; Lock & Ray, 1999).

At the Hospital for Sick Children, Toronto, Lee et al (1995) found that between 1987 and 1994, as hospital length of stay decreased from 4.5 to 2.7 days, readmission for jaundice increased from 3.3 to 9.3 per 1000 live births. A similar pattern was found by Liu et al (2000) in their analysis of CIHI newborn readmission data from 1989-1997. Provinces with higher neonatal readmission rates tended to have shorter average lengths of stay. The most common reason for neonatal readmission was jaundice.

The severity of the illness of infants readmitted with jaundice may be increased. Lee et al (1995) found that the number of infants readmitted with bilirubin levels greater than or equal to 510 umol/L was increased significantly during the seven years. In 1995, Maisels and Newman showed that although rare, severe jaundice and kernicterus could occur in full-term, health newborns with no apparent hemolysis or any other discernible cause for jaundice other than breastfeeding. Maisels and Kring reached similar conclusions in 1998. Although kernicterus had virtually disappeared, MacDonald (1995) showed a worrisome rise in the incident of kernicterus in infants with glucose-6-dehydrogenase deficiency. All four of the infants with

kernicterus were breastfed.

The detection of jaundice may be difficult with early discharge because jaundice may not become clinically evident until the 3rd day of life. Seidman, Stevenson, Ergaz and Gale, in a 1995 study assessing the incidence of severe hyperbilirubinemia in term, healthy newborns, showed that 3-4 of every 1000 healthy full term newborns with no more than mild hyperbilirubinemia on the 3rd day of life may subsequently develop moderate hyperbilirubinemia {defined as serum bilirubin levels > 18 mg/dl (306 umol/L)}. Maisels and Kring (1998) and Soskolne, Schumacher, Fyock, Young and Schork (1996) found that gestation no more than 38 weeks, jaundice in the nursery and a newborn length of stay less than 72 hours were important factors associated with the risk of readmission for jaundice. Maisels and Newman (1998) suggest that "discharge at any time less than 72 hours significantly increases the risk for readmission with hyperbilirubinemia when compared with discharge after 72 hours" (p.299).

There has been an increase in hyperbilirubinemia in the newborn population and perhaps an increase in bilirubin encephalopathy. The physician needs to evaluate and follow-up infants with risk factors for the development of severe hyperbilirubinemia, especially the breastfed, near-term infant.

3.4 EFFECT OF EARLY DISCHARGE ON OTHER MEDICAL CONDITIONS

Other newborn diagnoses during the first 2 weeks of age reported to have trends for increasing readmission rates include hypernatremic dehydration (Cooper, Atherton, Kahana & Kotagal, 1995; Lee et al, 1995), congenital anomalies of the heart and lower gastrointestinal tract (Lee et al, 1995) and infections (Conrad, Wilkening & Rosenberg, 1989). Newborn metabolic screening programs face added challenges as the timing of sampling is critical for the reliability of the newborn screen in detecting a genetic metabolic disorder.

Although the readmission rate for dehydration was low, the rate increased eightfold from 0.07 to 0.58 per 1000 healthy newborn infants between 1987 and 1994 in the cohort study by Lee et al (1995). These dehydrated infants had evidence of increased severity of illness as indicated by higher serum sodium concentrations. Two infants discharged within 48 hours of age were readmitted to a hospital in Toronto in 1993 and 1994 due to hypernatremic dehydration. Cooper et al (1995) reported a case series of five infants discharged within 48 hours in the Cincinnati area in 1994 who were readmitted with severe breastfeeding malnutrition and hypernatremia.

A growing body of evidence suggests that the trend toward earlier discharge may affect newborn morbidity because detection of significant

illness may be either missed or delayed outside of the hospital (Kessel, Keily, Nora & Sumaya, 1995; Perlman, 1996). For many infants, early discharge may precede completion of the transition to extra uterine life. Kessel and Ward (1998) outline specific observations at birth that are particularly important in identifying congenital malformations. As these observations are included in the discharge criteria recommended by the Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada, adherence to them should help to avoid missing diagnoses.

In a review of the impact of early discharge programs on the risk of neonatal infections such as early-onset neonatal bacterial sepsis and neonatal herpes virus infection, Radetsky (1998) concludes that early discharge should not place suitable newborns at risk of treatable infections as long as national criteria are followed.

McCabe (as cited in Brown, 1995) stated that screening performed 12 hours would miss 30% of infants with PKU, and screening between 12 and 24 hours of age would miss 10%. McCabe (as cited in Brown, 1995) concluded that the optimal time for the newborn screen is between 48 to 72 hours of age. To avoid this unacceptably high risk of false negative screening test results in infants discharged by 24 hours of age, the American Academy of Pediatrics (1994) recommends a second test at 1 to 2 weeks (as cited in Brown, 1995). Awareness by pediatricians of the need to perform repeated PKU screens is poor as demonstrated by a survey in 1995 by Sinai, Kim,

Casey and Pinto-Martin.

3.5 IDENTIFICATION OF RISK FACTORS FOR NEWBORN READMISSION

Although many questions remain after reviewing the literature, it can be stated that there exists "an element of risk in early discharge". (American Academy of Pediatrics, 1980, as cited in Brown, 1995).

Considerable discussion in the medical literature has focused on factors that might render a mother and newborn at potentially increased risk for adverse outcomes if discharged early. Considerable evidence exists to suggest that factors other than shorter neonatal stay should be considered as possible causes of increased readmission rates.

A 1993-4 Manitoba study (Manitoba Centre for Health Policy and Evaluation, Monitoring the Winnipeg System, 1996) as well as one by Meickle et al (1998) suggest that mothers with recognized potential and observed problems are rarely discharged early, as are newborns. Meickle et al (1998) further conclude that the healthiest mothers and infants are those with the shortest initial hospital stays.

These studies, as well as one by Britton et al (1994), emphasize the importance of individualized assessment in preparation for potential early discharge in order to identify the factors that can lead to poor outcomes.

3.6 CLINICAL PRACTICE GUIDELINES

Identification of risk factors for neonatal readmission other than shorter length of neonatal stay and suggestion of the possibility that high risk women and newborns are being correctly screened prior to discharge and kept in longer, advocates for the need for discharge criteria incorporating these risk factors.

The first guidelines related to the discharge of newborns can be traced back to the 1943 first edition of the American Academy of Pediatrics Committee on the Fetus and Newborn but there is little mention of timing of discharge. The early guidelines included the importance of instruction in newborn care, feeding, bathing, evaluation of the home environment and the need for follow-up post discharge (American Academy of Pediatrics, as cited in Thilo et al, 1998).

The American Academy of Pediatrics 6th edition in 1977 contains the first reference to the timing of discharge which states that "mature infants usually are discharged at 72 to 96 hours of life, although they may go home earlier if they are stable." (American Academy of Pediatrics, as cited in Thilo et al, 1998, p.259).

In 1980, criteria for early discharge after a minimum stay of 6 hours were developed. The importance of an uncomplicated course for mother and term infant, maternal demonstration of basic newborn skills, availability of a support person to assist in the home, and a physician-directed source of

follow-up care with an appointment in 2 to 3 days was emphasized (Thilo et al, 1998).

In 1983, the American College of Obstetricians and Gynecologists joined the American Academy of Pediatrics in producing the 1st joint statement, with the most current statement published in 1996. The statement included minimal criteria for newborn discharge as well as the recommendation that at least 48 hours were needed to fulfill the criteria (Thilo et al, 1998).

The Canadian Pediatrics Society and the Society of Obstetricians and Gynecologists of Canada also published discharge criteria in 1996 and recommended that 12 to 48 hours of hospital stay is adequate for women and their newborns if maternal or neonatal illness is absent or if social supports are present.

There are numerous publications documenting the success of clinical practice guidelines in reducing length of stay for specific adult conditions (Kong et al, 1997; Rich et al, 1995). However, a recent systematic review by Worral et al (1997) suggests that the implementation of guidelines does not necessarily lead to an improvement in clinical outcome. Flores et al (2000) also believe that usefulness of most clinical practice guidelines has not been convincingly demonstrated and question whether use of guidelines based on extensive scientific evidence actually improves patient care. Flores et al (2000) encourage clinical testing of clinical practice guidelines and advocate

for clinical practice guidelines that are not only outcome-based but outcome-justified. McDonagh, White, Singh and Mohide (2002) questioned the methodological quality of obstetrical clinical practice guidelines, including the 1996 CPS/SOGC joint policy statement for early discharge and length of stay for term birth. They rated the guidelines fairly well with respect to "context and content" and to "application" but poorly with respect to "rigour of development". These deficits might undermine the ability of the guidelines to impact clinical practice since physicians may be reluctant to incorporate the recommendations of guidelines that are not sufficiently evidence-based or outcome-justified.

Although APP/ACOG official guidelines constitute the best current statement of the prevailing perinatal standards of care, the extent to which physician practice conforms to them remains unknown. Variations in compliance for several pediatric guidelines have been described. Flores et al (2000) and Christakis and Rivara (1998) have documented poor knowledge of and compliance with guideline recommendations. Current postpartum early discharge and follow-up practices appear to be influenced by physicians' perceptions of the appropriateness of the length of stay and are not in agreement with professional guidelines. The majority (60%) of Canadian and American obstetricians and American pediatricians surveyed did not adhere to guidelines as set by the AAP/ACOG (Britton, 1998; Britton, Baker, Spino & Bernstein, 2002; Maisels & Kring, 1997).

3.7 SUMMARY OF THE LITERATURE

While the findings from this review of early discharge literature are not consistent with the conclusion that early discharge is "safe", neither do they reveal the optimal length of postpartum stay for well newborns and mothers. In the absence of definitive data on the optimum length of stay, the burden is to identify cases at risk of readmission and either to prolong the infant's' birth hospital stay appropriately or to provide earlier follow-up.

In the words of Margolis (1995, p.633),

> "the goal of future research should not be to establish the correct duration of hospitalization, but rather to determine the most effective way to assure that the medical encounter at birth for mother and infants meets sound and agreed on health, education, and social objectives".

In light of the reality of shorter neonatal stay, it is expected that the physician and health care workers responsible for the discharge of the apparently normal neonate evaluate more carefully the functional and physical status of the mother and infant. The guidelines published by the CPS and the SOGC can serve as the basis for such objectives.

The criteria developed by the Canadian Pediatric Society have not been validated. Compliance to the guidelines is less than ideal. Clinical testing of clinical practice guidelines is important because, even for guidelines based on extensive scientific evidence, use in actual practice may not improve patient care. Outcome-justified research is required to answer the question as to whether failure to follow the criteria for discharge less than 48

hours after birth will increase neonatal readmissions. Establishing the predictive validity of the criteria may provide the justification required to assist clinicians in identifying individuals most at risk for readmission who might require either a longer hospital stay or more intensive community follow-up.

The present study will attempt to establish the predictive validity of the criteria for discharge less than 48 hours after birth developed by the Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada by comparing compliance with the guideline discharge criteria in newborns readmitted within 28 days of life to the Brandon Regional Health Centre between 1993/4 and 2000/1 (cases) and those not readmitted (controls). Compliance to guideline discharge criteria measures agreement between guideline discharge criteria status and discharge status. A range of factors that may influence the decision to discharge mothers from the hospital and, therefore, the eventual health of her infant will be controlled for.

CHAPTER 4: METHODS

4.1 STUDY DESIGN

A frequency matched, case-control study was conducted based on hospital chart reviews.

The case-control method of investigation is often the research strategy of choice when initiating an exploratory study of disease etiology or investigating a rare disease. The purpose of an exploratory case-control study is to collect data concerning the distribution of potentially important characteristics among cases and controls in the hope that etiologic clues worthy of further study may emerge. The case-control method is especially useful for the study of rare diseases as it is inefficient to devote virtually all of the effort to follow-up individuals who remain free of the study disease. The speed with which the case-control study can be accomplished, its smaller required sample size, the ability to use existing records and to allow the study of multiple potential causes of a disease, make it an obvious choice for the proposed study.

As the newborn readmission rate for the Brandon Regional Health Authority from 1994-1998 was 2.3% (Manitoba Perinatal Health Surveillance Report 1989-1998), 3 controls for every case were selected in order to

increase the statistical power of the study.

4.2 LIMITATIONS IN STUDY DESIGN

The case-control method is susceptible to many sources of bias. The establishment of the case and the control groups can be biased through improper ascertainment, diagnosis, or selection of subjects. Error in correctly determining past exposure can derive from improper records, faulty recall, or improper interviewing techniques.

4.2.1 *Errors in misclassification of disease*

Surveillance bias could occur among high-risk groups who tend to receive more frequent medical or community follow-up.

Diagnoses based on physical exam or laboratory findings may be subject to diagnosis bias. Observed variations in readmission rates may be due to physician-specific differences in diagnosis and treatment of hyperbilirubinemia. A separate analysis stratified on the basis of readmitting physician could be conducted to detect the possibility of diagnosis bias. If results were essentially unchanged, the effect of this bias would be negligible.

Differential referral patterns are another source of potential bias in hospital-based case-control studies. As BRHC is a regional referral centre, a case-control study based on cases deriving from this hospital might

overestimate the relative risk. To reduce the potential for this bias, only infants both delivered and readmitted from within the catchment area were to be included (however, this requirement was waived in order to achieve an adequate sample size).

4.2.2 *Errors in misclassification of exposure*

Studies based solely on medical records are more likely to encounter recall bias, since the recording of information tends to be selective rather than comprehensive in routine medical care.

Interviewer bias may occur if the interviewer tends to probe the case group more intensively for histories of exposure than they do the comparison group. Use of a standardized data collection form was used to minimize interviewer bias.

4.2.3 *Power limitations*

Because birth is such a common event, there is considerable public health significance of a 20%, 10%, or even a 5% increased risk of serious adverse events when it affects the entire maternal-newborn population. Case and control groups contained 104 and 312 infants respectively. This sample size was sufficient to detect a relative risk of 2.0 for infant readmissions (alpha=0.05, 2-sided, beta=0.20, p=0.60). Largest and smallest detectable

risk for a sample size of 100 and a probability of exposure of 0.50 are 2.23 and 0.45. A p=0.60 is based on a 1998 survey by Britton of Canadian and American Obstetricians and Gynecologists. Overall, 60% of those surveyed did not adhere to AAP/ACOG criteria when discharging their patients. Therefore 60% of controls in the target population are "exposed" to a contra-indication for discharge.

4.3 SETTING OF THE STUDY

Manitoba has a population of 1.12 Million (2001 Census) and approximately 14,170 live births annually (Statistics Canada 2000-2001).

Brandon, Manitoba is an agro-industrial university community with a population of 42,000 situated in the Canadian Prairies. Brandon Regional Health Centre, with a catchment area of 100,000, is a secondary referral centre with a Level II nursery and more than 1300 deliveries annually.

Manitoba is divided into geographical areas called Regional Health Authorities. As a regional referral centre, Brandon Regional Health Centre provides care to 4 regional health authorities. Obstetrical services are provided to most residents within the Brandon and Assiniboine Regional Health Authorities as only two communities within these 2 health authorities provided obstetrical care during the study period. High-risk obstetrical care is provided on a regular basis to the other 2 regional health authorities on a

referral basis. Similarly, most pediatric patients are admitted to Brandon Regional Health Centre.

For the purpose of this study, the references to RHA of residence will mean the Brandon or Assiniboine Regional Health Authorities.

4.4 POPULATION AND STUDY PERIOD

The Brandon Regional Health Centre (BRHC) was a convenience site providing a sample frame. The hospital admission list served as the actual frame for the selection of both cases and controls. All newborns delivered at and discharged or transferred from BRHC between October 1, 1993 and September 30, 2001 were eligible. Cases were drawn from all eligible newborns readmitted to BRHC within 28 days of birth. Three controls for each case were selected from the BRHC delivery database and frequency matched by time period of delivery, mother's RHA of residence, and transfer status from BRHC to another hospital. Maternal charts of all eligible cases and controls were also analyzed.

Exclusion criteria essentially consisted of the maternal criteria for discharge less than 48 hours after birth. In this way mothers of both cases and controls were equally eligible for consideration of early discharge and for the discharge criteria to be applied to them at less than 48 hours. Time of discharge was neither an exclusion nor an inclusion criterion.

Maternal Exclusion Criteria:

Mothers with intrapartum or postpartum complications that required ongoing medical treatment or observation were excluded. ICD-9CM maternal exclusion codes and criteria are listed in Table 2.

Table 2. Maternal exclusion codes and criteria.

ICD-9CM Maternal Exclusion Codes	Maternal Exclusion Criteria
659.3	Complications of the administration of anesthetic or other sedation in labor and delivery
670	Major puerperal infection
673	Obstetrical pulmonary embolism
674	Other and unspecified complications of the puerperium, not elsewhere classified

The original study proposal also included the following additional exclusion criteria:

- Newborn transfers to and from hospitals other than BRHC
- Non-Brandon RHA residency

However, in order to obtain the desired number of cases, these 2 latter criteria were removed during the data collection portion of the study. Because the purpose of the study was to identify risk factors for readmission and because the study did not exclude newborns admitted to the BRHC neonatal intensive care unit, it was decided that newborns transferred from BRHC could be included in the study. Limitations created by the removal of the non-Brandon RHA residency criterion will be reviewed in the Discussion section.

As all newborns readmitted to BRHC within 28 days of life also were delivered at BRHC, it is felt that this limitation is minimal.

Newborn Exclusion Criteria:

Newborns were excluded if they were multiples, born by caesarean delivery or readmitted as boarder babies, for social reasons or for neonatal circumcision. Newborn ICD-9CM exclusion codes and criteria are listed in Table 3.

Table 3. Newborn exclusion codes and criteria.

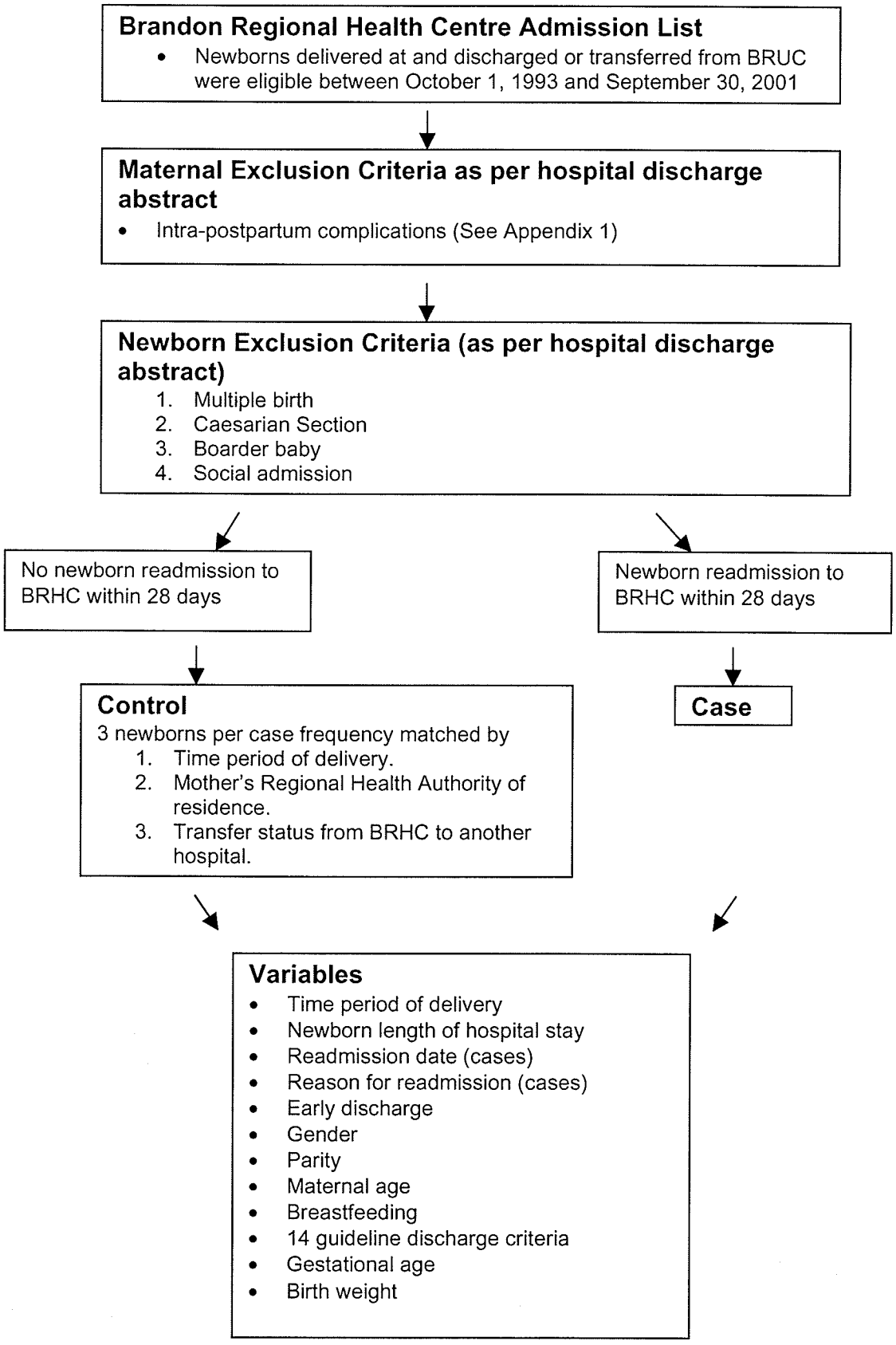
ICD-9CM Newborn Exclusion Codes	**Newborn Exclusion Criteria**
651	Multiple gestation
V30.01	Caesarean delivery
V20	Health supervision of infant or child
V650	Social reasons
V50.2	Readmission for neonatal circumcision

The BRHC sample frame and inclusion and exclusion criteria were available manually from a BRHC Medical Records database from October 1, 1993 to April 1, 1997 and electronically thereafter. BRHC Medical Records personnel provided the writer with eligible hospital charts for data collection.

Figure 2 illustrates the sampling process. Case and control groups contained 104 and 312 infants respectively.

Ethics approval from the University of Manitoba Human Research Ethics Board was received on November 26, 2001 and annual re-approval on

Figure 2. Flow diagram for sample selection



October 10, 2002. Approval from the Brandon Regional Health Authority was granted after HREB approval.

4.5 DATA COLLECTION

A retrospective hospital chart review was conducted solely by the writer. Information was collected from hospital separation abstracts, provincial postpartum referral forms and nursing records in eligible newborn and maternal charts.

Data was entered directly onto a MS Excel 2000 spreadsheet using a standardized data collection form.

See Appendix 2 for the Data Collection Instructions.

4.6 DEFINITION OF MEASURES

The **dependent variable** or primary outcome is newborn readmission. A *newborn index admission* is defined as the stay due to the birth of the individual. A *readmission* is defined as an admission to Brandon Regional Health Centre within 28 days after birth. Only the first readmission was included in the analysis if there was more than one during the 28-day period. The primary readmission diagnosis was obtained from the International Classification of Diseases, 9th revision, Clinical Modification codes assigned at discharge. The age of the newborn at readmission was also collected.

The **independent variables** include the CPS/SOGC guideline discharge criteria for discharge less than 48 hours after birth as well as compliance to the guideline discharge criteria.

The **guideline discharge criteria** are defined as follows:

- Term infant (AGA: 37-42 weeks and 2.7-4.05 kg / not / missing).
- Normal cardiorespiratory adaptation to extra uterine life (No need for intubation or assisted ventilation after 24 hours of age and heart rate 110-150/minute and respiratory rate 30-60/minute / not / missing).
- No evidence of sepsis (No use of antibiotics after 24 hours of age / Antibiotic use after 24 hours of age / missing).
- Temperature stable in cot (36.1° C to 37°C / not / missing).
- No apparent feeding problems (At least 2 successful feedings documented / not / missing).
- Normal physical examination by physician within 12 hours before discharge (No need for additional observation and/or therapy in hospital / Additional observation and/or therapy in hospital needed / missing).
- Baby has urinated (At least 1 voiding / not / missing).
- No bleeding after circumcision if performed (No bleeding at least 2 hours after circumcision / Bleeding / missing).
- Receipt of necessary medication and immunization (Received / not / missing).

- Metabolic screen completed or satisfactory arrangements made (Completed at >24 hours of age or request to complete indicated on postpartum referral form / Not completed or unsatisfactory arrangement / missing).
- Mother is able to provide routine infant care and recognizes signs of illness and other infant problems (Capable / not / missing).
- Follow-up arrangements are made for the baby to be evaluated within 48 hours of discharge (Referral made to Brandon RHA postpartum discharge program / not / missing).
- Physician responsible for continuing care is identified (Identified / not / missing).

An additional discharge criteria was created and is defined as follows:

- No hyperbilirubinemia (Serum bilirubin <170 umol/L at 0-24 hours of age and/or <260 umol/L at 25-48 hours of age / not / missing).

Compliance to guideline discharge criteria is summarized as follows:

Compliance = agreement between guideline discharge criteria status and discharge status.

Compliant if:

- individual criterion met AND newborn discharged early.
- individual criterion not met AND newborn not discharged early.

Non-compliance = disagreement between guideline discharge criteria status and discharge status.

Non-compliant if:

- individual criterion not met AND newborn discharged early.
- individual criterion met AND newborn not discharged early.

Overall compliance = agreement between all guideline discharge criteria status and discharge status.

Overall non-compliance = disagreement between $\geq$1 guideline discharge criteria status and discharge status.

The **mediating variables** or potential confounders influencing neonatal readmission are defined as follows:

- Infant gender (Male / Female).
- Parity after index birth (Primiparous / Multiparous).
- Maternal age at delivery in years.
- Newborn length of hospital stay in hours / missing.
- Time period of birth (I = October 1, 1993 - May 31, 1996 / II = June 1, 1996 - January 31, 1999, III = February 1, 1999 - September 30, 2001).
- Gestational age in weeks.
- Birth weight in grams.
- Breastfed (Exclusively breastfed or any combination of breast and bottle / exclusively bottle-fed).

- Discharged early (Newborn length of hospital stay less than 48 hours / Newborn length of hospital stay $\geq$ 48 hours / missing).

4.7 DATA ANALYSIS

Data was imported from a MS Excel 2000 spreadsheet into SPSS 11.0.

Variables were initially analyzed in terms of skewness and kurtosis. The only variable that showed extreme skewness was newborn length of stay. Newborn length of stay was skewed to the right and required a log transformation.

Descriptive statistics were used to compare case and control groups as to confounding variables. Frequency counts and percentages, means and standard deviations or medians for skewed distributions, were calculated for continuous variables. Descriptive statistics were also used to characterize the case group. Mean, standard deviation and range was used to describe the newborn's age at readmission. The primary diagnosis of the readmission was categorized into groups according to the International Classification of Diseases codes (9th revision, clinical modification) by major category groups. The categories accounting for the largest proportion of readmissions were further examined to identify whether readmissions were more common at 7, 14 or 28 days of life. Logistic regression analyses were performed to

compare diagnostic groups and were reported as odds ratios, p-values and 95% confidence intervals. P-values were considered statistically significant at < 0.05. Logistic regression analyses were also conducted to identify the probability of readmission for each mediating and independent variable. These results were reported as crude and adjusted odds ratios with p-values and 95% confidence intervals. P-values were considered statistically significant at <0.05 for logistic regression analyses.

CHAPTER 5: RESULTS

5.1 SAMPLE CHARACTERISTICS

Of the 334 readmissions within 31 days to BRHC during the study period, 201 newborns (60%) were readmitted to the hospital within the first 28 days of life. All 201 newborns were also delivered at BRHC. Among those 201 mother-newborn pairs, 56 (28%) were excluded as caesarean births, 3 (1%) as multiple births, and 9 (4%) for maternal intrapartum complications. An additional 29 (14%) were excluded as they were boarder babies. None were readmitted for elective surgery such as circumcision. Using a similar exclusion process, 312 control infants were identified. There were no neonatal deaths amongst the case or control groups.

The resulting sample of 416 included 104 newborns in the case group and 312 newborns in the control group.

Amongst the 104 case newborns, the mean age at readmission was 12.69 days, with a standard deviation of 8.06. Ages at readmission ranged from 2 to 28 days.

Table 4 reports newborn readmissions by primary diagnosis. Among the 104 readmissions, 38 (36.5%) were readmitted with jaundice, 25 (24.0%)

with respiratory problems, and 22 (21.1%) with feeding problems. The remaining 19 (18.2%) readmissions were combined to form an "Other" group.

Table 4. Primary diagnosis of 104 newborns readmitted by age 28 days.

Primary diagnosis at readmission	**Newborns readmitted N = 104**
	%, N with primary diagnosis
Jaundice	36.5% (38/104)
Respiratory problems	24.0% (25/104)
Feeding problems	21.2% (22/104)
Other	18.3% (19/104)

Of the 38 newborns admitted with jaundice, 1 case was related to hemolytic disease and 1 was classified as having kernicterus. The remainder were diagnosed as having physiologic jaundice. The 25 newborns with respiratory problems were mostly readmitted with lower respiratory tract conditions such as bronchiolitis, bronchitis, pneumonia and meconium aspiration (13). Eight were readmitted with viral upper respiratory infections and the remaining 4 had apneic / cyanotic / choking spells. Of the 22 newborns admitted with feeding problems, 2 also had failure to thrive, 2 were dehydrated, 1 was vomiting and 1 was colicky. The "Other" group included 7 (6.8%) with congenital anomalies (6 - pyloric stenosis, 1 - tracheomalacia), 6 (5.8%) with urinary tract infections, 2 each with sepsis and injuries (1.9% each), and 1 each with conjunctivitis and seizures (0.9%).

Table 5 shows the proportion of newborns within each of the 4 specific diagnostic categories. Of the 38 infants readmitted with jaundice, 29 (76.3%) were readmitted within the first 7 days of life and only 9 (23.7%) in the next 21 days. These differences were statistically significant (p-value < 0.001). Sixteen (64.0%) of all infants readmitted with respiratory problems were readmitted within days 15 - 28 of life as compared to 9 (36.0%) within the first 2 weeks. These differences were also statistically significant (p-value = 0.004). Readmissions for the remaining 2 groups were evenly distributed throughout the 28-day period.

Table 5. Probability of readmission for primary diagnosis by age at readmission (days). [+]Logistic regression. P-value significant at <0.05. *p-value < 0.01**p-value < 0.001.

Primary diagnosis at readmission	**Age at readmission** **Proportion, N readmitted for primary diagnosis by age of readmission.**		
	Day 0-7 **N = 37**	**Day 8-14** **N = 27**	**Day 15-28** **N = 40**
Jaundice Proportion, N Crude O.R. (95%C.I.)	0.76 (29/38) 23.36 (8.16,66.86)**	0.18 (7/38) reference	0.05 (2/38) reference
Respiratory problems Proportion, N Crude O.R. (95%C.I.)	0.08 (2/25) reference	0.28(7/25) reference	0.64 (16/25) 4.07 (1.58,10.50)*
Feeding problems Proportion, N Crude O.R. (95%C.I.)	0.18 (4/22)	0.36 (8/22)	0.46 (10/22)
Other Proportion, N Crude O.R. (95%C.I.)	0.11 (2/19)	0.26 (5/19)	0.63 (12/19)

Comparisons were then done of the entire sample of 416. Case and control groups were examined to determine the proportion of newborns in each guideline discharge criteria status and discharge status category for each of the 14-guideline discharge criteria (including hyperbilirubinemia). Table 6 illustrates the number and percentage of newborns that had no criteria that contra-indicated early discharge. Taking the guideline discharge criteria "term" as an example, there were 411 newborns for which information was available. Of those 411, 327 newborns met the "term" criterion and were eligible for early discharge (79.6%). The guideline discharge criteria were met approximately 97% of the time (range 94.6-100.0) for the majority of the newborns with the exception of 2 criteria. The criterion for "discussed Public Health Nurse referral" was met in only 53.2% of newborns. As previously noted, only 79.6% of newborns met the criteria for term.

Table 6 also illustrates the proportion of newborns discharged early whose guideline discharge criteria status was such that they could be discharged early (met guideline). Similarly, the proportion of newborns not discharged early whose guideline discharge criteria status was such that they could not be discharged early (did not meet guideline) is also shown. There were approximately an equal proportion of newborns meeting the guideline discharge criteria status that were discharged early as newborns not discharged early. Because none of the circumcised males bled after circumcision, this criterion provides the proportion of circumcised males

discharged early. There was, however, a greater proportion of newborns not meeting the guideline discharge criteria status who were not discharged early as newborns discharged early, most significantly those with unmet criteria for cardiorespiratory status, sepsis, temperature, discharge exam and hyperbilirubinemia (92 - 100%).

Table 6. Number and percentage of newborns compliant with guideline discharge criteria (agreement between discharge status and guideline discharge criteria status). BRHC 1993-2001.

Guideline discharge criteria	**Number with information**	**Compliance*: agreement of discharge status* with guidelines**	
		Met guideline*. %, N discharged early	**Did not meet guideline*. %, N not discharged early**
Term	411	49.2% (161/327)	47.6% (40/84)
Normal CR+ status	410	51.3% (204/398)	91.7% (11/12)
No sepsis	410	50.5% (205/406)	100.0% (4/4)
Temperature stable	410	50.1% (205/409)	100.0% (1/1)
No feeding problem	410	51.8% (203/392)	88.9% (16/18)
Normal discharge exam	402	52.7% (197/374)	96.4% (27/28)
Urinated	410	50.2% (205/408)	0% (0/0)
No bleeding after circumcision	205 Males 64 circumcised	29.7% (19/64)	0% (0/0)
Received meds & immunizations	410	49.8% (202/406)	25.0% (1/4)
Metabolic screening done or arranged	411	50.0% (194/388)	52.2% (12/23)
Mother capable	407	50.6% (203/401)	83.3% (5/6)
Discussed PHN+ referral	410	50.5% (110/218)	50.5% (97/192)
MD+ identified	410	50.0% (194/388)	50.0% (11/22)
No hyperbilirubinemia	410	50.9% (205/403)	100.0% (7/7)
No jaundice at discharge exam	402	53.4% (183/343)	74.6% (44/59)

Table 7 reports the agreement between guideline discharge criteria status and discharge status. Overall compliance to the eligibility criteria for a 48 hour discharge was achieved in 215 out of 410 newborns {(83+132)/410} = 52.4%). Reasons for non-compliance included 122/195 (62.6%) newborns having been discharged early despite having at least 1 unmet criterion, and 73/195 (37.4%) of newborns not being discharged early despite having all criteria met. Reasons for compliance included 132/215 (61.4%) newborns not being discharged early and having at least 1 unmet criterion, and 83/215 (38.6%) having been discharged early with all of their criteria met.

5.2 EVIDENCE FOUND THAT SUPPORTS OR FAILS TO SUPPORT EACH OF THE RESEARCH OBJECTIVES

Guideline discharge criteria and compliance to guideline discharge criteria variables were entered into a logistic regression model in order to determine predictors for readmission before and after adjusting for confounding variables.

5.2.1 Objective 1: Relationship between discharge status and guideline discharge criteria status (crude and adjusted).

The relationship between newborn discharge status and guideline discharge status was examined in order to determine whether any guideline

Table 7. Percentage and number of readmitted newborns (cases) per guideline discharge criteria status and discharge status category. BRHC 1993-2001.

Discharge criteria	**Number with information**	**Guideline discharge criteria status & discharge status*** ED^ N=250; NED^ N=250			
		Met guideline* & discharged early	**Met guideline* & not discharged early**	**Did not meet guideline* & discharged early**	**Did not meet guideline* & not discharged early**
		%, N readmitted	**%, N readmitted**	**%, N readmitted**	**%, N readmitted**
Overall compliance°	99 Cases 311 Controls	26.5% (22/83)	21.9% (16/73)	23.8% (29/122)	24.2% (32/132)
Term	99 Cases 312 Controls	24.2% (39/161)	22.9% (38/166)	27.3% (12/44)	25.0% (10/40)
Normal CR^{+} status	99 Cases 311 Controls	25.0% (51/204)	22.7% (44/194)	0% (0/1)	36.4% (4/11)
No sepsis	99 Cases 311 Controls	24.9% (51/205)	23.9% (48/201)	0% (0/0)	0% (0/4)
Temperature stable	99 Cases 311 Controls	24.9% (51/205)	23.0% (47/204)	0% (0/0)	100% (1/1)
No feeding problem	99 Cases 311 Controls	24.6% (50/203)	24.3% (46/189)	50.0% (1/2)	12.5% (2/16)
Normal discharge exam	97 Cases 305 Controls	24.9% (49/197)	23.2% (41/177)	0% (0/1)	25.9% (7/27)
Urinated	99 Cases 311 Controls	24.9% (51/205)	23.2% (47/203)	0% (0/0)	50.0% (1/2)
No bleeding after circumcision	64 circumcised males 7 Cases 57 Controls	10.5% (2/19)	11.1% (5/45)	0% (0/0)	0% (0/0)
Received meds and immunizations	99 Cases 311 Controls	24.8% (50/202)	23.5% (48/204)	33.3% (1/3)	0% (0/1)
Metabolic screening done or arranged	99 Cases 312 Controls	47.5% (49/194)	23.7% (46/194)	18.2% (2/11)	16.7% (2/12)
Mother capable	99 Cases 308 Controls	25.1% (51/203)	23.2% (46/198)	0% (0/1)	40.0% (2/5)
Discussed referral with PHN^{+}	99 Cases 311 Controls	25.5% (28/110)	23.1% (25/108)	24.2% (23/95)	23.7% (23/97)
MD^{+} identified	99 Cases 311 Controls	24.7% (48/194)	23.7% (46/194)	27.3% (3/11)	18.2% (2/11)
No hyperbilirubinemia	99 Cases 311 Controls	24.9% (51/205)	21.7% (43/198)	0% (0/0)	71.4% (5/7)
No jaundice at discharge exam	97 Cases 305 Controls	39.4% (44/183)	34.5% (27/160)	33.3% (5/15)	47.7% (21/44)

discharge criteria were associated with early discharge itself. (Table 8 - data reported only for significant findings).

The risk of early discharge was significantly reduced when cardiorespiratory status was abnormal {O.R. 0.09(0.01,0.68); p-value = 0.02}, when feeding problems were identified {O.R. 0.12(0.03,0.51); p-value = 0.004} and when the discharge exam was abnormal {O.R. 0.03(0.01,0.25); p-value = 0.001}, including the presence of jaundice alone {O.R. 0.30(0.16,0.56); p-value < 0.001}. Even after adjusting for confounding variables, these findings remained statistically significant. Newborns were still less likely to be discharged early if they had an abnormal cardiorespiratory status {O.R. 0.11(0.01,0.95); p-value = 0.04}, feeding problems {O.R. 0.17(0.04,0.84); p-value = 0.03}, an abnormal discharge exam {O.R. 0.04(0.01,0.34); p-value = 0.003} including jaundice alone at discharge exam {O.R. 0.27(0.14,0.53); p-value < 0.000}. Analyses for sepsis and hyperbilirubinemia were not possible because of empty cells. None of the other criteria were found to be associated with early discharge. Table 8 also shows a greater likelihood of early discharge the greater the gestational age {O.R. 1.34(1.12,1.60); p-value 0.001} even after adjusting for other confounding variables.

Table 8. Probability of early discharge if selected guideline discharge criteria not met*. Crude and Adjusted (for confounding variables-excluding newborn length of stay) Odds Ratio = Odds of early discharge if criteria not met versus odds of not being discharged early if criteria not met (with 95%ile confidence intervals). Logistic regression. P-value significant at <0.05.

Table 8 Guideline discharge criteria	**Number with information**	**Guideline discharge criteria status**		**Probability of early discharge if did not meet guideline***	
		Discharged early & did not meet guideline* / Discharged early & did meet guideline* Proportion, N	**Not discharged early & did not meet guideline* / Not discharged early & did meet guideline* Proportion, N**	**Crude O.R. (95% C.I.) P-value**	**Adj. O.R. (95% C.I.) P-value**
Normal CR^{+} status	410 ED N=205 Non-ED N=205	0.005(1/205//204/205)	0.06(11/205//194/205)	0.09(0.01,0.68) 0.02	0.11(0.01,0.95) 0.04
No sepsis	410 ED N=205 Non-ED N=205	0(0/205//205/205)	0.02(4/205//201/205)	–	–
No feeding problem	410 ED N=205 Non-ED N=205	0.01(2/205//203/205)	0.09(16/205//189/205)	0.12(0.03,0.51) 0.004	0.17(0.04,0.84) 0.03
Normal discharge exam	402 ED N=198 Non-ED N=204	0.005(1/198//197/198)	0.15(27/204//177/204)	0.03(0.01,0.25) 0.001	0.04(0.01,0.34) 0.003
No hyperbilirubinemia	410 ED N=205 Non-ED N=205	0(0/205//205/205)	0.04(7/205//198/205)	–	–
No jaundice at discharge exam	402 ED N=198 Non-ED N=204	0.08(15/198//183/198)	0.28(44/204//160/204)	0.30(0.16,0.56) 0.000	0.27(0.14,0.53) 0.000

Table 8 Guideline discharge criteria	Number with information	Guideline discharge criteria status		Probability of early discharge if did not meet guideline*	
		Discharged early & did not meet guideline* / Discharged early & did meet guideline* Proportion, N	Not discharged early & did not meet guideline* / Not discharged early & did meet guideline* Proportion, N	Crude O.R. (95% C.I.) P-value	Adj. O.R. (95% C.I.) P-value
Gestational age, wk	410 ED N=205 Non-ED N=205			1.29(0.16,0.56) 0.001	1.34(1.12,1.60) 0.001

*Met (not met) guideline = guideline discharge criteria status such that newborn could (not) be discharged early.
+CR=cardiorespiratory; PHN=public health nurse; MD=physician.

statistically significant. Newborns were still less likely to be discharged early if they had an abnormal cardiorespiratory status {O.R. 0.11(0.01,0.95); p-value = 0.04}, feeding problems {O.R. 0.17(0.04,0.84); p-value = 0.03}, an abnormal discharge exam {O.R. 0.04(0.01,0.34); p-value = 0.003} including jaundice alone at discharge exam {O.R. 0.27(0.14,0.53); p-value < 0.000}. Analyses for sepsis and hyperbilirubinemia were not possible because of empty cells. None of the other criteria were found to be associated with early discharge. Gestational age was also identified in the initial analysis as a risk factor for readmission therefore a sub-analysis was conducted to identify whether it was also associated with early discharge. Table 8 shows a greater likelihood of early discharge the greater the gestational age {O.R. 1.34(1.12,1.60); p-value 0.001} even after adjusting for other confounding variables.

5.2.2 Objective 2: Relationship between discharge decision and risk of readmission (crude and adjusted).

Risk of readmission if non-compliant overall (crude and adjusted).

Whether measured as a dichotomous variable (Table 9) or as a continuous variable (Table 11 - see later), case and control groups did not differ with respect to overall compliance {agreement between eligibility for discharge (met guideline discharge criteria) and actual discharge status

Table 9. Probability of readmission by compliance* category. Crude and Adjusted (for confounding variables excluding early discharge & newborn length of stay) O.R. = Odds Ratio = Odds of readmission by compliance category versus odds of readmission by compliance category met guideline & not discharged early (with 95% Confidence Intervals). Logistic regression. P-value significant at <0.05.

Table 9 Guideline discharge criteria	**Number with information** Case/Control	**Proportion of cases/controls per compliance* category**				**Probability of readmission if guideline discharge criteria not met***
		Met guideline* & discharged early Proportion,N Case/Control	**Met guideline* & not discharged early Proportion,N Case/Control**	**Did not meet guideline* & discharged early Proportion,N Case/Control**	**Did not meet guideline* & not discharged early Proportion,N Case/Control**	
Overall compliance	410 (99/311)	0.36(22/61) 1.29 (0.61,2.69) 1.52 (0.70,3.27)	0.28(16/57)	0.31(29/93) 1.11 (0.56,2.22) 1.03 (0.49,2.17)	0.32(32/100) 1.14 (0.58,2.26) 0.99 (0.49,2.01)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Term	411 (99/312)	0.32(39/122) 1.08 (0.65,1.80) 1.22 (0.71,2.10)	0.30(38/128)	0.38(12/32) 1.26 (0.59,2.69) 0.96 (0.41,2.29)	0.33(10/30) 1.12 (0.50,2.50) 0.72 (0.30,1.76)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Normal CR^{+} status	410 (99/311)	0.33(51/153) 1.14 (0.72,1.80) 1.25 (0.76,2.07)	0.29(44/150)	0(0/1) _ _ _ _	0.57(4/7) 1.95 (0.55,6.96) 1.45 (0.37,5.72)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**

Table 9 Guideline discharge criteria	Number with information Case/Control	Proportion of cases/controls per compliance* category				Probability of readmission if guideline discharge criteria not met*
		Met guideline* & discharged early Proportion,N Case/Control	Met guideline* & not discharged early Proportion,N Case/Control	Did not meet guideline* & discharged early Proportion,N Case/Control	Did not meet guideline* & not discharged early Proportion,N Case/Control	
No sepsis	410 (99/311)	0.33(51/154) 1.06 (0.67,1.66) 1.20 (0.73,1.97)	0.31(48/153)	0(0/0) _ _ _ _	0(0/4) _ _ _ _	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Temperature stable	410 (99/311)	0.33(51/154) 1.11 (0.70,1.74) 1.24 (0.75,2.05)	0.30(47/157)	0(0/0) _ _ _ _	0(1/0) _ _ _ _	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
No feeding problem	416 (104/312)	0.33(50/153) 1.02 (0.64,1.61) 1.14 (0.69,1.88)	0.32(46/143)	1(1/1) 3.11 (0.19,50.70) 2.06 (0.12,35.28)	0.14(2/14) 0.45 (0.10,2.03) 0.23 (0.04,1.22)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Normal discharge exam	402 (97/305)	0.33(49/148) 1.10 (0.68,1.77) 1.16 (0.70,1.94)	0.30(41/136)	0(0/1) _ _ _ _	0.35(7/20) 1.16 (0.50,2.94) 0.67 (0.22,2.05)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**

Table 9 Guideline discharge criteria	**Number with information** Case/Control	**Proportion of cases/controls per compliance* category**				**Probability of readmission if guideline discharge criteria not met***
		Met guideline* & discharged early Proportion,N Case/Control	**Met guideline* & not discharged early** Proportion,N Case/Control	**Did not meet guideline* & discharged early** Proportion,N Case/Control	**Did not meet guideline* & not discharged early** Proportion,N Case/Control	
Urinated	410 (99/311)	0.33(51/154) 1.10 (0.70,1.73) 1.24 (0.75,2.04)	0.30(47/156)	0(0/0) _ _ _ _	1(1/1) 3.32 (0.20,54.90) 4.99 (0.28,90.33)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
No bleeding after circumcision	64 Circumcised Males (7/57)	0.12(2/17) 0.94 (0.17,5.34) 0.99 (0.17,5.76)	0.13(5/40)	0(0/0) _ _ _ _	0(0/0) _ _ _ _	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Received meds and immunizations	410 (99/311)	0.33(50/152) 1.07 (0.68,1.69) 1.12 (0.74,1.99)	0.31(48/156)	0.50(1/2) 1.63 (0.14,18.31) 2.33 (0.19,29.06)	0(0/1) _ _ _ _	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Metabolic screening done or arranged	411 (99/312)	0.34(49/145) 1.09 (0.68,1.73) 1.21 (0.73,2.02)	0.31(46/148)	0.22(2/9) 0.72 (0.15,3.43) 0.84 (0.17,4.17)	0.20(2/10) 0.64 (0.14,3.04) 0.60 (0.13,2.89)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**

Table 9 Guideline discharge criteria	Number with information Case/Control	Proportion of cases/controls per compliance* category				Probability of readmission if guideline discharge criteria not met*
		Met guideline* & discharged early Proportion,N Case/Control	Met guideline* & not discharged early Proportion,N Case/Control	Did not meet guideline* & discharged early Proportion,N Case/Control	Did not meet guideline* & not discharged early Proportion,N Case/Control	
Mother capable	410 (99/311)	0.33(51/153) 1.08 (0.68,1.69) 1.21 (0.73,1.98)	0.31(48/155)	0(0/1) – – – –	0(0/2) – – – –	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Discussed PHN+ referral	410 (99/311)	0.34(28/82) 1.13 (0.61,2.11) 1.37 (0.71,2.64)	0.30(25/83)	0.32(23/72) 1.06 (0.56,2.03) 1.06 (0.53,2.11)	0.31(23/74) 1.03 (0.54,1.97) 0.99 (0.51,1.93)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
MD+ identified	410 (99/311)	0.33(48/146) 1.06 (0.67,1.68) 1.18 (0.71,1.95)	0.31(46/148)	0.38(3/8) 1.21 (0.31,4.74) 1.29 (0.31,5.31)	0.22(2/9) 0.72 (0.15,3.43) 0.54 (0.11,2.79)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
No hyperbili-rubinemia	410 (99/311)	0.33(51/154) 1.19 (0.75,1.90) 1.32 (0.80,2.19)	0.28(43/155)	0(0/0) – – – –	2.5(5/2) 9.01 (1.69,48.08)^ 7.46 (1.32,42.05)^	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**

Table 9 Guideline discharge criteria	Number with information Case/Control	Proportion of cases/controls per compliance* category				Probability of readmission if guideline discharge criteria not met*
		Met guideline* & discharged early Proportion,N Case/Control	Met guideline* & not discharged early Proportion,N Case/Control	Did not meet guideline* & discharged early Proportion,N Case/Control	Did not meet guideline* & not discharged early Proportion,N Case/Control	
No jaundice at discharge exam	402 (97/305)	0.32(44/139) 1.56 (0.91,2.66) 1.74 (0.97,3.11)	0.20(27/133)	0.50(5/10) 2.46 (0.78,7.78) 3.04 (0.92,10.04)	0.91(21/23) 4.45 (2.19,9.26)^^ 4.23 (2.00,8.94)^^	**Crude O.R. (95% C.I.)** **Adj. O.R. (95% C.I.)**

*Compliance = agreement between guideline discharge criteria status and discharge status.
*Overall compliance = agreement between all guideline discharge criteria status and discharge status.
*Met (not met) guideline = guideline discharge criteria status such that newborn could (not) be discharged early.
+CR=cardiorespiratory; PHN=public health nurse; MD=physician.
P-values all non-significant except ^p-value significant at < 0.05; ^^p-value significant at < 0.001.

(discharged early or not)}. No threshold was identified above which a certain number of unmet criteria were a predictor of readmission. Compliance overall remained non-significant even after adjusting for confounding variables (Table 9).

Risk of readmission if non-compliant with individual guideline discharge criteria (crude and adjusted).

Cases and controls were then compared to identify agreement between eligibility for discharge (met guideline discharge criteria) and actual discharge status (discharged early or not). Meeting the guideline and not being discharged early was the compliance category chosen as the reference group for logistic regression analysis as this group was intuitively thought to be at least risk for readmission. See Table 9. Case and control groups did not differ with respect to compliance to guideline discharge criteria with the exception of hyperbilirubinemia. Newborns who were hyperbilirubinemic and who were not discharged early were at a greater risk of readmission than newborns who were not hyperbilirubinemic and who were not discharged early {crude O.R. 9.01(1.69,48.08); p-value < 0.05} {adjusted O.R. 7.46(1.32,42.05); p-value < 0.05}. The confounding variables "early discharge" and "newborn length of stay" were removed as confounders as "early discharge" is a determinant of the 4 compliance categories. (See

Secondary analyses section for reporting of "no jaundice at discharge exam" findings.)

Risk of readmission if guideline discharge criteria is such that the newborn is not eligible for discharge at 48 hours (crude and adjusted).

Table 10 presents the results of the analysis of the probability of readmission if criteria for discharge at 48 hours after birth are "unmet". Cases and controls were compared to identify eligibility for discharge at 48 hours of age. There was an increased probability of readmission in hyperbilirubinemic newborns (crude O.R. 7.83(1.50,40.98); p-value = 0.015). These differences persisted even after adjusting for all confounders (O.R. 8.44(1.48,48.21); p-value = 0.017). There was no difference in the probability of readmission when comparing infants discharged with "unmet" criteria compared to those discharged with "met" criteria for any other variables. (See Secondary analyses section for reporting of "no jaundice at discharge exam" findings)

Case and control groups were then compared with respect to the 9 confounding variables. Characteristics of all 104 infants readmitted within 28 days of life compared with the 312 controls are summarized in Table 11. The two groups had similar characteristics with the exception of gestational age. Infants in the case group had a lower gestational age than control infants {38.99 $\pm$ 1.36 weeks versus 39.45 $\pm$ 1.45 weeks; O.R. 0.81 (0.70,0.94); p-value = 0.005}. Gestational age for the cases ranged from 35 - 41 weeks

Table 10. Probability of readmission if guideline discharge criteria not met*. Crude and Adjusted (for confounding variables) Odds Ratio = Odds of not meeting guideline discharge criteria among cases versus odds of not meeting guideline discharge criteria among controls (with 95% Confidence Intervals). Logistic regression. P-value significant at <0.05.

Table 10 Guideline discharge criteria	**Number with information**	**Guideline discharge criteria status**		**Probability of readmission if guideline discharge criteria not met**	
		Cases who did not meet guideline* / Cases who did meet guideline* Proportion, N	**Controls who did not meet guideline* / Controls who did meet guideline* Proportion, N**	**Crude O.R (95% C.I.) P-value**	**Adj. O.R. (95% C.I.) P-value**
Term	416 Case N=104 Control N=312	0.27(22/104//82/104)	0.25(62/312//250/312)	1.08 (0.63,1.87) N.S.	0.83 (0.43,1.58) N.S.
Normal CR^{+} status	416 Case N=104 Control N=312	0.06(6/104//98104)	0.03(8/312//304/312)	2.33 (0.79,6.87) N.S.	1.76 (0.45,6.83) N.S.
No sepsis	416 Case N=104 Control N=312	0(0/104//104/104)	0.01(4/312//308/312)	0.006 (0,∞) N.S.	0.005 (0,∞) N.S.
Temperature stable	416 Case N=104 Control N=312	0.01(1/104//103/104)	0(0/312//312/312)	545 (0,∞) N.S.	1409 (0,∞) N.S.
No feeding problem	416 Case N=104 Control N=312	0.06(6/104//98/104)	0.05(15/312//297/312)	1.21 (0.46,3.21) N.S.	0.43 (0.10,1.83) N.S.
Normal discharge exam	408 Case N=102 Control N=306	0.11(10/102//92/102)	0.07(21/306//285/306)	1.48 (0.67,3.25) N.S.	0.92 (0.28,3.03) N.S.

Table 10 Guideline discharge criteria	Number with information	Guideline discharge criteria status		Probability of readmission if guideline discharge criteria not met	
		Cases who did not meet guideline* / Cases who did meet guideline* Proportion, N	Controls who did not meet guideline* / Controls who did meet guideline* Proportion, N	Crude O.R (95% C.I.) P-value	Adj. O.R. (95% C.I.) P-value
Urinated	416 Case N=104 Control N=312	0.01(1/104//103/104)	0.003(1/312//311/312)	3.02 (0.19,48.71) N.S.	4.8 (0.27,88.19) N.S.
No bleeding after circumcision	64 Circumcised Males Case N=7 Control N=57	0(0/7//7/7)	0(0/57//57/57)	–	–
Received meds and immunizations	414 Case N=102 Control N=312	0.01(1/102//101/102)	0.01(3/312//309/312)	1.02 (0.11,9.91) N.S.	1.12 (0.11,11.81) N.S.
Metabolic screening done or arranged	414 Case N=102 Control N=312	0.06(6/102//96/102)	0.07(19/312//293/312)	0.96 (0.37,2.48) N.S.	0.61 (0.20,1.91) N.S.
Mother capable	411 Case N=102 Control N=309	0.02(2/102//100/102)	0.01(4/309//305/309)	1.52 (0.28,8.45) N.S.	1.93 (0.32,11.63) N.S.
Discussed PHN^{+} referral	414 Case N=102 Control N=312	0.92%(49/102//53/102)	0.89(147/312//165/312)	1.04 (0.66,1.62) N.S.	0.85 (0.53,1.37) N.S.
MD^{+} identified	414 Case N=102 Control N=312	0.05(5/102//97/102)	0.06(18/312//294/312)	0.84 (0.30,2.33) N.S.	0.81 (0.28,2.33) N.S.
No hyperbilirubinemia	416 Case N=104 Control N=312	0.05(5/104//99/104)	0.007(2/312//310/312)	7.83 (1.50,40.98) 0.015	8.44 (1.48,48.21) 0.017

Table 10 Guideline discharge criteria	Number with information	Guideline discharge criteria status		Probability of readmission if guideline discharge criteria not met	
		Cases who did not meet guideline* / Cases who did meet guideline* Proportion, N	Controls who did not meet guideline* / Controls who did meet guideline* Proportion, N	Crude O.R (95% C.I.) P-value	Adj. O.R. (95% C.I.) P-value
No jaundice at discharge exam	408 Case N=102 Control N=306	0.36(27/102//75/102)	0.12(33/306//273/306)	2.98 (1.69,5.26) 0.000	3.30 (1.77,6.15) 0.000

*Met (not met) guideline = guideline discharge criteria status such that newborn could (not) be discharged early.
+CR=cardiorespiratory; PHN=public health nurse; MD=physician.

Table 11. Summary of characteristics for 416 maternal and newborn pairs comparing newborns who were readmitted within the first 28 days of life (cases) and newborns who were not readmitted (controls). Logistic regression with P-value significant at <0.05. Crude and adjusted (for remaining confounding variables) O.R. = Odds of readmission per characteristic (with 95% confidence intervals). BRHC 1993-2001.

Table 11 Maternal-newborn pair characteristic	**Number with Information**	**Readmitted** N=104	**Not readmitted** N=312	**Probability of readmission per characteristic**	
Continuous variables		**Mean ± SD Range**	**Mean ± SD Range**	**Crude O.R. (95% C.I.) P-value**	**Adj. O.R. (95% C.I.) P-value**
Maternal age, y	416	26.98 ± 5.39 15-42	26.57 ± 5.35 14-42	1.01 (0.97,1.06) N.S.	No O.R. N.S.
Birth weight, g	416	3532.5 ± 482.0 2510-4780	3519.7 ± 484.3 1710-4860	1.000 (1.000,1.001) N.S.	No O.R. N.S.
Gestational age, wk	416	38.99 ± 1.36 35-41	39.45 ± 1.45 33-42	0.81 (0.70,0.94) 0.005	No O.R. 0.012
Parity	416	2.17 ± 1.29 1-7	1.99 ± 1.09 1-8	As categorical variable	As categorical variable
Newborn length of stay°, dhm	410	Median 1 23:42 Range 1 01:50-3 06:42 10^{th}, 90^{th}ile 0 09:55-12 05:45	Median 2 00:39 Range 1 04:50-3 07:18 10^{th}, 90^{th}ile 0 04:08-25 12:49	0.90 (0.59,1.36) N.S.	No O.R. N.S.
Overall compliance*	408	6.98 ± 5.63 0-13	6.58 ± 5.79 0-14	1.01 (0.97,1.05) N.S.	No O.R. N.S.

°# Missing: Early discharge - 5 cases & 1 control; Time period - 2 controls.
*Overall compliance = agreement between all guideline discharge criteria status and discharge status.

Table 11 Maternal-Newborn Pair Characteristic	Number with Information	Readmitted	Not readmitted	Probability of readmission per characteristic	
Categorical variables		**%, N**	**%, N**	**Crude O.R. (with 95% C.I.); P-value**	**Adj. O.R. (with 95% C.I.); P-value**
Sex	416				
Male		49.0%(51)	49.4%(154)	0.99 (0.63,1.54); N.S.	0.94 (0.59,1.52); N.S.
Female		51.0%(53)	50.6%(158)	reference	reference
Parity	416				
Primiparous		37.5%(39)	41.0%(128)	0.86 (0.55,1.36); N.S.	1.20 (0.68,2.10); N.S.
Multiparous		62.5%(65)	59.0%(184)	reference	reference
Early Discharge°	410				
Yes		51.5%(51)	49.5%(154)	1.08 (0.69,1.70); N.S.	0.89 (0.47,1.69); N.S.
No		48.5%(48)	50.5%(157)	reference	reference
Time Period°	414				
1: 10/01/93 - 05/31/96		1-32.7%(34)	1-31.7%(99)	1-1.03 (0.62,1.71); N.S.	1-1.15 (0.68,1.94); N.S.
2: 06/01/96 - 01/31/99		2-20.2%(21)	2-21.2%(66)	2-0.96 (0.53,1.72); N.S.	2-0.97 (0.52,1.81); N.S.
3: 02/01/99 - 09/30/01		3-47.1%(49)	3-47.1%(147)	3-reference	3-reference
Breastfed	416				
Yes		80.8%(84/104)	78.5%(245/312)	1.15 (0.66,2.01); N.S.	1.25 (0.68,2.30); N.S.
No		19.2%(20/104)	21.5%(67/312)	reference	reference

°# Missing: Early discharge - 5 cases & 1 control; Time period - 2 controls.

whereas it ranged from 33 - 42 weeks for controls. Gestational age remained significant even after adjusting for the other confounding variables. The lesser the gestational age, the greater the probability of readmission (p-value = 0.012). No change in readmission risk was found for parity after birth, maternal age at delivery, gender, birth weight, breastfeeding and time period of delivery. Time of discharge did not significantly predict readmission as neither newborn length of stay nor being discharged early affected readmission.

5.3 RESULTS OF SECONDARY ANALYSES

5.3.1 *Jaundice at discharge exam as a risk factor for readmission*

The initial data analysis identified hyperbilirubinemia as a risk factor for readmission as there was a statistically significant difference between study groups when the guideline discharge criterion for hyperbilirubinemia was unmet even after adjusting for confounders. As well, statistically significant differences between study groups were identified when there was disagreement between guideline discharge status for hyperbilirubinemia and discharge status, even after adjusting for confounders. In addition, jaundice accounted for the majority of the readmissions. Although there was no statistically significant difference between study groups for abnormalities detected at discharge physical exam, a large proportion of charts subjectively

noted jaundice at discharge exam. To refine and clarify the nature of the primary associations between hyperbilirubinemia and readmission, subgroup analyses were conducted.

Groups were dichotomized into either jaundice noted or not noted at discharge exam. Information was available on 402 newborns. Table 6 illustrates that the guideline discharge criteria for jaundice at discharge exam was met in only 85.3% (343/402) of newborns. There were a greater proportion of newborns jaundiced at discharge exam that were not discharged early.

Table 9 shows the probability of readmission if non-compliant (disagreement between the guideline discharge criteria and discharge status) to the guideline discharge criteria for jaundice at discharge exam. Newborns jaundiced at discharge exam and not discharged early were at a greater risk of readmission than newborns who were not jaundiced at discharge exam and who were not discharged early (the reference group) even after adjusting for confounders (excluding "early discharge" and "newborn length of stay") {O.R. 4.23(2.00,8.94); p-value < 0.001}.

The probability of readmission if the guideline discharge criterion for jaundice at discharge exam regardless of discharge status was unmet is shown in Table 10. Twenty-seven (26.5%) of the 102 readmitted newborns were noted to be jaundiced at discharge exam compared with 273 (89.2%) of the 306 newborns in the control group who were not jaundiced. This finding

was highly significant at p-value < 0.000 with O.R. = 2.98 (1.69,5.26). The finding of jaundice at discharge exam was retained in the model, even after adjusting for confounding variables. There was a 3-fold greater risk of readmission when jaundice was noted at discharge exam {OR=3.30 (1.77,6.15), p-value < 0.001} (Table 10).

5.3.2 *Early discharge as a risk factor for readmission*

The original dataset included 205 newborns discharged at less than 48 hours(early discharge) as well as 205 newborns discharged at 48 hours or more (not early discharge). As seen in Table 11, there was no risk of readmission with early discharge, however it was theoretically possible that newborns kept in longer than 48 hours would have a reduced risk of readmission. In order to eliminate the possible confounding effect of not being discharged early on the risk of readmission, separate subgroup analyses were conducted on the early discharge and not early discharge subsets.

Table 12 shows the probability of readmission per discharge status if the guideline discharge criteria were such that the newborn was not eligible for discharge at 48 hours. There was no statistically significant difference in risk of readmission for the early discharge group whether the guideline discharge criteria were met or not. However, newborns in the non-early

Table 12. Probability of readmission if guideline discharge criteria not met by discharge status*. Crude and Adjusted (for confounding variables) Odds Ratio = Odds of not meeting guideline discharge criteria among early discharged cases versus odds of not meeting guideline discharge criteria among early discharged controls (with 95% Confidence Intervals). Logistic regression. P-value significant at <0.05.

Table 12 Guideline discharge criteria	**Number with information**	**Guideline discharge criteria status**		**Probability of cases not meeting guideline**	
		Cases who did not meet guideline / Cases who did meet guideline Proportion, N	**Controls who did not meet guideline / Controls who did meet guideline Proportion, N**	**Crude O.R. (95% C.I.) P-value**	**Adj. O.R. (95% C.I.) P-value**
Term	410				
Early discharge	205=Ca51+Co154	0.31(12/51//39/51)	0.26(32/154//122/154)	1.17(0.55,2.50) N.S.	0.91(0.34,2.44) N.S.
Not early discharge	205=Ca48+Co157	0.26(10/48//38/48)	0.24(30/157//127/157)	1.11(0.50,2.49) N.S.	0.93(0.35,2.50) N.S.
Normal CR^{+} status	410				
Early discharge	205=Ca51+Co154	0(0/51//51/51)	0.007(1/154//153/154)	_	_
Not early discharge	205=Ca48+Co157	0.09(4/48//44/48)	0.05(7/157//150/157)	1.95(0.55,6.96) N.S.	2.92(0.64,13.29) N.S.
No sepsis	410				
Early discharge	205=Ca51+Co154	0(0/51//51/51)	0(0/154//154/154)	_	_
Not early discharge	205=Ca48+Co157	0(0/48//48/48)	0.03(4/157//153/157)	_	_

Table 12 Guideline discharge criteria	Number with information	Guideline discharge criteria status		Probability of cases not meeting guideline	
		Cases who did not meet guideline / Cases who did meet guideline Proportion, N	Controls who did not meet guideline / Controls who did meet guideline Proportion, N	Crude O.R. (95% C.I.) P-value	Adj. O.R. (95% C.I.) P-value
Temperature stable	410				
Early discharge	205=Ca51+Co154	0(0/51//51/51)	0(0/154//154/154)	_	_
Not early discharge	205=Ca48+Co157	0.02(1/48//47/48)	0(0/157//157/157)	_	_
No feeding problem	410				
Early discharge	205=Ca51+Co154	0.02(1/51//50/51)	0.007(1/154//153/154)	3.06(0.19,49.83) N.S.	1.74(0.09,35.53) N.S.
Not early discharge	205=Ca48+Co157	0.04(2/48//46/48)	0.10(14/157//143/157)	0.45(0.10,2.03) N.S.	0.33(0.05,2.24) N.S.
Normal discharge exam	402				
Early discharge	198=Ca49+Co149	0(0/49//49/49)	0.007(1/149//148/149)	_	_
Not early discharge	204=Ca48+Co156	0.17(7/48//41/48)	0.15(20/156//136/156)	1.16(0.46,2.94) N.S.	1.31(0.33,5.18) N.S.
Urinated	410				
Early discharge	205=Ca51+Co154	0(0/51//51/51)	0(0/154//154/154)	_	_
Not early discharge	205=Ca48+Co157	0.02(1/48//47/48)	0.006(1/157//156/157)	3.32(0.20,54.09) N.S.	7.35(0.36,151.40) N.S.

Table 12 Guideline discharge criteria	Number with information	Guideline discharge criteria status		Probability of cases not meeting guideline	
		Cases who did not meet guideline / Cases who did meet guideline Proportion, N	Controls who did not meet guideline / Controls who did meet guideline Proportion, N	Crude O.R. (95% C.I.) P-value	Adj. O.R. (95% C.I.) P-value
No bleeding after circumcision	64 circumcised				
Early discharge	19=Ca2+Co17	0(0/2//2/2)	0(0/17//17/17)	_	_
Not early discharge	45=Ca5+Co40	0(0/5//5/5)	0(0/40//40/40)	_	_
Received meds and immunizations	410				
Early discharge	205=Ca51+Co154	0.02(1/51/50/51)	0.01(2/154//152/154)	1.52(0.14,17.12) N.S.	2.85(0.22,36.22) N.S.
Not early discharge	205=Ca48+Co157	0(0/48//48/48)	0.006(1/157//156/157)	_	_
Metabolic screening done or arranged	410				
Early discharge	205=Ca51+Co154	0.04(2/51//49/51)	0.06(9/154//145/154)	0.66(0.14,3.15) N.S.	0.59(0.11,3.03) N.S.
Not early discharge	205=Ca48+Co157	0.04(2/48//46/48)	0.19(9/157//48157)	0.72(0.15,3.43) N.S.	0.67(0.13,3.31) N.S.
Mother capable	407				
Early discharge	204=Ca51+Co153	0(0/51//51/51)	0.007(1/153//152/153)	_	_
Not early discharge	203=Ca48+Co155	0.04(2/48//46/48)	0.02(3/155//152/155)	2.20(0.36,13.59) N.S.	4.49(0.62,32.46) N.S.

Table 12 Guideline discharge criteria	Number with information	Guideline discharge criteria status		Probability of cases not meeting guideline	
		Cases who did not meet guideline / Cases who did meet guideline Proportion, N	Controls who did not meet guideline / Controls who did meet guideline Proportion, N	Crude O.R. (95% C.I.) P-value	Adj. O.R. (95% C.I.) P-value
Discussed PHN+ referral	410				
Early discharge	205=Ca51+Co154	0.82(23/51//28/51)	0.88(72/154//82/154)	0.94(0.50,1.77) N.S.	0.77(0.38,1.54) N.S.
Not early discharge	205=Ca48+Co157	0.92(23/48//25/48)	0.89(74/157//83/157)	1.03(0.54,1.97) N.S.	0.99(0.50,1.97) N.S.
MD+ identified	410				
Early discharge	205=Ca51+Co154	0.06(3/51//48/51)	0.06(8/154//146/154)	1.14(0.29,4.47) N.S.	1.27(0.31,5.25) N.S.
Not early discharge	205=Ca48+Co157	0.04(2/48//46/48)	0.06(9/157//148/157)	0.72(0.15,3.43) N.S.	0.48(0.09,2.49) N.S.
No hyperbilirubinemia	410				
Early discharge	205=Ca51+Co154	0(0/51//51/51)	0(0/154//154/154)	–	–
Not early discharge	205=Ca48+Co157	0.12(5/48//43/48)	0.01(2/157//155/157)	9.01(1.69,48.08) 0.01	11.68(1.86,73.56) 0.009
No jaundice at discharge exam	402				
Early discharge	198=Ca49+Co149	0.11(5/49//44/49)	0.07(10/149//139/149)	1.58(0.51,4.87) N.S.	1.81(0.56,5.90) N.S.
Not early discharge	204=Ca48+Co156	0.78(21/48//27/48)	0.17(23/156//133156)	4.50(2.19,9.26) 0.000	4.04(1.87,8.73) 0.000

*Met (not met) guideline = guideline discharge criteria status such that newborn could (not) be discharged early. Discharge status = (not) early discharge.

+CR=cardiorespiratory; PHN=public health nurse; MD=physician. Ca=Case; Co=Control

discharge group had a greater probability of readmission if hyperbilirubinemic {O.R. 9.01 (1.69,48.08); p-value = 0.01} or if jaundiced at discharge exam{O.R. 4.50 (2.19,9.26); p-value < 0.001}. When these variables were adjusted for confounders, both remained statistically significant with an eleven-fold probability of readmission for hyperbilirubinemic infants not discharged early {O.R. 11.68(1.86,73.56); p-value = 0.009} and a four-fold probability for infants jaundiced at discharge exam {O.R. 4.04 (1.87,7.73); p-value < 0.001}. (Table 12).

5.3.3 *Gestational age and risk of readmission*

The initial analysis identified a lower gestational age as a risk factor for readmission. However, premature newborns should have a reduced risk of being readmitted as they are less likely to be discharged at less than 48 hours. In order to explore this further, a sub-analysis was conducted excluding newborns delivering at less than 37 weeks.

Babies born at 37 weeks or more had a greater risk of readmission if hyperbilirubinemic {O.R. 11.06(1.09,111.84); p-value = 0.04) or if jaundiced at discharge exam {O.R. 2.54(1.33,4.87) p-value = 0.005}, after adjusting for confounders. The finding of an association between an abnormal discharge exam and readmission did not remain statistically significant after adjusting for confounders. Table 13. Disagreement between guideline discharge criteria status for hyperbilirubinemia or for jaundice at discharge exam and discharge

Table 13. Probability of readmission if guideline discharge criteria not met*. Gestational age greater or equal to 37 weeks only. Crude and Adjusted (for confounding variables - excluding gestational age) Odds Ratio = Odds of not meeting guideline discharge criteria among cases versus odds of not meeting guideline discharge criteria among controls (with 95% Confidence Intervals). Logistic regression. P-value significant at <0.05.

Table 13 Guideline discharge criteria	**Number with information**	**Guideline discharge criteria status**		**Probability of cases not meeting guideline***	
		Cases who did not meet guideline* / Cases who did meet guideline* Proportion, N	**Controls who did meet guideline* / Controls who did meet guideline* Proportion, N**	**Crude O.R. (95% C.I.) P-value**	**Adj. O.R. (95% C.I.) P-value**
Term	397 Case N=98 Control N=299	0.23(18/98//80/98)	0.20(49/299//250/299)	1.15(0.63,2.08) N.S.	1.10(0.54,2.23) N.S.
Normal CR^{+} status	397 Case N=98 Control N=299	0.05(5/98//93/98)	0.02(5/299//294/299)	3.16(0.90,11.16) N.S.	1.85(0.39,8.88) N.S.
No sepsis	397 Case N=98 Control N=299	0(0/98//98/98)	0.01(3/299//296/299)	–	–
Temperature stable	397 Case N=98 Control N=299	0.01(1/98//97/98)	0(0/299//299/299)	–.	–
No feeding problem	397 Case N=98 Control N=299	0.05(5/98//93/98)	0.02(6/299//293/299)	2.63(0.78,8.80) N.S.	1.23(0.23,6.66) N.S.
Normal discharge exam	389 Case N=96 Control N=293	0.09(8/96//88/96)	0.03(9/293//284/293)	2.87(1.08,7.66) 0.035	1.97(0.58,6.67) N.S.

Table 13 Guideline discharge criteria	Number with information	Guideline discharge criteria status		Probability of cases not meeting guideline*	
		Cases who did not meet guideline* / Cases who did meet guideline* Proportion, N	Controls who did meet guideline* / Controls who did meet guideline* Proportion, N	Crude O.R. (95% C.I.) P-value	Adj. O.R. (95% C.I.) P-value
Urinated	397 Case N=98 Control N=299	0.01(1/98//97/98)	0.003(1/299//298/299)	3.07(0.19,49.58) N.S.	5.82(0.31,108.84) N.S.
No bleeding after circumcision	62 Circumcised Males Case N=7 Control N=55	0%(0/7)	0%(0/55)	–	–
Received meds and immunizations	395 Case N=96 Control N=299	0.01(1/96//95/96)	0.01(2/299//297/299)	1.56(0.14,17.43) N.S.	2.36(0.19,28.70) N.S.
Metabolic screening done or arranged	395 Case N=96 Control N=299	0.06(5/96//91/96)	0.07(18/299//281/299)	0.86(0.31,2.38) N.S.	0.57(0.16,2.05) N.S.
Mother capable	392 Case N=96 Control N=296	0.02(2/96//94/96)	0.01(4/296//292/296)	1.55(0.28,8.62) N.S.	1.47(0.24,8.96) N.S.
Discussed PHN^{+} referral	395 Case N=96 Control N=299	0.88(45/96//51/96)	0.87(139/299//160/299)	1.02(0.545,1.61) N.S.	0.89(0.54,1.45) N.S.
MD^{+} identified	395 Case N=96 Control N=299	0.05(5/96//91/96)	0.06(16/299//283/299)	0.97(0.35,2.73) N.S.	0.97(0.33,2.87) N.S.
No hyperbilirubinemia	397 Case N=98 Control N=299	0.03(3/98//95/98)	0.003(1/299//298/299)	9.41(0.97,91.54) N.S.	11.06(1.09,111.84) 0.04

Table 13 Guideline discharge criteria	Number with information	Guideline discharge criteria status		Probability of cases not meeting guideline*	
		Cases who did not meet guideline* / Cases who did meet guideline* Proportion, N	Controls who did meet guideline* / Controls who did meet guideline* Proportion, N	Crude O.R. (95% C.I.) P-value	Adj. O.R. (95% C.I.) P-value
No jaundice at discharge exam	389 Case N=96 Control N=293	0.32(23/96//73/96)	0.13(33/293//260/293)	2.48(1.37,4.49) 0.003	2.54(1.33,4.87) 0.005

*Met (not met) guideline = guideline discharge criteria status such that newborn could (not) be discharged early.
+CR = cardiorespiratory; PHN=public health nurse; MD=physician.

status was also statistically significant, after adjusting for confounders. Specifically, hyperbilirubinemic newborns born at 37 weeks or more who were not discharged early, were at greater risk of readmission than non-hyperbilirubinemic newborns born at 37 weeks or more who were not discharged early {O.R. 11.10(1.10,112.40); p-value < 0.05}. Similarly, babies born at 37 weeks or more who were jaundiced at discharge exam and not discharged early were at greater risk of readmission than non-jaundiced newborns who were not discharged early {O.R. 2.90(1.32,6.35); p-value < 0.01}. Table 14 ("early discharge" and "newborn length of stay" removed as confounders as already a determinant of compliance categories).

5.3.4 *Risk factors for readmission by primary diagnosis at readmission*

The initial data analysis identified gestational age and hyperbilirubinemia as risk factors for readmission. Secondary analysis identified jaundice at discharge exam as a risk factor for readmission. Subgroup analyses were done in order to identify whether any of the identified risk factors were also associated with a particular primary diagnosis at readmission.

The subset of 38 infants readmitted for jaundice was compared to the remaining readmitted newborns with respect to the risk factors identified in the

Table 14. Probability of readmission by compliance* category. Gestational Age greater or equal to 37 weeks only. Crude and Adjusted (for confounding variables excluding gestational age, early discharge & newborn length of stay) O.R. = Odds Ratio = Odds of readmission by compliance category A versus odds of readmission by compliance category B (with 95% Confidence Intervals). Logistic regression. P-value significant at <0.05.

Table 14 Guideline discharge criteria	**Number with information** Case/Control	**Proportion of cases/controls per compliance* category**				**Probability of readmission if guideline discharge criteria not met***
		Met guideline* & discharged early Proportion,N Case/Control	**Met guideline* & not discharged early Proportion,N Case/Control**	**Did not meet guideline* & discharged early Proportion,N Case/Control**	**Did not meet guideline* & not discharged early Proportion,N Case/Control**	
Overall compliance	410 (99/311)	0.36(22/61) 1.37 (0.65,2.90) 1.76 (0.80,3.87)	0.26(15/57)	0.29(27/92) 1.12 (0.55,2.27) 1.17 (0.54,2.53)	0.33(29/88) 1.25 (0.62,2.54) 1.32 (0.63,2.74)	**Crude O.R. (95% C.I.)** **Adj. O.R. (95% C.I.)**
Term	411 (99/312)	0.32(39/122) 1.14 (0.68,1.91) 1.34 (0.77,2.34)	0.28(36/128)	0.32(10/31) 1.15 (0.51,2.56) 1.05 (0.41,2.69)	0.44(8/18) 1.58 (0.64,3.93) 1.64 (0.63,4.31)	**Crude O.R. (95% C.I.)** **Adj. O.R. (95% C.I.)**
Normal CR^{+} status	410 (99/311)	0.32(49/152) 1.11 (0.69,1.78) 1.23 (0.74,2.06)	0.29(41/141)	0(0/1) _ _ _ _	0.75(3/4) 2.58 (0.56,11.99) 2.41 (0.47,12.34)	**Crude O.R. (95% C.I.)** **Adj. O.R. (95% C.I.)**

Table 14 Guideline discharge criteria	**Number with information** Case/Control	**Proportion of cases/controls per compliance* category**				**Probability of readmission if guideline discharge criteria not met***
		Met guideline* & discharged early Proportion,N Case/Control	**Met guideline* & not discharged early Proportion,N Case/Control**	**Did not meet guideline* & discharged early Proportion,N Case/Control**	**Did not meet guideline* & not discharged early Proportion,N Case/Control**	
No sepsis	410 (99/311)	0.32(49/153) 1.03 (0.65,1.65) 1.15 (0.69,1.91)	0.31(44/142)	0(0/0) – – – –	0(0/3) – – – –	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Temperature stable	410 (99/311)	0.32(49/153) 1.08 (0.68,1.73) 1.19 (0.72,1.98)	0.31(44/142)	0(0/0) – – – –	0(0/3) – – – –	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
No feeding problem	416 (104/312)	0.32(48/1521.03 (0.64,1.65) 1.16 (0.70,1.94)	0.31(43/140)	1(1/1) 3.26 (0.20,53.16) 2.04 (0.12,35.57)	0.20(1/5) 0.65 (0.07,5.73) 1.01 (0.11,9.25)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Normal discharge exam	402 (97/305)	0.32(47/147) 1.12 (0.69,1.81) 1.24 (0.73,2.10)	0.29(39/136)	0(0/1) – – – –	0.63(5/8) 2.18 (0.68,7.04) 2.25 (0.66,7.72)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**

Table 14 Guideline discharge criteria	Number with information Case/Control	Proportion of cases/controls per compliance* category				Probability of readmission if guideline discharge criteria not met*
		Met guideline* & discharged early Proportion,N Case/Control	Met guideline* & not discharged early Proportion,N Case/Control	Did not meet guideline* & discharged early Proportion,N Case/Control	Did not meet guideline* & not discharged early Proportion,N Case/Control	
Urinated	410 (99/311)	0.32(49/153) 1.07 (0.67,1.71) 1.19 (0.71,1.97)	0.30(43/144)	0(0/0) _ _ _ _	1(1/1) 3.35 (0.21,54.67) 5.73 (0.31,106.74)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
No bleeding after circumcision	64 Circumcised Males (7/57)	0.12(2/17) 0.89 (0.16,5.08) 0.90 (0.15,5.30)	0.14(5/38)	0(0/0) _ _ _ _	0(0/0) _ _ _ _	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Received meds and immunizations	410 (99/311)	0.32(48/151) 1.05 (0.66,1.67) 1.16 (0.70,1.93)	0.30(44/145)	0.50(1/2) 1.65 (0.15,18.61) 2.72 (0.22,34.00)	0(0/0) _ _ _ _	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Metabolic screening done or arranged	411 (99/312)	0.33(48/151) 1.09 (0.68,1.75) 1.19 (0.71,1.99)	0.30(42/137)	0.1(1/9) 0.36 (0.05,2.95) 0.46 (0.06,3.84)	0.22(2/9) 0.73 (0.15,3.49) 0.70 (0.14,3.41)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**

Table 14 Guideline discharge criteria	**Number with information** Case/Control	**Proportion of cases/controls per compliance* category**				**Probability of readmission if guideline discharge criteria not met***
		Met guideline* & discharged early Proportion,N Case/Control	**Met guideline* & not discharged early Proportion,N Case/Control**	**Did not meet guideline* & discharged early Proportion,N Case/Control**	**Did not meet guideline* & not discharged early Proportion,N Case/Control**	
Mother capable	410 (99/311)	0.32(49/151) 1.05 (0.66,1.67) 1.16 (0.70,1.92)	0.30(42/140)	0(0/1) _ _ _ _	0.67(2/3) 0.01 (0,∞) 0.01 (0,∞)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
Discussed PHN+ referral	410 (99/311)	0.34(28/82) 1.16 (0.62,2.18) 1.44 (0.74,2.81)	0.30(23/78)	0.30(21/71) 1.00 (0.51,1.97) 1.02 (0.50,2.08)	0.31(21/67) 1.06 (0.54,2.09) 1.13 (0.56,2.27)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
MD+ identified	410 (99/311)	0.32(46/145) 1.04 (0.65,1.68) 1.15 (0.68,1.93)	0.30(42/138)	0.38(3/8) 1.23 (0.31,4.85) 1.31 (0.31,5.50)	0.29(2/7) 0.94 (0.19,4.69) 0.78 (0.15,4.17)	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**
No hyperbili-rubinemia	410 (99/311)	0.32(49/153) 1.13 (0.70,1.81) 1.26 (0.75,2.10)	0.29(41/144)	0(0/0) _ _ _ _	3(3/1) 10.54 (1.07,104.01)^ 11.10 (1.10,112.40)^	**Crude O.R.** **(95% C.I.)** **Adj. O.R.** **(95% C.I.)**

Table 14 Guideline discharge criteria	**Number with information** Case/Control	**Proportion of cases/controls per compliance* category**				**Probability of readmission if guideline discharge criteria not met***
		Met guideline* & discharged early Proportion,N Case/Control	**Met guideline* & not discharged early Proportion,N Case/Control**	**Did not meet guideline* & discharged early Proportion,N Case/Control**	**Did not meet guideline* & not discharged early Proportion,N Case/Control**	
No jaundice at discharge exam	402 (97/305)	0.32(49/151) 1.34 (0.79,2.34) 1.45 (0.81,2.59)	0.30(42/140)	0(0/1) 2.24 (0.71,7.09) 2.72 (0.82,9.01)	0.91(21/23) 3.31 (1.56,7.03)^^ 2.90 (1.32,6.35)^^	**Crude O.R. (95% C.I.)** **Adj. O.R. (95% C.I.)**

*Compliance = agreement between guideline discharge criteria status and discharge status.
*Overall compliance = agreement between all guideline discharge criteria status and discharge status.
*Met (not met) guideline = guideline discharge criteria status such that newborn could (not) be discharged early.
+CR=cardiorespiratory; PHN=public health nurse; MD=physician.
^p-value < 0.05.
^^p-value < 0.01.

analysis as well as to feeding problems and breastfeeding, characteristics reported in the literature to be risk factors for jaundice. After adjusting for confounders, gestational age was the only significant predictor of readmission with jaundice {O.R. 0.57(0.37,0.86); p-value < 0.01}. Table 15.

5.3.5 *Other associations*

As the criterion "bleeding if circumcised" was the only one that always met the guideline, it was removed from the analysis. Instead, case and control groups were compared with regards to the proportion of cases that were circumcised. Table 16 shows that circumcised males were less likely to be readmitted, even after adjustment for confounders by logistic regression {O.R. 0.31 (0.13,0.77); p-value = 0.012}.

Table 16. Probability of readmission if circumcised. Crude and Adjusted (for confounding variables) Odds Ratio (with 95% Confidence Intervals). Logistic regression. P-value significant at <0.05.

Guideline discharge criteria	**No. with information** Case/Control	**Circumcised cases/ Uncircumcised cases Proportion, N**	**Circumcised controls / Uncircumcised controls Proportion, N**	**Crude O.R (95% C.I.) P-value**	**Adj. O.R. (95% C.I.) P-value**
Circumcision	205 males (51/154) 64 circ'ed males (7/57)	0.16 (7/51//44/51)	0.59 (57/154//97/154)	0.27^^ (0.11,0.64)	0.31^ (0.13,0.77)

^p-value significant at < 0.05; ^^p-value significant at < 0.01.

As there were no circumcised males readmitted with jaundice, it was not possible to analyze whether an association between circumcision and

Table 15. Probability of readmission for jaundice if guideline discharge criteria not met*. Crude and Adjusted (for confounding variables) Odds Ratio = Odds of not meeting guideline discharge criteria among newborns readmitted with jaundice versus odds of not meeting guideline discharge criteria among newborns not readmitted with jaundice (with 95% Confidence Intervals). Logistic regression. P-value significant at <0.05.

Guideline discharge criteria	**Number with information**	**Guideline discharge criteria status**		**Probability of readmission with jaundice if guideline not met***	
		Cases readmitted with jaundice who did not meet guideline* / Cases readmitted with jaundice who did meet guideline* Proportion, N	**Cases not readmitted with jaundice who did not meet guideline* / Cases not readmitted with jaundice who did meet guideline* Proportion, N**	**Crude O.R (95% C.I.) P-value**	**Adj. O.R. (95% C.I.) P-value**
Breastfed	104 Jaundice N=38 "Other" N=66	0.12(4/38//34/38)	0.32(16/66//50/66)	2.72(0.84,8.84) N.S.	2.66(0.70,10.05) N.S.
Feeding problem	104 Jaundice N=38 "Other" N=66	0.03(1/38//37/38)	0.08(5/66//61/66)	0.33(0.04,2.93) N.S.	0.42(0.03,6.46) N.S.
No jaundice at discharge exam	102 Jaundice N=38 "Other" N=64	0.73(16/38//22/38)	0.21(11/64//53/64)	3.50(1.40,8.75) p-value = 0.007	2.98(0.92,9.66) N.S. p-value = 0.07
Hyperbilirubinemia	104 Jaundice N=38 "Other" N=66	0.09(3/38//35/38)	0.03(2/66//64/66)	2.74(0.44,17.20) N.S.	3.31(0.39,28.40) N.S.
Gestational age	104 Jaundice N=38 "Other" N=66			0.66(0.49,0.91) p-value = 0.011	0.57(0.37,0.86) p-value = 0.008

*Met (not met) guideline = guideline discharge criteria status such that newborn could (not) be discharged early.

readmission for jaundice existed.

As babies with pyloric stenosis have a 100% chance of being readmitted, the 6 babies with this diagnosis were excluded in the following sub analysis. The remaining babies had a greater risk of readmission if hyperbilirubinemic whether discharged early ($p = 0.017$) or not ($p=0.014$), even after adjusting for confounders. They also had a greater risk of readmission if jaundiced at discharge exam, even if not discharged early ($p = 0.007$). No other significant associations were found. (Data not shown.) As similar findings were reported in the entire subset of readmitted newborns, this sub analysis was not felt to add additional information.

5.4 SUMMARY OF FINDINGS

The study sample included 104 newborns in the case (or readmitted) group and 312 in the control (or not readmitted) group. Among the 104 newborn readmissions, the mean age at readmission was 12.69 $\pm$ 8.06 days. Thirty-eight (36.5%) were readmitted with jaundice, 25 (24.0%) with respiratory problems, 22 (21.1%) with feeding problems and 19 (18.2%) with other diagnoses. Table 4. Of the 38 infants with jaundice, 29 (76.3%) were readmitted within the first 7 days of life and only 9 (23.7%) in the next 21 days (p-value < 0.001). Sixteen (64.0%) of all infants readmitted with respiratory problems were readmitted within days 15 - 28 of life as compared to 9

(36.0%) within the first 2 weeks (p-value = 0.004). Readmissions for the remaining 2 groups were evenly distributed throughout the 28-day period. Table 5. No risk factors for readmission for jaundice were identified. Table 15.

The guideline discharge criteria were met approximately 97% of the time with the exception of the criteria for "discussed Public Health Nurse referral" (53.2%) and "term" (79.6%). Table 6. There were approximately an equal proportion of newborns meeting the guideline discharge criteria status that were discharged early as newborns not discharged early. However, a greater proportion of newborns not meeting the guideline discharge criteria status were not discharged early compared to newborns discharged early, most significantly those with unmet criteria for cardiorespiratory status, sepsis, temperature, discharge exam and hyperbilirubinemia (92 - 100%). Table 6. Overall compliance (agreement between guideline discharge criteria status and discharge status) to the eligibility criteria for a 48-hour discharge was achieved in only 52.4%. Reasons for non-compliance predominantly included newborns having been discharged early despite having at least 1 unmet criterion (62.6%). Reasons for compliance predominantly included newborns not being discharged early and having at least 1 unmet criterion (61.4%). Table 7.

Guideline discharge criteria status was associated with discharge status. The risk of early discharge was significantly reduced when

cardiorespiratory status was abnormal {adjusted O.R. 0.11(0.10,0.95); p-value = 0.04}, when feeding problems were identified {adjusted O.R. 0.17(0.04,0.84); p-value = 0.03} and when the discharge exam was abnormal {adjusted O.R. 0.04(0.01,0.34); p-value = 0.003}, including the presence of jaundice alone {adjusted O.R. 0.27(0.14,0.53); p-value < 0.000}. A greater likelihood of early discharge was associated with advancing gestational age {adjusted O.R. 1.34(1.12,1.60); p-value < 0.01. (Table 8).

An association between discharge decision and risk of readmission was identified for certain guideline discharge criteria. When study groups were compared with respect to the degree of compliance (agreement between eligibility for discharge and actual discharge status) with individual discharge criteria or with compliance overall, the only guideline discharge criteria significantly associated with a risk of readmission were the presence of hyperbilirubinemia and jaundice at discharge exam. Hyperbilirubinemic newborns who were not discharged early were at a greater risk of readmission than non-hyperbilirubinemic newborns who were not discharged early {adjusted O.R. 7.46(95% C.I. 1.32,42.05); p-value < 0.05}. Table 9. Newborns jaundiced at discharge exam and not discharged early had a greater probability of readmission than newborns who were not jaundiced at discharge exam and who were not discharged early {O.R. 4.23 (2.00,8.94); p-value < 0.001}. These differences were still present in the subset of newborns born at 37 weeks or more for both hyperbilirubinemia and jaundice

at discharge exam even after adjusting for confounders. Specifically, hyperbilirubinemic newborns born at 37 weeks or more who were not discharged early, were at greater risk of readmission than non-hyperbilirubinemic newborns born at 37 weeks of more who were not discharged early {O.R. 11.10(1.10,112.40); p-value < 0.05}. Similarly, babies born at 37 weeks or more who were jaundiced at discharge exam and not discharged early were at greater risk of readmission than non-jaundiced newborns who were not discharged early {O.R. 2.90(1.32,6.35); p-value < 0.01}. Table 14.

When compared to identify eligibility for discharge at 48 hours of age, cases and controls did not differ with respect to the degree with which the discharge criteria were met or not with the exception of hyperbilirubinemia and jaundice at discharge exam. Hyperbilirubinemia increased the risk of readmission eight-fold {adjusted O.R. 8.44(1.48,48.21); p-value = 0.017}. There was a 3-fold greater risk of readmission when jaundice was noted at discharge exam {adjusted O.R. 3.30 (1.77,6.15); p-value < 0.001}. Table 10.

This increased risk was still present in the subset of newborns born at 37 weeks or more gestation. Babies born at 37 weeks or more had a greater risk of readmission if hyperbilirubinemic {adjusted O.R. 11.06(1.09,111.84); p-value=0.04} or if jaundiced at discharge exam {O.R. 2.54(1.33,4.87); p-value = 0.005}. Table 13. Hyperbilirubinemic infants {adjusted O.R. 11.68(1.86,73.56); p-value = 0.009} and those with jaundice at discharge

exam {adjusted O.R. 4.04 (1.87,7.73); p-value < 0.001} were more likely to be readmitted even in the subset of newborns not discharged early. Table 12.

Cases and controls had similar characteristics with the exception of gestational age. Infants of greater gestational age were less likely to be readmitted {(38.99 $\pm$ 1.36 weeks versus 39.45 $\pm$ 1.45 weeks); O.R. 0.81 (0.70,0.94); p-value = 0.005}. These differences persisted after adjusting for confounders (p-value = 0.012). Table 11. Of note was the finding that compared with uncircumcised males, the risk of readmission for circumcised males was reduced three-fold even after adjusting for confounders {O.R. 0.31 (0.13,0.77); p-value = 0.012}.

No change in readmission risk was found for parity after birth, maternal age at delivery, gender, birth weight, breastfeeding and time period of delivery. Time of discharge did not significantly predict readmission as neither newborn length of stay nor being discharged early affected readmission.

Table 17 shows a summary of the predictors of readmission identified in the present study.

Table 17. Summary of identified predictors of readmission. Crude and Adjusted (for confounding variables) Odds Ratio (with 95% Confidence Intervals). Logistic regression. P-value significant at <0.05.

Guideline discharge criteria	**Number with information** **Case/Control**	**Cases with risk factor*/ Cases without risk factor* Proportion, N**	**Controls with risk factor*/ Controls without risk factor* Proportion, N**	**Crude O.R (95% C.I.) P-value**	**Adj. O.R. (95% C.I.) P-value**
Circumcision	205 males (51/154) 64 circumcised males (7/57)	0.16(7/51//44/51)	0.59(57/154//97/154)	0.27 (0.11,0.64)^^	0.31 (0.13,0.77)^
No hyperbilirubinemia	416 Case N=104 Control N=312	0.05(5/104//99/104)	0.007(2/312//310/312)	7.83 (1.50,40.98)^	8.44 (1.48,48.21)^
No jaundice at discharge exam	408 Case N=102 Control N=306	0.36(27/102//75/102)	0.12(33/306//273/306)	2.98 (1.69,5.26)^^^	3.30 (1.77,6.15)^^^
		Mean ± SD Range	**Mean ± SD Range**		
Gestational age, w	416 Case N=104 Control N=312	38.99 ± 1.36 35-41	39.45 ± 1.45 33-42	0.81 (0.70,0.94)^^	No O.R.^

CHAPTER 6: DISCUSSION AND IMPLICATIONS

6.1 DISCUSSION

6.1.1 *Conclusions based on findings*

The present study looked at whether non-compliance to the joint CPS/SOGC guidelines for discharge at less than 48 hours was a valid predictor of readmission. Readmitted newborns were compared to non-readmitted newborns with respect to the degree of compliance (agreement between "readiness" for discharge and actual discharge status) with individual discharge criteria or with compliance overall. The findings indicate that non-compliance to the existing Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada guideline discharge criteria did not increase the risk of readmission.

Guideline discharge criteria status was associated with discharge status. Newborns were less likely to be discharged early if of lower gestational age, with an abnormal cardiorespiratory status, feeding problems, an abnormal discharge exam, including the presence of jaundice alone.

An association between discharge decision and risk of readmission was identified for certain guideline discharge criteria. Readmission was

strongly associated with hyperbilirubinemia and jaundice at discharge exam. This association was observed in the sub-group of infants discharged later than 48 hours following birth as well as in the subset of newborns born at 37 weeks or more.

Infants of greater gestational age were less likely to be readmitted. Circumcised males were at less risk of readmission than uncircumcised males. No difference in readmission risk was found for parity after birth, maternal age at delivery, gender, birth weight, breastfeeding and time period of delivery. Time of discharge did not significantly predict readmission as neither newborn length of stay nor being discharged early affected risk of readmission.

Gestational age, non-circumcision, hyperbilirubinemia and jaundice at discharge exam were the sole statistically significant predictors of readmission.

6.1.2 *Alternative explanations for the findings*

The present study looked at whether non-compliance to the joint CPS/SOGC guidelines for discharge at less than 48 hours was a valid predictor of readmission. Is disagreement between guideline discharge criteria status and discharge status a valid predictor of readmission? The results support the need for a critical review of the effective utilization of the discharge criteria. Specifically, a) Are the guideline discharge criteria being

utilized and if not, why not? Utilization of the discharge criteria includes their use in determining eligibility for early discharge, the results of which assist in determining the need for prolonging the hospital stay or the need for community follow-up. b) If utilized, are the guideline discharge criteria effective in identifying newborns at risk of readmission? Risk of readmission may be affected by the newborn's eligibility for early discharge or by the actual agreement between guideline discharge criteria status and discharge status. The study did not address the use of discharge criteria in determining the need for community follow-up. Further research is required to answer whether a) identifying newborns at high risk of readmission leads to a modification of community follow-up and whether b) modifying community follow-up leads to a decrease in readmission.

Are the guideline discharge criteria being utilized? If not, why not?

With the exception of arranging follow-up with a Public Health Nurse within 48 hours of discharge, jaundice at discharge exam and being term, over 90% of readmitted and non-readmitted newborns were discharged having met the individual discharge criteria (Table 6). However, it does not appear that having met the criteria influenced the decision to discharge the infant early. Forty-one percent (83/205) of newborns discharged early met all discharge criteria and were discharged early. Sixty-five percent (132/205) of newborns not discharged early had 1 or more unmet criteria and were not

discharged early. Overall compliance to the eligibility criteria for a 48-hour discharge was only achieved in 52.4% of all 410 newborns. (Table 7).

Poor compliance to national guidelines is identified not only in this study but also in surveys of pediatricians and obstetricians done by Britton (1998), Britton et al (2002) and Maisels and Kring (1997). A survey of U.S. and Canadian obstetricians by Britton (1998) found that only 39% of respondents advised follow-up visits for the mother post-discharge. Of those advising follow-up, only half recommended follow-up within 48 hours of discharge, as recommended by the AAP/ACOG. A survey of U.S. pediatricians by Maisels and Kring (1997) found only 33% scheduled follow-up visits within 14 days after discharge with infants at high risk for jaundice being seen within 3 days of discharge. Britton et al (2002) found that breastfed babies were more likely to be scheduled for follow-up within the first week of discharge than non-breastfed babies. Maisels and Kring (1997) suggest that the wide variations seen in compliance may also be related to the inability of the mother to travel, adverse road or weather conditions, and a lack of routinely available home nursing visits.

This study's findings that 62.6% of newborns were discharged early despite having at least 1 unmet criterion and that 37.4% of newborns were not discharged early despite all criteria being met raises the question as to which factors are considered important by physicians in considering early discharge (Table 7). The survey of obstetricians done by Britton (1998) found that the

physical health of the mother was considered more important than social risk and that the physician's decision to discharge was likely influenced more by perceptions of the appropriateness of the length of stay rather than by professional guidelines. In general, clinical practice guidelines are not considered particularly useful by physicians, as there is doubt in their ability to improve clinical outcomes (Flores et al, 2000). Physicians prefer to draw their own conclusions from review articles combined with their own experience (Christakis & Rivara, 1998). Rigorous methodological quality is also needed in order to render guidelines evidence-based (McDonagh et al, 2002).

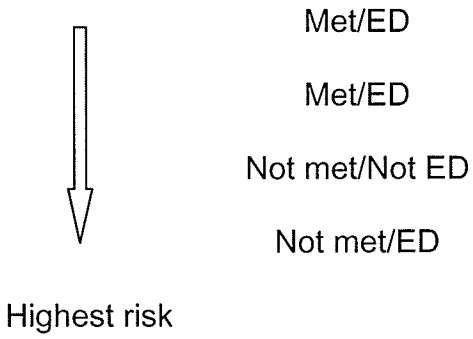
This study offers a more specific explanation. The findings support the use of certain discharge criteria in determining eligibility for early discharge. Newborns of lower gestational age, or with an abnormal cardiorespiratory status, feeding problems, an abnormal discharge exam and jaundice at discharge were significantly less likely to be discharged early. Although not amenable to statistical analysis due to empty cells, the findings that 4/4 newborns with query sepsis were not discharged early, and 0/250 hyperbilirubinemic newborns were discharged early suggest that these criteria may have been considered in the decision not to discharge early. (Table 8).

If utilized, are the guideline discharge criteria effective in identifying newborns at risk of readmission?

The findings of the present study indicate that non-compliance to most

of the individual discharge criteria developed by the Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada are not valid predictors of readmission. The findings that risk of readmission differs by compliance category for hyperbilirubinemia and jaundice at discharge exam suggest that there may be a "risk ranking scale". Figure 3 illustrates this scale.

Figure 3. Risk ranking scale



From Tables 9 and 14, we learn that not meeting the guideline and not being discharged early is of greater risk for readmission than meeting the guideline and not being discharged early (the reference group). Similar analyses using the other compliance categories as reference groups (data not shown) show that not meeting the guideline and not being discharged early is also of greater risk for readmission than meeting the guideline and being discharged early. Tables 10 and 8 confirm that not meeting the guideline is of greater risk for both readmission and for early discharge than meeting the

guideline. The data did not show that early discharge is itself a risk for readmission but other literature has shown this to be true. Therefore, from lowest to highest risk, compliance category risk ranking could be as follows: met guideline & not discharged early, met guideline & discharged early, did not meet guideline & not discharged early, did not meet guideline & discharged early.

The Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada guidelines incorporate clinical parameters known to be particularly important in identifying congenital anomalies or in identifying those infants not having successfully completed transition to extrauterine life. Successful completion of transition is usually achieved within the first 6 to 12 hours after birth for most well term newborns, however for others, completion of transition may not occur until 24 to 48 hours after birth (Britton 1998). This study's findings that newborns with abnormal cardiorespiratory status, feeding problems, abnormal discharge exam and jaundice at discharge are being kept in hospital longer support the interpretation that newborns with transitional difficulties are being correctly identified and do not require later readmission because of missed or delayed diagnosis.

Other clinical parameters found in the present study to be significant risk factors for readmission in the neonatal period included lower gestational age, non-circumcision, jaundice at discharge exam and serum hyperbilirubinemia.

Jaundice at discharge exam and hyperbilirubinemia have been identified as risk factors by several authors. Readmitted newborns are more likely to be preterm (Heimler, Shekhawat, Hoffman, Chetty & Sasidharan, 1998; Maisels & Kring, 1998), with prematurity and low birth weight equally predicting readmission (Danielson et al, 2000). Maisels and Kring (1998) also found male infants to be at increased risk of readmission, a finding that was substantiated by Pascale et al (1996) who found that circumcised males were more at risk of readmission. Pascale et al (1996) offer an explanation by suggesting that the pain of circumcision might reduce breastfed newborns' willingness to nurse often and effectively after discharge, thus placing them at increased risk of dehydration. Maisels and Kring (1998), Pascale et al (1996) and Soskolne et al (1996) all found an increased readmission risk in infants with either hyperbilirubinemia or the presence of jaundice in the nursery.

Several parameters were not identified as risk factors for readmission in the present study. Length of hospital stay after birth was not identified as a risk factor, with similar conclusions drawn by Sword et al (2001) who conducted a multi-site, cross-sectional study in Ontario. Unlike the present study, other studies have identified newborns of primigravidas and young mothers (<18 years if age) to be at increased risk for rehospitalization after early discharge (Grupp-Phelan et al, 1999; Liu et al, 1997). Other maternal characteristics placing infants at risk include infants of poorly educated, single mothers with no prenatal classes (Millar, Gloor, Wellington & Joubert, 2000).

Breastfeeding newborns constitute another group that has a high risk of developing jaundice or dehydration after a short hospital stay (Brown et al, 1999; Edmonson et al, 1997; Maisels & Kring, 1998; Soskolne et al, 1996). Establishing neonatal feeding could decrease the need for readmission for the baby, since inadequate breast milk intake is associated with increased neonatal jaundice (Neifert, 1998). The present study did not identify breastfed newborns to be at increased risk for readmission, not even for readmission for jaundice. Many factors could account for this discrepancy: prenatal education, lactation consultation and support at home are but some of the possibilities.

In contrast to the present study, Pascale, Brittian, Lenfestey and Jarrett-Pulliam (1996) found an increased risk of readmission in circumcised breastfed babies. Specifically, circumcision was associated with dehydration, which could lead to jaundice. The present study found a protective effect between circumcision and readmission. As there were no circumcised males readmitted with jaundice, it was not possible to analyze whether an association between circumcision and readmission for jaundice existed.

The time interval between circumcision and discharge tends to be less than 6 hours in BRHC. Although not taken into consideration in the present study, this factor was found to be significant by Pascale et al (1996). Over the time period of the study, the patterns of practice could have changed, including the number of circumcisions performed and the use of anesthesia.

Nor was identification of physician or public health nurse follow-up found to be a significant predictor of readmission. This in contrast to many studies which found that neonates receiving home care visits were less likely to require hospital readmission (Bragg et al, 1997; Dalby, Williams, Hodnett & Rush, 1996; Danielson, Castles, Damberg & Gould, 2000; Escobar et al, 2001; Gagnon et al, 1997; Meickle, Lyons, Hulac & Orleans, 1998). However, identification of a health care provider does not necessarily reflect actual practice. It is possible that community follow-up post-discharge is occurring despite a lack of documentation in the hospital discharge instructions.

It is also likely that public health nurse follow-up practice differs by area of maternal residence. In Manitoba, postpartum clients receive comprehensive and coordinated hospital/community services based on individualized in-hospital assessment and intervention, communication of ongoing client needs to community services, and appropriate follow-up and/or referral as determined by client need. Since October 1993, Brandon Regional Health Centre offers an enhanced postpartum community follow-up program providing 7 day a week service by trained maternal-child nurses. An initial assessment within 24 hours of discharge is provided as well as further follow-up dependent on assessed client need. An average of 3 pre-scheduled home visits or phone calls are made per client. A 24-hour "hotline" to the hospital nursery is also available. This is in comparison with Manitoba's standard postpartum community follow-up program in which public health nurses

provide services 5-day a week. The initial assessment generally occurs within 5 days of discharge and usually consists of 1 phone consultation.

6.1.3 *Limitations*

The case-control method is susceptible to many sources of bias. The establishment of the case and the control groups can be biased through improper ascertainment, diagnosis, or selection of subjects. Error in correctly determining past exposure can derive from improper records, faulty recall, or improper interviewing techniques.

Errors in misclassification of disease.

Surveillance bias:

Correctly identified high-risk newborns could have received preferential medical or community follow-up care. This could have lead to either an increase in readmission of the sickest newborns or to a decrease in readmission if they were offered more community follow-up care. Actual risk would seem to depend more on the care provided after identification of the risk factor. This study lacked data on post-discharge practices.

Unmeasured differences between newborns may lead to biased and inconsistent estimates of the effect of the discharge criteria on the risk of readmission. The direction of the bias caused by omitted variables depends

on their correlation with newborn readmission.

Diagnosis bias:

Diagnoses based on physical exam or laboratory findings may be subject to diagnosis bias. Parameters measuring severity of jaundice, including peak bilirubin measurements on admission and discharge, length of stay for readmission, presence of risk factors for jaundice, could reduce the chances of diagnosis bias.

Readmission practice may differ by physicians. Variations in readmission rates may be due to physician-specific differences in diagnosis and treatment of hyperbilirubinemia. Some "cases" may be managed in the community leading to an underestimation of the variable as a predictor. A separate analysis stratified on the basis of readmitting physician could be conducted to detect the possibility of diagnosis bias. If results are essentially unchanged, the effect of this bias is negligible.

Unique hospital characteristics may influence the risk of infant readmission. Factors such as the average number of beds in the intensive care or well-baby nurseries and the average census in the intensive care or well-baby nurseries may influence the readmission of infants.

Reliability of the hospital separation abstracts is subject to incompleteness and inaccuracy through inconsistent definitions of disease, omission of secondary diagnoses and faulty coding of diagnoses. The use of

hospital discharge abstract data for diagnostic coding has reported a concordance of 95% with chart reviews of principal diagnosis (Roos, Sharp & Wajda, 1989). In the present review, the primary diagnosis was the one identified as the cause for readmission.

Differential referral patterns:

Differential referral patterns are another source of potential bias in hospital-based case-control studies. As BRHC is a regional referral centre, a case-control study based on cases deriving from this hospital might overestimate the relative risk. To reduce the potential for this bias, the study was to include only infants both delivered and readmitted from within the catchment area. However, this exclusion criterion was removed in order to obtain a sufficient sample size. Unfortunately, by allowing non-BRHA newborns, another differential referral pattern bias was introduced. Non-BRHA newborns delivering at BRHC might have been readmitted to local hospitals resulting in using "cases" as "controls" leading to an underestimation of risk. An analysis based on RHA of maternal residence might assist in this regard.

Newborns transferred in or out of BRHC were another potential source of differential referral pattern bias that could have overestimated the relative risk of readmission. To reduce the potential for this bias, the study was to exclude all infants transferred at birth admission. However, this exclusion

criterion was removed in order to obtain a sufficient sample size. Because the purpose of the study was to identify risk factors for readmission and because the study did not exclude newborns admitted to the BRHC neonatal intensive care unit, it was decided that newborns transferred from BRHC could be included in the study.

Errors in misclassification of exposure.

Recall bias:

Studies based solely on medical records are more likely to encounter recall bias, since the recording of information tends to be selective rather than comprehensive in routine medical care.

Because of the availability of selective rather than comprehensive information, care was taken by the reviewer to "apply" the guideline discharge criteria at less than 48 hours. Correctly "applying" the criteria is dependent on timing and accuracy of the documentation in the clinical records. Information on guideline discharge criteria status was available mostly at discharge rather than prior to 48 hours. As criteria met at discharge may not have been met at 48 hours, this could have led to an underestimation of risk.

It is also likely that public health nurse follow-up practice differs by area of maternal residence. An analysis based on RHA of maternal residence might assist in this regard.

The missing values encountered for various discharge criteria may

have resulted in an underestimation of the readmission risk. As transferred babies accounted for most of the missing data, their exclusion from the analysis might have removed this limitation.

The impact of breastfeeding on readmission might be underestimated because it included completely and partially breastfeed infants.

Interviewer bias:

Interviewer bias may occur if the interviewer tends to probe the case group more intensively for histories of exposure than they do the comparison group. Use of a standardized data collection form was used to minimize interviewer bias.

Other.

Study design:

Although the case-control design was particularly suited for this particular study where the outcome (readmission) was a rare event and where multiple risk factors for a single outcome were to be studied, it was not particularly suited for studying rare exposures. As discussed in the Power section below, "exposures" to unmet criteria or to non-compliance were rare events resulting in some cells with zero or small counts. Temporal sequence, a common limitation of case-control studies, is not felt to be a concern in the present study as birth must occur before readmission.

Validity:

In order to determine "predictive validity" (the ability of the measure to predict the criterion), it may be preferable to calculate relative risk which can only be estimated from an odds ratio in case-control designs. The concept of a "risk ranking scale" gives construct validity (the ability of the measure to correspond to theoretical concepts) to the study. The findings reported in this single-site study may not be generalizable to other hospital and community setting. A larger population-based study is needed.

Power:

Because birth is such a common event, there is considerable public health significance of a 20%, 10%, or even a 5% increased risk of serious adverse events when it affects the entire maternal-newborn population. The proposed sample size was sufficient to detect a relative risk of 2.0 for infant readmissions (power=0.8). However, because of small and sometimes zero cell counts (small numbers of "unmet criteria" and of "non-compliance with criteria"), the study may not have had sufficient power to identify statistically significant differences. On the other hand, the stability or accuracy of the odds ratios found to be statistically significant might be questioned given the small cell counts. Wide confidence intervals for some of the statistically significant findings also speak to the limitations in interpreting the odds ratios.

Although not statistically conclusive, certain observations of associated

risks in this study should not be dismissed. In small studies, the absence of statistically significant findings does not necessarily indicate the absence of clinically meaningful differences. The risk of committing a Type II error (i.e. concluding that readmission is unaffected when in fact it is) would seriously compromise client safety and overlook the need to identify risk factors for readmission. Ideally an appropriate study should have sufficient power to detect not only a statistically significant difference but also a clinically meaningful difference.

6.2 IMPLICATIONS

6.2.1 *Implications for clinical practice*

The present study looked at non-compliance (disagreement between guideline discharge criteria status and discharge status) to the discharge criteria as valid predictors of readmission. The results justify support for the existing national guidelines and justify the consideration of additional criteria.

Non-compliance to the existing guideline discharge criteria did not increase the risk of readmission however other risk factors were identified. Specifically, newborns not discharged early and hyperbilirubinemic or jaundiced at discharge exam had a greater risk of readmission than newborns not discharged early and non-hyperbilirubinemic or non-jaundiced at discharge exam.

Implication #1: Risk factors such as jaundice at discharge exam and hyperbilirubinemia should be added to the existing guidelines.

Some of the unmet criteria were found to be predictors for readmission whereas some were not. Jaundice at discharge exam, hyperbilirubinemia, non-circumcision and gestational age were associated with an increased risk of readmission. It appears that correctly identifying newborns at risk does not necessarily reduce their risk of readmission.

Implication #2: Certain existing criteria should be prioritized such as gestational age. Other risk factors should be added to the existing guidelines and prioritized such as jaundice at discharge, hyperbilirubinemia and non-circumcision. Prioritization should then influence appropriate clinical management.

The findings of an association between newborns not discharged early and newborns of lower gestational age with unmet criteria for abnormal cardiorespiratory status, feeding problems, abnormal exam at discharge and jaundice at discharge, suggest that the infants are being screened appropriately. Query sepsis and hyperbilirubinemia appeared clinically associated with early discharge decision-making. Furthermore, the presence of one or more of the unmet criteria in the group of newborns not discharged

early suggests that these risk factors are being prioritized. These results seem to reflect a clinically sound process of selecting the appropriate candidates for early discharge.

Implication #3: Findings that some guideline discharge criteria are predictors of early discharge indicate that newborns at risk are correctly being identified and are being kept in longer.

As seen in the group of infants with jaundice at discharge exam and hyperbilirubinemia, newborns are still being readmitted despite not being discharged early. This implies that newborns appearing jaundiced in the nursery have a higher risk of readmission whether being identified as requiring ongoing medical follow-up or not. This also suggests that a lengthier length of stay is not the solution. This has implications for community follow-up practice. The American Academy of Pediatrics has published guidelines for the management of hyperbiliburinemia in the healthy term newborn (Practice Parameter: Management of Hyperbilirubinemia in the Healthy Term Newborn, American Academy of Pediatrics, 1994). Evaluation of dermal icterus by blanching the skin with digital pressure is also included in the American Academy of Pediatrics' recommendations as an evaluation tool. The task of correctly identifying newborns at risk for jaundice is a complex matter involving a thorough risk assessment. This study confirms that

correctly identifying newborns at risk for jaundice may not be sufficient in reducing the risk of readmission.

Implication #4: Follow-up management may have more impact on readmission risk than prolonging hospital length of stay in newborns who are hyperbilirubinemic and jaundiced at discharge. Nevertheless, identifying dermal icterus is a recommended practice.

Compliance to the guideline discharge criteria may not be the most important parameter in predicting readmission. Readmission may depend not only on compliance to the guideline discharge criteria but also on the clinical care offered after identification of the risk factor. It is possible that newborns at risk are correctly being identified and managed appropriately either by prolonging length of initial hospital stay or by modifying community follow-up. Readmission as an outcome may not reflect the clinical parameters that are meaningful to patients and physicians. The guideline discharge criteria may be predictors of other outcomes such as public health nurse visits, physician office visits or outpatient department visits.

Implication #5: Readmission may depend not only on compliance to the guideline discharge criteria but also on the clinical care offered after identification of the risk factor.

Implication #6: Readmission as an outcome may not reflect the clinical parameters that are meaningful to patients and physicians. The guideline discharge criteria may be predictors of other health utilization services.

6.2.2 *Implications for future research*

Further research is required to validate the predictive validity of the criteria in other hospital settings. A large, population-based study is needed incorporating multiple sites and multiple community settings.

Implication #7: Rigorous studies are required to examine the impact of outcome-justified best practices on a range of outcomes for newborns in diverse populations and settings.

Further research is required to validate the clinical importance of the prioritized discharge criteria and of the parameters identified as significant but not currently included in the national guidelines.

Implication #8: Rigorous studies are required to validate the clinical importance of the prioritized discharge criteria and of the parameters identified as significant but not currently included in the national guidelines.

CHAPTER 7: RECOMMENDATIONS

7.1 RECOMMENDATIONS FOR CLINICAL PRACTICE

Recommendation #1: The SOGC/CPS may want to consider revising its statement by adding dermal icterus and hyperbilirubinemia to their guidelines.

Recommendation #2: Clinicians should prioritize gestational age, abnormal cardiorespiratory status, feeding problems and sepsis when assessing newborns for discharge readiness. Consideration should also be given to prioritizing jaundice at discharge exam, hyperbilirubinemia and non-circumcision.

Recommendation #3: Clinicians should consider the SOGC/CPS guidelines as effective assessment tools to identify newborns at risk. Practical risk assessment instruments need to be developed and disseminated. Checklists could define some of the criteria more clearly. Critical paths could identify best practices at critical times post-natally.

Recommendation #4: The SOGC/CPS may want to consider revising its statement by adding dermal icterus to their guidelines (subject to further

validation - see Recommendation #8).

Recommendation #5: The importance of appropriate follow-up care cannot be ignored. Follow-up care after discharge rather than timing of discharge seems to be a growing focus of more recent studies.

Recommendation #6: Further research is required to determine which outcomes are clinically relevant (See Recommendation #7).

7.2 RECOMMENDATIONS FOR FUTURE RESEARCH

Recommendation #7: Rigorous studies are required to examine the impact of outcome-justified best practices on a range of outcomes for newborns in diverse populations and settings.

Recommendation #8: Further research should incorporate the following:

- Include peak serum bilirubin measurements in order to determine severity of jaundice.
- Include jaundice at discharge and non-circumcision in the analysis.
- Separate infants completely breastfed from those partially breastfed.
- Determine what post-natal services (including hospital, outpatient, and home-based services) actually are being received.

- Consider post-natal service utilization as an outcome in addition to readmission.
- Include RHA of maternal residence as a confounding variable.
- Exclude transferred infants from the analysis.

CHAPTER 8: SUMMARY CONCLUSION

The study set out to establish the predictive validity of the guideline discharge criteria in order to identify those individuals most at risk for readmission who might require either a longer hospital stay or more intensive community follow-up. Establishing the predictive validity of the guideline discharge criteria as well as identifying other risk factors may have provided answers to the following question: What are appropriate eligibility criteria for early discharge?

The findings indicate that non-compliance to the existing Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada guideline discharge criteria did not increase the risk of readmission. However other risk factors were identified which are predictors. Specifically, hyperbilirubinemic infants and those with jaundice at discharge exam were more likely to be readmitted than non-hyperbilirubinemic infants and those not jaundiced at discharge exam even in the subset of newborns not discharged early. Newborns at risk were correctly being identified and were being kept in longer.

The results support the need for a critical review of the effective utilization of the discharge criteria, with a focus on prioritizing gestational age, abnormal cardiorespiratory status, feeding problems and sepsis in the clinical

assessment of newborns at risk. Special consideration should also be given to the addition and prioritization of dermal icterus, hyperbilirubinemia and circumcision in the existing guidelines. The results also support the need to re-evaluate the existing criteria as predictors of utilization of other health services rather than of readmission.

The findings suggest that the task is not only in identifying high risk newborns through prioritized discharge criteria but also in reviewing what constitutes appropriate follow-up care. Ultimately, the issue of whether correctly identifying high-risk newborns can decrease the risk of readmission may depend on what clinical modifications are done as a result of the identified high risk factor and whether other health services utilization outcomes are impacted.

Rigorous studies are required to validate the clinical importance of the prioritized discharge criteria and of the parameters identified as significant but not currently included in the national guidelines. Rigorous studies are required to examine the impact of outcome-justified best practices on a range of outcomes for newborns in diverse populations and settings.

Only in this way will the goal identified by Margolis be fulfilled:

> The goal of future research should not be to establish the correct duration of hospitalization, but rather to determine the most effective way to assure that the medical encounter at birth for mother and infants meets sound and agreed on health, education, and social objectives.
>
> Margolis, 1995, p.633

Clearly the issue of whether implementation of discharge guidelines reduces readmissions is a key concern for policy makers, hospital administrators, consumers and health care providers. Evidence- and outcome-based research on the validity of clinical practice guidelines in predicting the risk of readmission in defined classes of people is needed to inform policy on cost-containment strategies and clinical care both in hospital and in the community for the general population in the vulnerable neonatal period.

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APPENDICES

Appendix 1. ICD - 9CM newborn diagnostic codes and criteria

ICD-9CM Newborn Diagnostic Codes	Newborn Diagnostic Criteria
783.2, 783.4	Inadequate weight gain
773.1, 774.2, 774.3x, 774.6, 774.7	Jaundice
276.0, 276.5, 775.5, 778.4	Dehydration
779.3, 783.3	Feeding problems

Appendix 2. Data collection instructions.

VARIABLE	SOURCE	OUTCOME	OUTCOME PARAMETER
Newborn hospital chart #	NB admission abstract		
Maternal hospital chart #	Mat. admission abstract		
Any maternal intra- or postpartum complications that require ongoing medical treatment or observation?	Mat. admission abstract	Yes / No	Mother should NOT be discharged until stable, if she has had: • Significant PPH or ongoing bleeding greater than normal • Temperature of 38C (taken on 2 occasions at least 1 hour apart) at any time during labor and after birth • Other complications requiring ongoing care **If yes, list ICD-9 code and text and exclude.** 640-677
Was newborn apprehended?	Maternal Postpartum Referral Form	Yes / No	**If yes,** indicate as missing data under mother capable variable.
Maternal date of birth	Maternal Postpartum Referral Form	dd/mm/yy	

VARIABLE	SOURCE	OUTCOME	OUTCOME PARAMETER
NB date of birth	Maternal Postpartum Referral Form	dd/mm/yy	
Time of birth	Maternal Postpartum Referral Form	hours	
Parity	Maternal Postpartum Referral Form		
Gender	Maternal Postpartum Referral Form	Male / Female	
Gestational Age	Maternal Postpartum Referral Form	Weeks	
Birth Weight	Maternal Postpartum Referral Form	Grams	
Is baby breastfed?	Maternal Postpartum Referral Form	Yes / No / Missing	**Yes if:** • Exclusively breastfed • Any combination of breast and bottle
Is metabolic screening completed (more than 24 hours after birth) or satisfactory arrangements made?	Maternal Postpartum Referral Form Nursery Discharge Instructions	Yes / No / Missing	
Has newborn received necessary medications and immunizations?	Maternal Postpartum Referral Form	Yes / No / Missing	Eg. Vitamin K, Hepatitis B vaccine, BCG if necessary

VARIABLE	SOURCE	OUTCOME	OUTCOME PARAMETER
Is physician responsible for continuing care identified?	Maternal Postpartum Referral Form	Yes / No / Missing	
Are arrangements made for baby to be evaluated within 48 hours of discharge?	Maternal Postpartum Referral Form	Yes / No / Missing	**Yes if:** • Discussed PHN referral.
Date of discharge	Maternal Postpartum Referral Form	dd/mm/yy	
Time of discharge	Maternal Postpartum Referral Form	hours	
Is mother able to provide routine infant care and recognize signs of illness and other infant problems?	Maternal Postpartum Parent Support Program Record of Parent Learning (BRHC Oct.92)	Yes / No / Missing	**Yes if:** • U = understanding indicated by verbal response • T = task performed safely **No if:** R or C.
Date of NB readmission	NB admission abstract	dd/mm/yy	
Reason for NB readmission	NB admission abstract	ICD-9CM code and text	List 1st P-code = Primary diagnosis. Eg. 740.0 - 779.9

VARIABLE	SOURCE	OUTCOME	OUTCOME PARAMETER
Has NB demonstrated normal cardiorespiratory adaptation to extrauterine life?	NB Progress Record	Yes / No / Missing	Vital signs normal and stable for the 12 hours preceding discharge. **Yes if:** • No need for intubation or assisted ventilation after 24 hours of age • Heart rate 110-150/minute • Respiratory rate 30-60/minute
Has NB demonstrated any evidence of sepsis?	NB Progress Record	Yes / No / Missing	**Yes if:** • Use of antibiotics
Does physical examination of baby by physician within 12 hours before discharge indicate need for additional observation or therapy in hospital?	NB Progress Record	Yes / No / Missing	
Is there any bleeding at least 2 hours after circumcision (if performed)?	NB Progress Record	Yes / No / Not applicable	

VARIABLE	SOURCE	OUTCOME	OUTCOME PARAMETER
Any evidence of jaundice?	NB Progress Record	Yes / No / Missing	**Yes if:** • Bilirubin ≥170 umol/L at 0-24 hours of life • Bilirubin ≥260 umol/L at 25-48 hours of life
Is temperature stable in cot?	NB Progress Record	Yes / No / Missing	**Yes if:** • 36.1C - 37.0C axillary
Has baby urinated?	NB Progress Record	Yes / No / Missing	
Are there any apparent feeding problems?	NB Progress Record	Yes / No / Missing	**No if:** • at least 2 successful feedings documented
Control hospital chart #.	NB admission abstract		List 3 controls.

Appendix 3.

Policy Statement. Facilitating discharge home following a normal term birth. A joint statement by the Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada.

Criteria for discharge less than 48 hours after birth

MOTHERS: To ensure that mothers are discharged safety following the birth of their babies, they should meet basic criteria and have appropriate arrangements for ongoing care. Before discharge, the following criteria should be met.

- Vaginal delivery
- Ensured care for the perineum
- No intrapartum or postpartum complications that require ongoing medical treatment or observation
- Mother is mobile with adequate pain control
- Bladder and bowel functions are adequate
- Mother has received Rh immune globulin and rubella vaccine, if eligible
- Demonstrated ability to feed baby properly; if breastfeeding, baby has achieved adequate latch
- Advice regarding contraception is provided
- Physician who will provide ongoing care is identified and, where necessary, notified
- Family is accessible for follow up and mother understands necessity for, and is aware of the timing for, health checks for herself and baby
- If home environment (safety, shelter, support, communication) is inadequate, measures have been taken to provide help (eg. Homemaking, social services)
- Mother is aware of, understand, and will be able to access community and hospital support resources

Mothers should not be discharged until stable if they have had

- Serious postpartum hemorrhage or abnormal ongoing bleeding,
- Temperature of 38C (taken on two occasions at least 1 hour part), or
- Other complications requiring ongoing care

Joint statement by the Canadian Paediatric Society Statement and the Society of Obstetricians and Gynaecologists of Canada, "Facilitating discharge home following a normal term birth." P*ediatr Child Health* 1996; 1(2):165-9.

Appendix 3.

Policy Statement. Facilitating discharge home following a normal term birth. A joint statement by the Canadian Pediatric Society and the Society of Obstetricians and Gynecologists of Canada.

Criteria for discharge less than 48 hours after birth

NEWBORNS: To ensure that newborns are discharged safely, they should meet basic criteria and have appropriate arrangements for ongoing care. Babies should be healthy in the clinical judgment of physicians, and mothers should have demonstrated reasonable ability to care for their babies.

- Full-term infant (37-42 weeks) with size appropriate for gestational age
- Normal cardiorespiratory adaptation to extrauterine life and no evidence of sepsis (infants requiring intubation or assisted ventilation and infants at increased risk for sepsis should be observed in hospital for at least 24 hours)
- Temperature stable in cot (axillary 36.1C - 37C)
- No apparent feeding problems (at least two successful feedings documented)
- Physical examination of baby by physician or other qualified health professional within 12 hours before discharge indicates no need for additional observation or therapy in hospital
- Baby has urinated
- No bleeding at least 2 hours after circumcision (if performed)
- Received necessary medications and immunizations (eg. Hepatitis B)
- Metabolic screen completed (more than 24 hours after birth) or satisfactory arrangements made
- Mother is able to provide routine infant care (eg. Of the cord) and recognizes signs of illness and other infant problems
- Arrangements are made for mother and baby to be evaluated within 48 hours of discharge
- Physician responsible for continuing care is identified with arrangements made for follow up within 1 week

Joint statement by the Canadian Paediatric Society Statement and the Society of Obstetricians and Gynaecologists of Canada, "Facilitating discharge home following a normal term birth." P*ediatr Child Health* 1996; 1(2):165-9.