“THROUGH THE LOOKING GLASS”:
AN EPIDEMIOLOGICAL LOOK AT THE ETHNIC DIFFERENCES IN
MATERNAL RISK FACTORS AND INFANT OUTCOMES IN
CANADIAN NEONATAL INTENSIVE CARE UNITS

by

JENNIFER ELIZABETH CLAYDON
B.Sc., The University of British Columbia, 2001

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE STUDIES
(Experimental Medicine)

THE UNIVERSITY OF BRITISH COLUMBIA

December 2006

© Jennifer Elizabeth Claydon, 2006
ABSTRACT

Objective: Identifying that there is a lack of Canadian evidence surrounding the interaction between ethnicity and reproductive risk factors and neonatal outcomes, this study sought to report on risk factors and outcomes amongst high-risk newborns requiring intensive neonatal care.

Study Design: The data source for this project was the Canadian Neonatal Network™ (CNN) Database. The CNN maintains a national standardized database that collects information on selected neonatal intensive care unit (NICU) practices and outcomes on every neonate admitted to a Canadian NICU.

Results: Mothers at risk of delivering newborns requiring intensive care showed differing perinatal priorities on the basis of ethnic origin. Furthermore, there were differences in the risk of mortality and major morbidity among newborns born of different ethnic backgrounds. The risks of poor infant outcome associated with ethnicity were observed over and above the presence of other well known risk factors for adverse outcome.

Conclusions: Increasing our understanding of ethnically-related differences in reproductive health issues is important in order to be able to minimize disparities in health delivery on the basis of ethnicity and to improve health outcomes for all.
# TABLE OF CONTENTS

Abstract .................................................................................................................. ii  
Table of Contents .................................................................................................. iii  
List of Tables.......................................................................................................... iv  
List of Figures ......................................................................................................... v  
Acknowledgements ................................................................................................. vi  
Co-Authorship Statement ....................................................................................... vii  

**CHAPTER I** Overview and Summary ................................................................. 1  
1.1 Introduction ........................................................................................................ 1  
1.2 Background ....................................................................................................... 2  
1.3 Research Questions and Objectives ................................................................. 6  
1.4 Research Methods ............................................................................................ 7  
1.5 References ....................................................................................................... 9  

**CHAPTER II** Ethnic Differences in Maternal Risk Factors and Infant Outcomes in Canadian High-Risk Births ................................................................. 14  
2.1 Methods........................................................................................................... 14  
2.2 Results ............................................................................................................ 16  
2.3 Discussion ...................................................................................................... 19  
2.4 Conclusion ..................................................................................................... 23  
2.5 Tables and Figures .......................................................................................... 24  
2.6 References ..................................................................................................... 29  

**CHAPTER III** Ethnic Differences in Risk Factors for Neonatal Mortality and Morbidity in the Neonatal Intensive Care Unit ................................................. 32  
3.1 Methods........................................................................................................... 32  
3.2 Results ............................................................................................................ 35  
3.3 Discussion ...................................................................................................... 36  
3.4 Tables and Figures .......................................................................................... 40  
3.5 References ..................................................................................................... 47  

**CHAPTER IV** Conclusions and Future Recommendations ................................. 49  
4.1 References ..................................................................................................... 53
LIST OF TABLES

Table 2.1 Outcomes among infants less than or equal to 32 weeks gestation.... 28
Table 3.1 Neonatal characteristics/outcomes by ethnic group..................... 40
Table 3.2 Neonatal outcomes in infants less than 33 weeks by ethnic group.... 41
LIST OF FIGURES

Figure 2.1 NICU population distributions by known ethnicity.......................... 24

Figure 2.2 Proportion of maternal substance abuse (i.e. illicit drug use, cigarette use or alcohol) by ethnicity................................................................. 25

Figure 2.3 Proportions of infants with mild and severe HIE by ethnicity......... 26

Figure 2.4 Proportion of inborn infants whose mothers received antenatal steroids prior to delivery................................................................. 27

Figure 3.1 Independent predictors of neonatal mortality in the NICU.............. 42

Figure 3.2 Independent predictors of NICU mortality by ethnic group........... 43

Figure 3.3 Independent predictors of NICU mortality among African infants... 44

Figure 3.4 Independent predictors of NEC in the NICU................................ 45

Figure 3.5 Independent predictors of severe IVH in the NICU....................... 46
ACKNOWLEDGEMENTS

I would like to acknowledge the continued support of my supervisors who have challenged me both academically and professionally and for whom I have great admiration and appreciation for. You have taught me a great deal, and afforded me opportunities in education and personal development which have brought me great joy in achievement.

I would also like to thank the financial support of the Canadian Institute of Health Research (CIHR) through the Neonatal-perinatal Interdisciplinary Capacity Enhancement (NICE) Team and the Strategic Training Initiative in Research in Reproductive Health Sciences (STIRRHS) who have supported me as a trainee.
CO-AUTHORSHIP STATEMENT

Co-authors to the two included manuscripts have contributed to the design and interpretation of the data analysis and to the revision of the manuscript. The thesis author is responsible for the premise and direction of the research project as well as all data analysis and preparation of the manuscripts.
CHAPTER I
Overview and Summary

Introduction

Neonatal intensive care in the industrialized world has undergone significant improvements, yet disparities still exist in neonatal outcomes among infants born of different ethnic groups. From Australian Aboriginees, South Asian immigrants in the U.K, African-American women and North American Native Aboriginals, mothers of ethnic minorities have been identified as being more likely to deliver premature or low birth weight infants. Furthermore, their newborns have a substantially higher infant mortality rate compared with the national average. Such disparities in reproductive health have a substantial impact on communities as well as the health care system at large. In California alone, African-American mothers were found to have a 70% higher hospitalization rate for complications during pregnancy compared with Caucasians, highlighting not only an increased burden of disease, but an increased strain on limited healthcare resources.

Disparities in socio-economic levels between ethnic groups have been suggested to account for these discrepancies. Many known maternal risk factors such as cigarette smoking, little or no prenatal care, poor diet, young maternal age, multi-parity, and substance abuse, all known to contribute to poorer neonatal outcomes are all more common among mothers of lower socio-economic status. However, despite this observation, racial disparities in the prevalence of small-for-gestational age (SGA) births persisted even among college-educated African-American women in Illinois. This study
suggests that ethnicity as an independent variable may be more predictive of SGA than socioeconomic level. Therefore, ethnic disparities in health outcomes may be much more complex than originally considered. Identifying racial differences in health risks and health care needs is an important concern to be able to serve Canada’s ever growing heterogeneous, multi-cultural population.

Background

Aboriginal Mothers & their Infants

Probably one of the most well studied minority populations in Canada is the Aboriginal population. With Aboriginals representing a large, economically-deprived group, there has been much attention in recent years to the disparities in health outcomes that are prevalent within this group.

Of significant obstetrical concern is the elevated risk for developing diabetes that is prevalent among Aboriginal mothers. Among Cree women in Northern Quebec, the prevalence of gestational diabetes was 12.8%, significantly greater than the 4% observed nationally. Theories regarding this disparity in diabetes health suggest that changes in traditional diet, increased sugar consumption and a so-called “thrifty-gene” (believed to be responsible for ethnic differences in carbohydrate and sugar digestion) are to blame. Diabetes is particularly concerning among expectant women as it raises concerns for potential complications during pregnancy and delivery, including maternal hypertension, preterm labour and infant macrosomia. Macrosomic infants, generally defined as birth weight over 4000 grams are at increased risk for adverse outcomes such as shoulder dystocia, brachial plexis injury, skeletal injuries, meconium aspiration, asphyxia or even
fetal death. An increased rate of macrosomia among Aboriginal newborns has been previously reported among provincial groups of Native Aboriginals and may be explained by an elevated prevalence of diabetes among this population.

In addition to carrying an increased burden of chronic diseases such as diabetes, Aboriginal peoples also suffer a disproportionate mortality risk. Although declines have been observed in infant mortality rates among Canadian Aboriginals, there is still inequality in comparing these rates to the majority non-Aboriginal population. Health Canada data from 2000 reported that the Aboriginal infant mortality rate was 6.4 deaths per 1,000 live births, a 16% higher proportion than the overall Canadian infant mortality rate. Although several reports suggest that the increased risk of mortality among Aboriginal infants can be primarily attributed to a higher prevalence of post-neonatal deaths due to infectious diseases, injuries and sudden infant death syndrome (SIDS), evidence regarding the specific risks of prematurity and low-birth weight among Aboriginal infants is conflicting. State and provincial reports from Washington and Saskatchewan have reported elevated occurrences of low-birth-weight infants amongst Aboriginal groups. However, although prematurity was reported twice as frequently among Aboriginal British Columbians than non-aboriginals, these infants were not found to be at greater risk for being small-for-gestational age (SGA). Other studies were unable to detect any such discrepancies at all and reported that despite having poor antenatal characteristics, Aboriginal infant outcomes were comparable to those of Caucasian race and demonstrated neither elevated risks of prematurity, low birth-weight nor macrosomia. To date, North American studies focusing on outcomes amongst
high-risk Aboriginal infants requiring intensive care have been limited to comparisons of provincial reports; national data have not previously been presented.

African Mothers & their Infants

Disparities in reproductive health outcomes between African-Americans living in the United States and Caucasians are well documented, including increased risks of maternal and infant mortality\textsuperscript{27,28}, premature delivery, intrauterine growth restriction\textsuperscript{29} and decreased survival from ovarian, endometrial and cervical cancers\textsuperscript{28}. Furthermore, an increased prevalence of maternal hypertension and pre-eclampsia has been identified in both African-American women in the United States\textsuperscript{30,31} and black Caribbean women in Canada\textsuperscript{32}. Maternal hypertension carries with it its own risks of poor fetal growth, placental abruption, still birth and pre-eclampsia, a pregnancy-specific syndrome that can result in reduced blood flow to vital organs in both mother and infant and may lead to life-threatening maternal seizures\textsuperscript{33}. The disparities observed in reproductive health outcomes among African-American women have been suggested to be due in part to factors such as poor socio-economic status, and racial discrimination\textsuperscript{34}. Although poorer socio-economic standards, inadvertent discrimination and issues regarding access to care are all challenges faced by both Aboriginal and African-American women, their obstetrical complications and subsequent neonatal outcomes appear to be quite unique.

In 2004, African-Americans made up 12.8\% of America's population\textsuperscript{35}; whereas they made up merely 2.2\%\textsuperscript{36} of Canada's overall population. Because African-American population characteristics in the United States may be significantly different from Africans living in Canada, the generalizability of American studies into the Canadian
context is questionable. On the whole, research on reproductive health disparities among women of African descent living in Canada has been limited.

**East Asian Mothers & their Infants**

Research regarding maternal risk factors and infant outcomes among Asian ethnicity has not been as well researched as some other groups. Generally considered a more affluent immigrant group, Japanese American mothers in Hawaii were found to be more likely to be married, older, have had more education and better prenatal care utilization than their Caucasian counterparts\(^3^7\). In Canada, a lower perinatal mortality rate was reported among Chinese infants compared with Caucasian infants and is believed to be related to the more favourable maternal characteristics observed in this group\(^3^8\). In contrast however, other studies have reported considerable variation in the risk profile among various Asian ethnic subgroups living in the United States\(^3^9\),\(^4^0\).

**South Asian Mothers & their Infants**

Research concerning perinatal outcomes among immigrant South Asian mothers has been reported to the greatest extent in the United Kingdom. Here, studies have shown that infants of Indian-, Bangladesh- and Pakistan-born mothers have higher mortality rates\(^4^1\),\(^4^2\), and are smaller in size than infants of locally-born mothers\(^4^3\). New immigrants often suffer disparities in health care as a result of challenges in access to care which result from being socially isolated due to differences in language or medical practices and beliefs\(^4^4\),\(^4^5\). To date there are no Canadian studies identifying perinatal risk factors, outcomes or such health disparities among South Asian immigrant mothers. However, with immigration rates from the East and South Asian sub-continents increasing more
than 20% over the last 20 years\textsuperscript{46}, understanding reproductive health issues among these populations becomes vital to serving the growing Canadian population.

**Research Questions & Objectives**

Given the lack of Canadian evidence that exists around some ethnic groups living in Canada, we sought to identify what the risk factors for preterm birth or admission to the neonatal intensive care unit (NICU) were for Canadian-born ethnic infants. Furthermore, we wanted to know what the outcomes are for these infants and whether they differ from those of the majority Caucasian population.

Our hypothesis is that risk factors and outcomes for infants admitted to the NICU will indeed differ based on maternal ethnicity.

This project is significant because it will report on perinatal risks and outcomes among ethnic groups living in Canada. Understanding differences in perinatal risks and health outcomes is important to be able to determine specific areas to target in improving healthcare delivery and reducing disparities in health outcomes among Canada's diverse population. The NICU population was chosen as the focal population to study in order to compare the highest-risk pregnancies with the most serious of outcomes. Furthermore, NICU care is extremely costly and pulls resources from a large number of medical subspecialties making it particularly resource intensive. In addition, where previous studies have looked merely at provincial or state ethnic groups, this study will compare risks and outcomes among ethnic infants from across the country.
Research Methods

The Canadian Neonatal Network™ (CNN) consists of a group of multi-disciplinary Canadian researchers who work together on issues relating to neonatal care. Health care professionals, health services researchers, health administrators and epidemiologists collectively collaborate on clinical outcomes, health services, health policy and informatics research aimed at improving the efficacy and efficiency of neonatal care across the country. It was founded in 1995 by Dr. Shoo K. Lee and has been active in research, conference proceedings and publishing in peer-reviewed journals.

The Network maintains a national standardized neonatal-perinatal database that provides a unique opportunity for the longitudinal study of clinical practice and neonatal outcomes. Data collection occurs via trained research assistants who abstract information directly from the patient’s medical health record into a secured, customized data entry program on lap-top computers. Several systems of error checking are in place to ensure a high standard of data quality and provide immediate feedback should an invalid entry be mistakenly entered.

Data are collected locally on all admissions to a level three neonatal intensive care unit (NICU) at a particular network site. Tertiary or level three care refers to a subspecialty of neonatal intensive care in which there are no restrictions on the type and/or duration of mechanical ventilation available. An admission is defined as an NICU stay of at least 24 hours, or death or transfer to another NICU within 24 hours. Information is gathered on patient demographics, obstetrical history, prenatal and delivery information, illness severity at admission to the NICU, as well as selected treatment and outcomes data for all patients. All study variables are defined according to
a standard manual of definitions. Local data are then stripped of all personal identifiers such as patient names and medical record numbers to ensure patient confidentiality and are transmitted electronically via a secured encrypted pathway to the CNN Coordinating Centre where they are compiled with all sites into a national registry. Each site is required to obtain formal approval from their local Research Ethics Board for participation in the network.

Data for this project include all admissions to nine of the CNN database centres during the period from October 2002 to December 2004. Although there were 12 centres actively collecting data on all admissions to the NICU during this time, 3 centres had to be excluded for lack of adequate reporting of ethnicity as a study variable. At these 3 centres, ethnicity was reported as unknown in more than 65% of cases. The remaining nine centres represented each of the 5 geographic regions in Canada: British Columbia (2 sites), the Prairies (3 sites), Ontario (2 sites), Quebec (1 site) and the Atlantic provinces (1 site). Each of these geographic regions utilizes a coordinated system of health care involving a network of primary-, secondary- and tertiary-level hospital facilities.

Descriptive, univariate, bivariate and multivariate analyses were used to describe the characteristics of the study population and to verify if an independent and interactive effect existed in determining risk factors and outcomes among ethnic infants admitted to Canadian NICUs. All statistical analyses were performed using SPSS (the Statistical Package for the Social Sciences) version 12.0 for Windows.
References


22 Statistics Canada, 2001 Census Data. (www.statcan.ca)


36 Statistics Canada (2001 Census) Online data available at:
http://www12.statcan.ca/english/census01


CHAPTER II

Ethnic Differences in Maternal Risk Factors and Infant Outcomes in Canadian High-Risk Births*

Despite significant improvements in neonatal intensive care in the industrialized world, disparities still exist in neonatal outcomes among infants born of different ethnic groups. In North America, perinatal risks amongst provincial/state Aboriginal and African-American groups have been well documented with increased risks of infant mortality, prematurity, and low birth-weight all associated with race.1,2,3,4,5,6,7,8,9 Such risks are often attributed to key maternal characteristics, such as young age, smoking and lower socio-economic status.10

To date, there has been less focus on perinatal risks and outcomes amongst immigrant mothers from East and South Asia. Furthermore, ethnic differences between mothers of the highest risk infants requiring neonatal intensive care have not been previously reviewed at a national level. Neonatal intensive care is important because of its implications for multidisciplinary and costly resource use. The purpose of this study was to describe ethnic differences in perinatal risks and infant outcomes amongst mothers of different ethnic groups who deliver the highest risk newborns admitted to a level three Canadian neonatal intensive care unit (NICU).

Methods

From October 2002 to December 2004, the Canadian Neonatal Network™ (CNN)
collected data from twelve tertiary perinatal centres from across the country. Data was gathered on treatments and outcomes for all patients who were admitted to the level three NICU at each of these centres. An admission was defined as an NICU stay for at least 24 hours, or death or transfer to another NICU within 24 hours. Level three care refers to a subspecialty of neonatal intensive care in which there are no restrictions on the type and/or duration of mechanical ventilation available.

In Canada’s regionalized system of health care, level three NICU’s serve distinct geographic regions. Within these regions, fully coordinated care is available through a network of primary-, secondary- and tertiary-level facilities. For the purpose of this study, three sites were excluded because they did not have adequate reporting of ‘ethnicity’ as a study variable (i.e. the variable was reported as ‘unknown’ more than 65% of the time). The participating nine sites represented each of the 5 geographic regions of the country including: British Columbia (2 sites), the Prairie provinces (3 sites), Ontario (2 sites), Québec (1 site), and the Atlantic provinces (1 site). Each site obtained approval for the project from their local Research Ethics Board.

There were 9,925 admissions to the 9 NICU’s during the 27-month period from October 1st, 2002 to December 31st, 2004. After accounting for duplications between sites due to readmissions and transfers, the study population included a total of 9,502 infants and 8,771 mothers (i.e. there were 731 admitted infants who were the second (or greater) live born infant from the current pregnancy).

Data were collected at each site by trained research assistants, who abstracted information from patient charts directly into a secured database program on lap top computers. A customized data entry program allowed for built-in error checking to ensure data quality. Data were stripped of personal identifiers to ensure patient confidentiality.
and were sent electronically to the Canadian Neonatal Network™ Coordinating Centre where they were compiled with all sites into a national registry.

Study variables were defined according to The Canadian Neonatal Network™ Abstractor’s Manual. Gestational age (GA) was defined as the best obstetric estimate based on early prenatal ultrasound, obstetric examination, and obstetric history, unless the postnatal pediatric estimate of gestation differed from the obstetric estimate by more than 2 weeks. In which case, the pediatric estimate of GA was used instead\textsuperscript{11}. An infant was defined as small-for-gestational age (SGA) if the birth weight was less than the third percentile for GA and large-for-gestational age (LGA) if the birth weight was greater than the ninety-seventh percentile for GA using appropriate growth charts for the Canadian population\textsuperscript{12}. Chorioamnionitis was defined as a clinical diagnosis of inflammation of the chorion and amnion by the treating physician. Also, reported by physicians, ethnicity was defined as ethnic race of the mother and was categorized under: Caucasian, African (including African-American), East Asian (including: Oriental and South East Asian), South Asian (including East Indian or Indo-Canadian) Aboriginal (Native American including: First Nations, Inuit, or Métis), Hispanic (Mexican), or Other (ethnic origin other than previously categorized, including: Eastern European, Pacific Islander, etc.) For the definition of all further study variables, please refer to the CNN Abstractors Manual\textsuperscript{13}.

All univariate analyses done in this descriptive paper were performed using SPSS (the Statistical Package for the Social Sciences) version 12.0 for Windows.

**Results**

Ethnic origin of the mother was unknown in nearly one third of admissions. Of those for which ethnicity was known, the majority were Caucasian. Native Aboriginal
ethnicity represented the greatest proportion by any individual minority group (Figure 2.1). As the proportion of Hispanic mothers in the study was relatively low, they have been combined together with the ethnic group titled ‘Other’ for all further analysis. Furthermore, no information has been presented on infants whose ethnicity was unknown, because as a group these results were felt to be uninformative. Thus, the following results and figures include data from a total of 6,018 mothers and 6,528 infants.

Aboriginal mothers tended to be younger, of higher parity, less likely to receive prenatal care and more likely to smoke and/or use drugs or alcohol during their pregnancy (Figure 2.2). Fewer Aboriginal mothers delivered via Caesarean section and nearly one quarter of all Aboriginal infants were born outside the tertiary centre and transferred to the NICU after delivery. Comparatively, other ethnic groups had fewer outborn infants than the Caucasian majority. Maternal diabetes was also a considerable concern among Aboriginal mothers. In fact, all ethnic groups demonstrated a higher prevalence of diabetes when compared to the Caucasian majority. While these maternal characteristics are often indicative of worse neonatal outcome, the mortality rate for Aboriginal newborns requiring intensive care was lower than other racial groups. However, despite lower mortality rates, Aboriginal newborns had higher rates of large-for-gestational age births. Labour and delivery among Aboriginal mothers was also often complicated by abnormalities in fetal heart rate or rhythm. At birth, confirmed neonatal seizures and diagnosis of mild or severe hypoxic ischemic encephalopathy (HIE) were problematic concerns among Aboriginal newborns (Figure 2.3). On the whole, Aboriginal term infants, along with term East Asian infants had lower Apgar scores at 5 minutes of life.

African mothers were of higher parity, and often developed maternal hypertension or chorioamnionitis. Furthermore, they had the greatest proportion of Caesarean
deliveries. Of substance using mothers, cigarettes were the most commonly used substance for all races, except African race. Among African mothers a greater proportion used illicit drugs (4.5%) compared to cigarettes (2.9%) (Figure 2.2). In the NICU there was a high proportion of African infants born very premature (>40% of African admissions were ≤32 weeks GA). Furthermore, surviving African infants, along with South Asian survivors stayed in hospital on average 10 days longer than infants of other groups.

South Asian mothers used less harmful substances such as cigarettes and illicit drugs and were more likely to have received prenatal care. However, despite more optimistic maternal characteristics, the overall burden of infant mortality and increased hospitalization time among survivors was carried primarily by Indo-Canadian infants. South Asian mothers had more chorioamnionitis, a serious infection of the placental membranes. Furthermore, nearly one-quarter of births were non-vertex presentation, further complicating delivery; and over half of all South Asian mothers required a Caesarean section. A large proportion of Indo-Canadian newborns were born small-for-gestational age (SGA), and very premature (i.e. 45% of South Asian births were less than 33 weeks gestation, compared with less than 25% of Caucasian births). Indo-Canadian infants also had higher occurrences of jaundice and hypoglycemia in the newborn period.

East Asian mothers were on average older, and were the most likely to have received prenatal care and not to have used any harmful substances during pregnancy compared with other mothers. Stratifying infants by gestational age at birth, it is evident that the majority of neonatal mortality occurs amongst infants born less than 29 weeks (i.e. extremely premature). Although Indo-Canadian infants had the highest overall mortality rate, amongst infants born extremely premature, East Asian infants fared worse
than all other racial groups with an age-specific mortality rate (i.e. age at birth was less than 29 weeks) approaching one-third. Furthermore, East Asian survivors in this age category had on average a longer length of stay compared with other newborns in the same age category. Nearly half of all East Asian infants admitted to the NICU developed jaundice, compared with less than a third of all Caucasian infants.

Maternal antenatal steroid use among ethnic inborn infants was highly variable, particularly when infants were stratified by gestational age. Among inborn infants born less than 29 weeks, East Asian mothers were least likely to have received antenatal steroids. However, as gestational age increased, it was Aboriginal mothers who received antenatal steroids less frequently. Among inborn infants born only moderately premature, between 33 to 37 weeks gestation, Aboriginal mothers received steroids only half as often as Caucasian mothers and merely one-third as often as South Asian mothers (Figure 2.4).

Among infants born less than 33 weeks gestation, neonatal mortality was highest among South and East Asian infants. Aboriginal infants appeared to be protected, demonstrating the lowest rate of infant mortality in this age group. As mortality appears to be variable by ethnicity, so does neonatal morbidity. Where respiratory distress (RDS), and patent ductus arteriosus (PDA) were most common among African infants; intraventricular hemorrhage (IVH) and necrotizing enterocolitis (NEC) were most frequent among Aboriginal infants. Indo-Canadian newborns, on the other hand, were more often diagnosed with retinopathy of prematurity (ROP) (Table 2.1).

Discussion

Despite Canada’s approach to health care providing universal health insurance to all and maintaining a highly regionalized system of neonatal-perinatal care, there are
ethnic variations in maternal perinatal risks and neonatal outcomes amongst the highest risk newborns requiring intensive care. Such differences highlight the diverse needs of ethnic mothers and their newborns and ought to be considered in the obstetrical, perinatal and neonatal management of these patients.

At first glance, elevated rates of poor fetal growth and SGA among Indo-Canadian infants may be thought to explain the increased infant mortality in this group. However, as many of the known risk factors for SGA including maternal cigarette and drug use are nearly negligible in this population, increased risks for poor fetal growth may be at least partially explained by genetically or culturally related factors influencing ethnic differences in birth weight. Furthermore, there is evidence to suggest that current assessments of SGA, such as the Canadian growth charts, which do not account for growth differences by race, may be over- or under-inflating mortality or morbidity risks within specific ethnic groups. Further research is required to understand the elevated mortality risk among Indo-Canadian infants in order to be able to address its root causes.

In addition to ethnic differences in neonatal outcome, there appear to be ethnically-specific obstetrical risk factors in the NICU. In light of increasing evidence that highlights the role of amniotic infection as an instigator of preterm labour, a higher prevalence of chorioamnionitis in African and Indo-Canadian women may explain the increased risk of preterm birth seen in these groups. Furthermore, the increased occurrence of maternal hypertension in African women and its associated elevated risks of preterm delivery and inadequate fetal growth may also contribute to poorer neonatal outcomes in this group. Racial differences in the incidence of chorioamnionitis and maternal hypertension have important clinical implications for obstetrical management of
these women. Such differences ought to be considered, in order to better manage these patients during the perinatal period, reducing risks to both mothers and their infants.

As was found in the current study, elevated risks of maternal diabetes among Aboriginal, as well as other minority populations have been previously documented\textsuperscript{18,19,20}. This is of concern as mothers with gestational diabetes have increased risks of developing gestational hypertension, pre-eclampsia, premature rupture of membranes (PROM) and are more likely to deliver by Caesarean section\textsuperscript{21}. Infants of diabetic mothers may also face additional risks at birth often associated with being macrosomic, including: asphyxia, shoulder dystocia, or other birth injuries\textsuperscript{22}. However, despite higher rates of diabetes in all minority groups, compared with Caucasian mothers; the proportion of large-for-gestational age (LGA) infants seemed problematic only among Aboriginal newborns.

These results suggest that there may be racial differences in the manifestation of risk outcomes for mothers with diabetes. One might speculate that prenatal nutritional management of diabetes is substantially improved among African, Asian and Indo-Canadian moms compared with Aboriginals. If so, prenatal education for proper nutrition and dietary control in the management of gestation diabetes would be an important area to target among Aboriginal mothers.

The high proportion of outborn high-risk Aboriginal newborns, in combination with low Caesarean rates may raise concerns for issues regarding access to care. Aboriginal mothers may be more likely than other minority groups to live in rural areas, thereby lacking timely access to more complex obstetric care. Furthermore, clinical practices in the decision-making regarding electing for a Caesarean section may vary between rural and urban centres.
Maternal corticosteroid administration prior to delivery has been instrumental in reducing neonatal mortality and reducing the burden of severe neonatal morbidity associated with prematurity including respiratory distress syndrome (RDS), patent ductus arteriosus (PDA), intraventricular hemorrhage (IVH), and necrotizing enterocolitis (NEC). As such, antenatal steroid use serves as a surrogate measure for advanced perinatal care and discrepancies in the use of antenatal steroids based on ethnicity may be indicative of greater racial disparities in obstetric care. Further research is required to examine the observation of decreased use of antenatal steroids among East Asian mothers who deliver at less than 29 weeks.

Continued research is needed in this area to further explore these issues and to determine the role that ethnicity plays as a predictor for neonatal outcome; however, challenges to data collection of ethnic origin have often limited research in this area.

One of the major limitations to this study is the collection and definition of ethnicity as a study variable. The exclusion of three perinatal units demonstrates the reluctance by some centres to report racial origin on the medical record. Furthermore, the ethnic groupings themselves, involve rather wide geographic areas and assume that all racial groups are within themselves homogenous, which they are not. Amongst Canadian Aboriginals, wide variations have been reported in the risk for adverse pregnancy outcomes among North American Indian and Inuit women in Quebec. Additionally, discrepancies in maternal risk factors and infant mortality have been identified within East Asian subgroups in California. Although ethnicity may play a role in indicating elevated risks for poor pregnancy outcomes, all women are not the same and racial origin alone must not be considered in isolation, but instead may be important to contributing to a more complete and comprehensive obstetrical management plan.
Conclusion

The present study demonstrates that high-risk mothers of different ethnic minorities have different perinatal concerns and warrants further exploration of these differences in perinatal management. Given the increasing evidence that ethnic origin has a significant role to play in neonatal-perinatal health outcomes, challenges to data collection should be addressed. Furthermore, highlighting ethnic differences would lead to improved neonatal and maternal outcomes by allowing for individually tailored prenatal education and obstetrical management programs for these women.
Figure 2.1  NICU population distributions by known ethnicity

- Caucasian: 4,146 (63.5%)
- Aboriginal: 929 (14.2%)
- Hispanic: 111 (1.7%)
- Other: 316 (4.8%)
- South Asian: 401 (6.1%)
- East Asian: 362 (5.5%)
- African: 263 (4.0%)
Figure 2.2 Proportion of maternal substance abuse (i.e. illicit drug use, cigarette use or alcohol) by ethnicity:
Figure 2.3  Proportions of infants with mild and severe HIE by ethnicity:
Figure 2.4 Proportion of inborn infants whose mothers received antenatal steroids prior to delivery:

- Caucasian
- African
- East Asian
- South Asian
- Aboriginal
- Other

Legend:
- □ GA ≤28 wks
- ■ GA 29-32 wks
- ■■ GA 33-37 wks
Table 2.1  Outcomes among infants less than or equal to 32 weeks gestation 
\( (n = 2,570) \)

<table>
<thead>
<tr>
<th>Infant Outcomes (≤ 32 wks GA)</th>
<th>Caucasian</th>
<th>African</th>
<th>East Asian</th>
<th>South Asian</th>
<th>Aboriginal</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Infants born ≤ 32 wks GA</td>
<td>1013 (24.4%)</td>
<td>114 (43.3%)</td>
<td>109 (30.1%)</td>
<td>184 (45.9%)</td>
<td>224 (24.2%)</td>
<td>133 (31.1%)</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>6.9</td>
<td>8.8</td>
<td>11.0</td>
<td>15.2</td>
<td>4.5</td>
<td>8.3</td>
</tr>
<tr>
<td>Mortality (GA ≤ 28wks) (%)</td>
<td>14.6</td>
<td>15.3</td>
<td>32.4</td>
<td>27.8</td>
<td>11.9</td>
<td>29.7</td>
</tr>
<tr>
<td>RDS (%)</td>
<td>64.2</td>
<td>68.2</td>
<td>55.3</td>
<td>60.7</td>
<td>63.5</td>
<td>53.1</td>
</tr>
<tr>
<td>PDA (%)</td>
<td>23.4</td>
<td>37.4</td>
<td>24.5</td>
<td>26.4</td>
<td>21.3</td>
<td>20.3</td>
</tr>
<tr>
<td>IVH-grade 3 or higher (%)</td>
<td>9.9</td>
<td>10.9</td>
<td>5.5</td>
<td>6.0</td>
<td>14.3</td>
<td>9.2</td>
</tr>
<tr>
<td>ROP-stage 3 or higher (%)</td>
<td>5.4</td>
<td>5.5</td>
<td>2.8</td>
<td>7.6</td>
<td>5.8</td>
<td>1.5</td>
</tr>
<tr>
<td>NEC (%)</td>
<td>4.7</td>
<td>3.7</td>
<td>0.0</td>
<td>5.6</td>
<td>6.6</td>
<td>0.8</td>
</tr>
</tbody>
</table>
References


CHAPTER III

Ethnic Differences in Risk Factors for Neonatal Mortality and Morbidity in the Neonatal Intensive Care Unit†

Despite a system of universal health care for all, disparities exist in neonatal outcome among high-risk infants born of different ethnic groups living in Canada. Overall, Canadian infant mortality rates are among the lowest in the world, but over the last 20 years, preterm birth rates in North America have been on the rise. In the United States, prematurity is reported as the leading cause of neonatal death among African-American newborns. Furthermore, advancements in NICU care have contributed to improved survival of infants with chronic disabilities. As such, neonatal morbidity is equally important as mortality as a factor for assessing neonatal health outcomes. The purpose of this study was to identify the role of ethnicity as a risk factor for NICU mortality and morbidity. Furthermore, we wanted to know whether various ethnic groups had different risk factors for NICU mortality and major morbidity.

Methods

National data on high-risk infants admitted to Canadian Neonatal Intensive Care Units (NICU’s) were obtained from the Canadian Neonatal Network™ Database. From October 2002 to December 2004, data were collected for every admission to nine Canadian NICUs. An admission was defined as an NICU stay of at least 24 hours, or

† A version of this chapter has been submitted for publication. Claydon JE, Mitton C, Koravangattu S, Lee SK and the Canadian Neonatal Network™. Journal of Perinatology [submitted November 2006].
death or transfer to another NICU within 24 hours. After accounting for duplications between sites due to readmissions and transfers there were 6,528 infants born to 6,018 mothers (due to multiple birth pregnancies). Together the nine units represented centres from each of the 5 geographic regions of Canada, including: British Columbia, the Prairies, Ontario, Quebec and the Atlantic provinces. Each of these geographic regions utilizes a system of comprehensive, coordinated health care through a regional network of primary-, secondary-, and tertiary-level hospital centres. Each centre received approval for the project from their local Research Ethics Board.

Data were collected at each centre and entered into a customized data entry program with built-in data quality checks. Study variables were defined according to a standard manual of definitions. For the purposes of this paper, very low birth weight (VLBW) was defined as a birth weight of 1,500 grams or less and small-for-gestational age (SGA) was defined as birth weight less than the third percentile for gestational age using the sex-based growth charts for the Canadian population\textsuperscript{4}. Severity of illness at admission was measured using the validated Score for Neonatal Acute Physiology Version II (SNAP-II)\textsuperscript{5}. SNAP-II is a score for neonatal illness severity that is based on 6 empirically weighted physiologic measurements taken during the first 12 hours after admission to the NICU. Higher SNAP-II scores are indicative of more severe illness. For the purposes of this paper, a SNAP-II score greater than 20 was chosen to be the cut-off to indicate an elevated risk of mortality\textsuperscript{6}. Ethnicity was reported as ethnic race of the mother recorded on the medical record and was categorized under: Caucasian, African, East Asian, South Asian (including East Indian and Indo-Canadian), Aboriginal, Hispanic, or Other.
Major neonatal morbidity recorded included patent ductus arteriosus (PDA) requiring surgery or medical treatment with indomethacin; necrotizing enterocolitis (NEC); severe intraventricular hemorrhage (IVH); retinopathy of prematurity (ROP) and bronchopulmonary dysplasia (BPD). NEC was defined according to Bell’s criteria, stage 2 or higher\textsuperscript{7}. Severe IVH was defined as a grade III or IV intraventricular hemorrhage, including ventricular enlargement, intraparenchymal echodensity and cystic encephalomalacia. ROP was defined as the worst stage in either eye as described by the International Committee on Retinopathy of Prematurity\textsuperscript{8}. Bronchopulmonary dysplasia (BPD) (also referred to as chronic lung disease) was defined as supplemental oxygen required at 36 weeks corrected age for all infants born at \leq 32 weeks gestation. A ‘persistent laboratory blood-stream infection’ (also referred to as neonatal sepsis) was defined as two or more cerebrospinal fluid (CSF) or blood cultures containing the same pure organism more than seven days, but less than ten days apart. Two or more positive cultures within seven days of one another were not considered to be a ‘persistent’ infection. A complete description of all study variables and data collection protocols can be found in the Canadian Neonatal Network\textsuperscript{TM} Abstractors Manual\textsuperscript{9}.

Univariate and bivariate analyses were performed to describe the characteristics of the study population. Multiple logistic regression was used to develop a risk adjustment model. The outcome in the model was neonatal death or major morbidity. Independent variables included baseline population risks (such as very low birth weight, gestational age, outborn status, young maternal age, etc.) Ethnic groups were compared as dummy variables with Caucasian race serving as the reference category. All statistical
analyses were carried out using the statistical software package SPSS 12.0 for Windows with significance considered at a p-value of <0.05.

Results

Of the total study population of known ethnicity 63.5% were of Caucasian origin. Other ethnic groups represented included: Aboriginal (14.4%), South Asian (6.1%), East Asian (5.5%), Other (4.8%). African (4.1%) and Hispanic (1.7%). Due to the low proportion of Hispanic ethnicity in the study population, Hispanic infants have been combined together with the ethnic group identified as ‘other’. Infant characteristics by ethnic group are presented in Tables 3.1 and 3.2.

We observed an increased mortality rate among infants of South Asian origin, which was more than 3 times the rate among Caucasian infants. Furthermore, South Asian infants were twice as frequently small for gestational age or less than 29 weeks gestation at birth compared with Caucasian infants. However, in a risk adjusted model for NICU mortality, adjusted for SGA, gestational age less than 29 weeks, SNAP score greater than 20 and outborn status, South Asian race remained significantly predictive (Figure 3.1).

In a comparison of risk-adjusted models for mortality by ethnicity, significant predictors for mortality varied between groups (Figure 3.2). A SNAP score greater than 20 was the strongest predictor among Caucasians, South Asians, Aboriginals and Others. Gestational age less than 29 weeks was also significantly predictive among all groups except Aboriginals. Additionally, SGA as a risk factor, was seen to be significantly predictive of mortality only in the Caucasian group.
Adding ‘persistent blood-stream infection’ as an indicator for mortality changed the model for NICU mortality among African infants, rendering persistent infection the strongest predictor of mortality over and above gestational age less than 29 weeks (Figure 3.3). Persistent blood-stream infection was not significant on univariate or multivariate analysis for any other group.

Although overall Aboriginal infants were at lower risk for neonatal mortality in the NICU, they were at greater risk of survival with major morbidity. Aboriginal infants were more than twice as likely as Caucasians to develop necrotizing enterocolitis (NEC) even after accounting for differences in risk factors including: gestational age less than 29 weeks, young maternal age less than 24 years, and a SNAP Score greater than 20 (Figure 3.4). Furthermore, Aboriginal infants had a 1.7 times greater odds of developing severe intraventricular hemorrhage (IVH), despite adjustments for very low birth weight (less than 1500g), SNAP score greater than 20, Apgar score less than 7 at 5 minutes of life, outborn status and maternal hypertension (Figure 3.5).

Discussion

Advances in neonatal intensive care have greatly reduced infant mortality rates. However, infants born small-for-gestational-age (SGA) are at greater risk for mortality, neonatal morbidity and prolonged lengths of stay compared to infants of the same gestational age\textsuperscript{10}. Furthermore, elevated SNAP scores, extreme prematurity (less than 29 weeks at birth) and outborn status have also been identified as strongly correlated with neonatal mortality in the NICU\textsuperscript{6}. However, despite adjusting for these well known predictors of mortality, South Asian race was still a significant indicator of infant
mortality in our model. These results imply that the difference observed in mortality rates between South Asian and Caucasian births is significant over and above the elevated proportion of SGA and extreme prematurity seen in this group.

Furthermore, in stratifying the analysis by ethnicity, we were able to observe that the indicators for mortality varied between ethnic groups. SGA appeared as a significant indicator only among Caucasian infants, but was not identified as an important indicator for mortality among any other racial group. This finding agrees with other evidence to suggest that the growth charts for determining SGA that have been identified for the Canadian population are not culturally sensitive. Thus, differences in growth and development which may be influenced by ethnic heritage may be a more important predictor for neonatal survival than size at birth alone.

Although Aboriginal infant mortality rates are substantially higher than the Canadian national average, decreased mortality rates among Aboriginals admitted to the NICU may be correlated to the fact that these infants tend to be both older (mean gestational age was 35.1 weeks) and bigger (mean birth weight was 100 grams greater than the mean birth weight among Caucasian infants). Elevated rates of obesity and diabetes among Aboriginal women may explain the discrepancy in heavier birthweight among Native infants. However, despite having a lower risk for mortality, Canadian NICU Aboriginal infants appear to be at significantly greater risk for survival with major morbidity. As was found in the current study, elevated rates of necrotizing enterocolitis (NEC) and intraventricular hemorrhage (IVH) have also been reported in Alaskan Native infants admitted to the NICU in Anchorage. Jacob et al. (2001) attribute these differences in infant outcomes to disparities in access to advanced obstetrical care.
In our study population Aboriginal infants were less likely to be delivered by Caesarean section and more likely to be delivered outside the urban centre where the tertiary-level NICU is located. Differences in Caesarean section rates between rural and urban centres may be indicative of differences in practice of when to intervene in the case of a prolonged and difficult labour\textsuperscript{10}. In extreme cases opting for a Caesarean section, rather than prolonging a difficult vaginal delivery may have prevented the occurrence of perinatal asphyxia in the infant. Elevated incidences of asphyxia among Canadian NICU Aboriginal infants as well as increased occurrences of severe morbidities such as NEC and IVH, which may be linked to asphyxia\textsuperscript{14,15} serve as worrisome reminders of potential disparities in health care in our country. Improving identification of high-risk Aboriginal pregnancies in the community should be a priority, particularly in rural areas. Earlier identification and referral of potentially high-risk pregnancies would help to ensure maternal transport to a tertiary obstetric centre prior to delivery, thereby improving outcomes for both mother and child\textsuperscript{16}.

Further evidence of potential racial disparities in health outcomes is noted in the results that identify persistent blood-stream infections as the strongest predictor of mortality among African infants, even greater than extreme prematurity. In 2004, Fiscella reported that racial disparities in neonatal mortality among U.S. African-American infants, was a result of: elevated rates of preterm birth, fetal growth restriction and neonatal sepsis\textsuperscript{17}. Our results suggest that reducing neonatal sepsis among ethnic African newborns should be a main priority in order to alleviate disparities in mortality due to neonatal infection among this group.
Limitations to this study include decreased study numbers among some of the smaller ethnic groups in Canada, particularly those of African descent. Therefore, further analysis is suggested in order to increase the potential for inquiry into this group. Furthermore, the defining of ethnic categories for this study covered rather wide geographic areas and makes the assumption that all racial groups are within themselves homogenous, which they are not. Addressing challenges to the collection and definition of ethnicity as a study variable, are important steps to being able to further our understanding of ethnic differences in health and meeting the health care needs of Canada’s diverse population.

In summary, this study makes an important contribution by highlighting that there are ethnic disparities in neonatal mortality and morbidity in the NICU. Understanding these disparities is important in order for us to be able to work towards improved neonatal outcomes for all.
Table 3.1  Neonatal characteristics/outcomes by ethnic group.

<table>
<thead>
<tr>
<th></th>
<th>Caucasian (n=4146)</th>
<th>African (n=263)</th>
<th>East Asian (n=362)</th>
<th>South Asian (n=401)</th>
<th>Aboriginal (n=829)</th>
<th>Other (n=427)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean GA (wks)</td>
<td>35.06</td>
<td>32.80</td>
<td>34.46</td>
<td>32.63</td>
<td>35.08</td>
<td>34.69</td>
</tr>
<tr>
<td>Mean birth-weight (g)</td>
<td>2543.24</td>
<td>2028.52</td>
<td>2335.11</td>
<td>1901.35</td>
<td>2667.02</td>
<td>2467.01</td>
</tr>
<tr>
<td>SGA &lt; 3rd percentile (%)</td>
<td>6.4</td>
<td>6.1</td>
<td>6.4</td>
<td>12.5</td>
<td>6.6</td>
<td>7.0</td>
</tr>
<tr>
<td>Outborn (%)</td>
<td>14.6</td>
<td>6.5</td>
<td>9.7</td>
<td>11.7</td>
<td>22.4</td>
<td>13.3</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>2.8</td>
<td>5.3</td>
<td>4.7</td>
<td>9.0</td>
<td>2.4</td>
<td>4.5</td>
</tr>
<tr>
<td>Any major morbidity</td>
<td>13.5</td>
<td>20.5</td>
<td>14.1</td>
<td>20.0</td>
<td>15.6</td>
<td>12.6</td>
</tr>
<tr>
<td>Asphyxia (% of BW ≥2000g)</td>
<td>3.9</td>
<td>3.1</td>
<td>5.7</td>
<td>5.2</td>
<td>6.0</td>
<td>3.4</td>
</tr>
</tbody>
</table>
Table 3.2  Neonatal outcomes in infants less than 33 weeks by ethnic group.

<table>
<thead>
<tr>
<th></th>
<th>Caucasian (n=1013)</th>
<th>African (n=114)</th>
<th>East Asian (n=109)</th>
<th>South Asian (n=184)</th>
<th>Aboriginal (n=224)</th>
<th>Other (n=133)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PDA (%)</strong></td>
<td>22.2</td>
<td>35.1</td>
<td>22.9</td>
<td>26.1</td>
<td>20.1</td>
<td>19.5</td>
</tr>
<tr>
<td><strong>BPD (%)</strong></td>
<td>18.1</td>
<td>13.2</td>
<td>13.8</td>
<td>12.5</td>
<td>14.7</td>
<td>10.5</td>
</tr>
<tr>
<td><strong>NEC (%)</strong></td>
<td>4.4</td>
<td>3.5</td>
<td>0.0</td>
<td>5.4</td>
<td>6.3</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>IVH (%)</strong></td>
<td>9.9</td>
<td>10.5</td>
<td>5.5</td>
<td>6.0</td>
<td>14.3</td>
<td>9.29.0</td>
</tr>
<tr>
<td><strong>ROP (%)</strong></td>
<td>5.3</td>
<td>5.3</td>
<td>2.8</td>
<td>7.6</td>
<td>5.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>
**Figure 3.1** Independent predictors of neonatal mortality in the NICU.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA ≤ 28 wks</td>
<td>5.885 (4.431, 7.816)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SGA</td>
<td>2.831 (1.833, 4.372)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Outborn</td>
<td>1.675 (1.224, 2.290)</td>
<td>.001</td>
</tr>
<tr>
<td>SNAP &gt; 20</td>
<td>8.810 (6.659, 11.656)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA ≤ 28 wks</td>
<td>4.964 (3.519, 7.001)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SGA</td>
<td>3.100 (1.891, 5.083)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Outborn</td>
<td>1.767 (1.219, 2.562)</td>
<td>.003</td>
</tr>
<tr>
<td>SNAP &gt; 20</td>
<td>8.478 (6.045, 11.891)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>African</td>
<td>1.552 (0.813, 2.962)</td>
<td>.183</td>
</tr>
<tr>
<td>East Asian</td>
<td>1.286 (0.684, 2.416)</td>
<td>.435</td>
</tr>
<tr>
<td>South Asian*</td>
<td>1.647 (1.027, 2.641)</td>
<td>.038</td>
</tr>
<tr>
<td>Aboriginal</td>
<td>0.807 (0.485, 1.341)</td>
<td>.407</td>
</tr>
<tr>
<td>Other*</td>
<td>1.834 (1.076, 3.125)</td>
<td>.026</td>
</tr>
</tbody>
</table>

* statistically significant at a p-value of < 0.05; OR-odds ratio; CI-confidence interval; Reference Category: Caucasian Race
**Figure 3.2** Independent predictors of NICU mortality by ethnic group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>CAUCASIAN</th>
<th>AFRICAN</th>
<th>EAST ASIAN</th>
<th>SOUTH ASIAN</th>
<th>ABORIGINAL</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA ≤ 28 wks</td>
<td>4.296 (2.659, 6.942)</td>
<td>10.130 (2.288, 44.855)</td>
<td>10.930 (2.880, 41.477)</td>
<td>4.171 (1.629, 10.679)</td>
<td>ns</td>
<td>10.723 (3.436, 33.466)</td>
</tr>
<tr>
<td>SGA</td>
<td>3.773 (1.993, 7.145)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Outborn</td>
<td>1.867 (1.105, 3.154)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>SNAP &gt; 20</td>
<td>9.457 (5.904, 15.147)</td>
<td>7.517 (1.733, 32.613)</td>
<td>ns</td>
<td>4.735 (1.840, 12.182)</td>
<td>14.194 (5.080, 39.660)</td>
<td>14.261 (4.225, 48.141)</td>
</tr>
<tr>
<td>Maternal Age ≤ 24 yrs</td>
<td>0.472 (0.251, 0.888)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

Odds Ratio: (presented in brackets: 95% Confidence Interval); ns=not significant.
-all values listed are statistically significant at a p-value of <0.05

43
**Figure 3.3** Independent Predictors of NICU Mortality among African Infants.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA ≤ 28 wks</td>
<td>3.611 (0.905, 14.407)</td>
<td>0.069</td>
</tr>
<tr>
<td>Non-vertex presentation*</td>
<td>6.380 (1.475, 27.599)</td>
<td>0.013</td>
</tr>
<tr>
<td>Persistent blood infection*</td>
<td>53.162 (2.853, 990.667)</td>
<td>0.008</td>
</tr>
</tbody>
</table>

* statistically significant at a p-value of < 0.05
### Figure 3.4  Independent Predictors of NEC in the NICU.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA ≤ 28 wks</td>
<td>9.758 (6.284, 15.151)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Maternal Age ≤ 24 yrs</td>
<td>1.747 (1.134, 2.691)</td>
<td>.011</td>
</tr>
<tr>
<td>SNAP &gt; 20</td>
<td>2.080 (1.299, 3.332)</td>
<td>.002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA ≤ 28 wks</td>
<td>10.406 (6.345, 17.066)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Maternal Age ≤ 24 yrs</td>
<td>1.797 (1.109, 2.911)</td>
<td>.017</td>
</tr>
<tr>
<td>SNAP &gt; 20</td>
<td>1.744 (1.009, 3.013)</td>
<td>.046</td>
</tr>
<tr>
<td>African</td>
<td>0.580 (0.175, 1.917)</td>
<td>.371</td>
</tr>
<tr>
<td>South Asian</td>
<td>1.161 (0.549, 2.454)</td>
<td>.696</td>
</tr>
<tr>
<td>Aboriginal*</td>
<td>2.103 (1.226, 3.607)</td>
<td>.007</td>
</tr>
<tr>
<td>Other</td>
<td>0.364 (0.087, 1.518)</td>
<td>.165</td>
</tr>
</tbody>
</table>

* statistically significant at a p-value of < 0.05
Figure 3.5 Independent Predictors of severe IVH in the NICU.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNAP &gt; 20</td>
<td>3.654 (2.710, 4.927)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Apgar &lt; 7 @ 5 min.</td>
<td>1.669 (1.225, 2.273)</td>
<td>.001</td>
</tr>
<tr>
<td>Outborn</td>
<td>1.844 (1.297, 2.622)</td>
<td>.001</td>
</tr>
<tr>
<td>Maternal Hypertension</td>
<td>0.463 (0.303, 0.707)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>BW ≤ 1500g</td>
<td>14.314 (10.289, 19.914)</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNAP &gt; 20*</td>
<td>3.608 (2.544, 5.117)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Apgar &lt; 7 @ 5 min.*</td>
<td>1.892 (1.328, 2.695)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Outborn*</td>
<td>1.634 (1.082, 2.468)</td>
<td>.019</td>
</tr>
<tr>
<td>Maternal Hypertension*</td>
<td>0.450 (0.274, 0.740)</td>
<td>.002</td>
</tr>
<tr>
<td>BW ≤ 1500g*</td>
<td>14.338 (9.805, 20.967)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>African</td>
<td>0.869 (0.446, 1.689)</td>
<td>.678</td>
</tr>
<tr>
<td>East Asian</td>
<td>0.539 (0.226, 1.287)</td>
<td>.164</td>
</tr>
<tr>
<td>South Asian*</td>
<td>0.423 (0.222, 0.806)</td>
<td>.009</td>
</tr>
<tr>
<td>Aboriginal*</td>
<td>1.718 (1.100, 2.682)</td>
<td>.017</td>
</tr>
<tr>
<td>Other</td>
<td>1.221 (0.675, 2.208)</td>
<td>.509</td>
</tr>
</tbody>
</table>

* statistically significant at a p-value of < 0.05
References


CHAPTER IV

CONCLUSION AND FUTURE RECOMMENDATIONS

Studying ethnic differences in health outcomes is challenging. It implies that we can be segregated into groups and that these groups are and ought to be treated differently. In a country that strives to promote tolerance and acceptance of all peoples, cultures and languages we would sometimes hesitate to say that we are not all the same. For fear of appearing politically incorrect, we would rather not overtly proclaim our differences, particularly when those differences place us in groups, even nominal ones. However, to say that we are all the same, is to deny a person of the unique physical, biological, intellectual, spiritual, and cultural composition that makes them an individual. The previous papers have demonstrated that reproductive health concerns and outcomes do differ according to a person's ethnic background. Therefore, rather than striving to treat everyone the same, we should be encouraging medical professionals to better understand ethnic differences in reproductive risk factors and outcomes such that the best possible medical care can be offered to all.

The current studies have highlighted the diverse needs that ethnic mothers and their newborns require in managing high-risk pregnancies. From differences in prenatal risk factors to disparities based on infant morbidity and mortality, incorporating these identified differences into the obstetrical, perinatal and neonatal management of these patients will lead to improved health delivery and outcomes for all. Primary areas for continued research and intervention include:
1. Reducing prematurity, poor fetal growth and chorioamnionitis among South Asian mothers.

The potential for ethnically relevant health care initiatives is currently being investigated by researchers and health care professionals at the Surrey Memorial Hospital in Surrey, BC, where a new approach will offer tailored prenatal nutritional advice to South Asian women in the community. Targeted health care programs such as this one provides both an opportunity for increased understanding of different ethnic reproductive health needs as well as evaluating our ability to deliver these needs.

2. Improving prenatal management of high-risk mothers and maternal diabetes among Aboriginal women.

Women living in rural areas present a particular ‘at-risk’ group as they reside in areas far removed from specialty obstetric medical personnel and services. An improved system for the earlier identification and transfer of high-risk mothers may improve outcomes for both newborns and their mothers. Studies done in the developing world where more than half of all pregnant women deliver in rural areas outside an obstetrical facility, have demonstrated that traditional birth attendants who received training were better able to identify danger signs during pregnancy and refer women for more advanced care. In Bangladesh, a non-governmental program called BRAC empowers poor women living in rural areas to become leaders of health in their community. Health information and health care support can then be easily disseminated within a community. The health leaders are generally responsible for approximately 300 households and provide health education, treatment for basic ailments, collect basic health information, and refer patients to higher level care where necessary. What would a system like BRAC look like
in Canada? Are there opportunities for recruiting local leaders to improve health care delivery in more remote areas of the country? In order to accomplish the challenging task of improving rural health delivery, particularly in terms of earlier identification of high-risk pregnancies and improved health education regarding management of gestational diabetes a continued understanding of maternal reproductive risk factors is required. Furthermore, additional studies should focus on investigating the specific risk factors of rural pregnancies that lead to the need for more advanced obstetrical care.

3. Furthering our understanding of the mechanics of neonatal sepsis in the African neonate in order to reduce its occurrence.

With persistent neonatal infection serving as the primary risk factor for mortality among African newborns admitted to the NICU, this provides an opportunity to target and alleviate this current health disparity. Improving our understanding of genetic differences in immune-defense interactions may lead to improvements in our ability to treat these patients.

Further complicating the picture of ethical differences in health outcome is the influence of socio-economic disparities. Differences in socio-economic levels have long since been described as the basis of ethnic disparities in pregnancy outcomes such as infant mortality, premature delivery and restricted fetal growth\textsuperscript{3,4}. However, using community level data matching postal codes with Census Canada data on median family income levels within communities, these trends were not observed within this NICU environment. In fact, South Asian infants were at greatest risk of NICU mortality despite being born into families of similar income levels of those of their Caucasian counterparts. Although individual socio-economic indicators may be considered to be more robust than
community level data, as immigrant groups over the past 20 years have in fact been
congregating in specific geographic communities and are less likely to disperse from
these communities\textsuperscript{5,6}, the use of community-level data may be equally valuable. The
discrepancies in poor socio-economics, ethnicity and poor outcomes in the NICU simply
highlight the complexity of the multiple different factors which may influence health.
Savitz et al. suggest that such intricacies may be explained by differences in the
implications of education and/or income level between different groups\textsuperscript{7}. However, whatever the cause of these discrepancies, it becomes apparent that our ethnic background
effects us on multiple levels: biologically and socially and that health care providers need
to be able to consider multiple dimensions of the individual in order to provide the most
comprehensively available care.

There is no denying that the costs of health disparities are multiple. They span
from increased financial burdens placed on health care resources due to longer
hospitalization periods and expensive specialized NICU care, to societal costs that see
some communities under-served and discriminated against. In order to further our
understanding of ethnically-related differences in reproductive health issues and to
minimize disparities in health outcomes it becomes imperative that challenges to data
collection be addressed. Continuing to deny that ethnicity plays a role in our unique
health needs will only inhibit future attempts to improve health care delivery for all
Canadians and all peoples worldwide.
REFERENCES


