THE UNIVERSITY OF CALGARY

REHOSPITALIZATION AND USE OF MEDICAL SERVICES BY VERY LOW BIRTH WEIGHT INFANTS: FACTORS IN THE FIRST YEAR OF LIFE THAT MODIFY RISK

by

Diane Joan Morrison

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF

MASTER OF SCIENCE

DEPARTMENT OF MEDICAL SCIENCE

CALGARY, ALBERTA

SEPTEMBER, 1991

ISBN 0-315-75149-5

THE UNIVERSITY OF CALGARY

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled, "Rehospitalization and Use of Medical Services by Very Low Birth Weight Infants: Factors in the First Year of Life that Modify Risk" submitted by Dr. Diane Morrison in partial fulfillment of the requirements for the degree of Master of Science.

R.S. Sauve

Dr. R.S. Sauve, Supervisor
Departments of Community Health Sciences and Pediatrics

Rollin Brant

Dr. Rollin Brant
Department of Community Health Sciences

E.A. Henderson

Dr. Elizabeth A. Henderson
Department of Community Health Sciences

Charlene Robertson

Dr. Charlene Robertson
External Examiner
Department of Paediatrics
The University of Alberta

September 27, 1991

ABSTRACT

The major purpose of this study was to identify factors at neonatal intensive care unit (NICU) discharge which predict rehospitalization(s), duration of rehospitalization, and use of other medical services by very low birth weight (VLBW) infants in the first three years of life. An additional purpose was to identify factors, in the first year of life, which would allow more accurate prediction of subsequent rehospitalization, duration of rehospitalization and use of medical services than was available through NICU factors alone. The study population was VLBW infants cared for at Foothills Hospital NICU in 1986 and 1987 and followed through the Alberta Children's Hospital Perinatal Follow-up Program.

One hundred and thirty-one patients survived to discharge from the NICU and were seen in follow-up. Follow-up information was available for 90 patients at 36 months. Partial follow-up information was available for an additional 41 patients.

The research questions were answered by simple linear regression and multiple regression models as well as survival analyses. Modification of risk was addressed by stratified analysis and multiple regression models. Neonatal hospital stay and bronchopulmonary dysplasia (BPD) were themselves correlated and both predicted hospitalization and other medical service use in the first three years. BPD predicted duration of hospitalization from

12 to 36 months. Hospitalizations in the first year were predictive of hospitalizations in the second and third year. Duration of hospitalization in the first 12 months predicted subsequent duration of hospitalization. Medical service use in the first year predicted medical service use after 12 months. More accurate prediction of hospitalization after one year could be made by looking at whether infants with BPD or long neonatal stay had been hospitalized by 12 months. Neonatal stay, hospitalizations 0-12 months and neurologic disability in a multiple regression model were useful to predict hospitalizations 12-36 months.

ACKNOWLEDGEMENTS

This project could not have been completed without the assistance of many individuals and institutions. Help was always willingly given.

I would first like to thank my supervisor, Dr. Reg Sauve, for his wise advice, support and unfailing good humour. I learned a great deal from him.

My committee members, Dr. Rollin Brant and Dr. Betty Anne Henderson, were consistent in their helpful suggestions and their enthusiasm for the project. I really appreciated their input. Dr. Charlene Robertson kindly came to Calgary from Edmonton as my external examiner. I thank her for encouragement as well as new perspectives.

I also thank Dr. Love for encouraging me to pursue this course of study. Advice and support from faculty, colleagues and staff in the Department of Community Health Science was always available and it was a pleasure working in the Department. I owe special thanks to Heather Christianson and Lyndsey Guyn, research assistants in the Perinatal Follow-up program. They provided background information, computer assistance and ongoing encouragement.

Dr. Robert McArthur, the Alberta Children's Hospital and the University of Calgary, by approving my sabbatical leave, made it possible for me to complete this project and I thank them.

I am grateful to the staff of the medical record rooms at Alberta Children's Hospital and Foothills Hospital, who assisted with computer searches as well as chart retrieval. I also thank the record room staff at many hospitals in Southern Alberta and further afield for providing additional information.

The capable assistance of Marilyn Ellergodt in the typing of this thesis to meet the deadlines was much appreciated.

Finally I want to thank my husband Bernie for his support and willingness to do more than his share at home to allow me to complete this study, and also my little girls Kristina and Andrea for patience and understanding beyond their years.

DEDICATION

To my father, who encouraged me to wonder and learn; and to my daughters, in hope that they too, may experience the lifelong pleasure of learning.

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CHAPTER 1

INTRODUCTION

Very low birth weight (VLBW) infants are known to have increased mortality and morbidity (1,2). Increased frequency and duration of hospitalization, as well as increased medical service use by this group is well documented (3,4,5,6,7). Specific medical and sociodemographic risk factors for increased hospitalizations and use of medical services have been described for this population (3,4,5,6,8) as well as for the general pediatric population (9,10).

Most studies have described U.S. clinic populations. Although illness factors might be expected to be similar in Canada, the very different socioeconomic profile of cities in this country as well as differences in health care might be anticipated to have different effects.

The cost of medical services is a concern in the forefront today and the description and understanding of populations with high service needs is essential for appropriate health care planning.

Hospitalization itself may have negative consequences for learning as well as behaviour (11,12,13,14). Prediction of which infants are at risk for hospitalization is an important goal.

Risk, however, is not static. The biological pliability and resilience of the VLBW population has been well described (15,16). Cumulative risk models have been developed for prediction of developmental outcomes (15,16,17,18). This methodology has not yet been applied to prediction of medical service needs.

The goal of this study was to describe a VLBW population from a Canadian centre and to look at factors predictive of hospitalization and other medical service use. Modification of risk over time was also considered. This goal was achieved by posing two research questions:

1) In a population of VLBW infants can factors be identified, at the time of NICU discharge, which predict:
   a) rehospitalization in the first three years.
   b) duration of rehospitalization(s)
   c) use of other medical services (number of visits, to M.D., Emergency, or outpatient clinic).
2) Will additional factors, identified at 4, 8 and 12 months, allow more accurate prediction of:
   a) rehospitalization from 12-36 months
   b) duration of rehospitalization(s)
   c) use of other medical services

CHAPTER 2

LITERATURE REVIEW

Morbidity of VLBW infants is a frequent topic in the pediatric literature of the last two decades. Developmental outcome is the most commonly addressed. Some authors have considered the broader morbidity of these infants including rehospitalization and the use of other medical services. This review will concentrate on studies which have dealt with these specific outcomes for VLBW infants. Whenever available, Canadian data and findings will be presented. The broader pediatric literature will also be considered where it addresses factors predicting rehospitalization and medical service use, costs and effects of hospitalization, and the issue of modification of risk.

I. Frequency and Duration of Hospitalization of VLBW Infants

Increased frequency and duration of hospitalization of VLBW infants in early life has been well documented. Most studies have been done on British and U.S. populations. The only Canadian figures available were from a 1987 Pediatric Monitoring Group Draft Report for the Hamilton Wentworth District Health Council. This report, looking at under 1,000 gram infants born in 1983 and 1984, found they were 5.86 times more likely to be hospitalized and accounted for 20.7 times the number of hospital days in their first year of life compared to the average Ontario born infant (7).

Four U.S. studies based on specific neonatal follow-up clinic or intensive care unit populations have considered frequency and duration of, as well as reasons for, hospital admission in low birth weight or very low birth weight infants.

In a 1971 study from New York City, Glass reported that 17 of 99 LBW (low birth weight) (< 2500 gm) infants were hospitalized in the first 9 months of life (4). This study was divided into retrospective and prospective phases. Lack of prenatal care (23/99), receipt of public assistance (63/99), absence of father (58/99) and siblings in the home (60/99) were found to be associated with increased rates of hospitalization in the restrospective phase. In the prospective phase, these factors were weighted and used to predict hospitalization.

Hack published results of a prospective study of 90 VLBW (< 1500 gm) infants in Cleveland (5). Thirty infants (33%) required rehospitalization on 51 occasions in the first year. Rehospitalization rates in each of the second and third year were 10%. Infants at highest risk for rehospitalization in the first year were those with chronic complications resulting from severe neonatal disease (70% rehospitalized) and those with neurodevelopmental impairment (40% rehospitalized). Although socioeconomic parameters were described, their association with risk of hospitalization was not addressed.

Combs-Orme studied 79 VLBW (<1500 gm) infants cared for in a Louisiana Charity Hospital and tracked to their second birthday (3). Twenty-five infants (31%) required rehospitalization in the study period. In the hierarchical regression model proposed by this study, young maternal age, low maternal education, single mother, birth weight and gestational age were useful to predict rehospitalization.

Twenty-eight extremely low birth weight infants (< 1001 gm) cared for in the University of North Carolina neonatal intensive care unit were assessed for neurodevelopmental health and growth status at six years. Eighteen (64%) of these children had required rehospitalization compared to 5 (20%) of the term controls (19). Information regarding hospitalizations was obtained by telephone interview with mothers.

The first three of the above studies identified the populations studied as typically lower socioeconomic, younger mothers, and characterized by poor health care compliance.

Two British studies examined frequency of hospitalization in VLBW infants by record linkage studies.

Morgan, in Liverpool, in 1985, compared rehospitalization rates in 111 VLBW (< 1500 gm) infants to those in 216 term controls (20). Fifty-nine (53%) of the VLBW infants were admitted to hospital in the first year compared to 21 (10%) of controls. When admissions to the pediatric hospital were considered, the inpatient load of VLBW infants was 16 times that of controls.

The other British study suggested that rates of rehospitalization in these high risk infants were increasing. Rehospitalization rates prior to age two for VLBW (< 1500 gm) infants during two different periods of time, 1968-72 and 1974-78 (21) were considered. Over that time VLBW survival rates had improved 35 to 48% and rehospitalization for this group increased from 22 to 27%. The comparable rates for normal birth weight infants decreased from 9.8% to 8.9%. Structural defects (inguinal hernias) accounted for the majority of increase in relative risk for rehospitalization of the VLBW infants.

All the above studies relate to specific clinic or narrow geographically defined populations making results obtained difficult to generalize. One large U.S. study (n=4,989) by McCormick looked at a random sample of one-year-olds from eight geographically defined U.S. populations (6). The sample was stratified to include 82% of infants with birth weight 2500 gm or less. Information regarding hospitalizations was collected by lay interviewers when infants were approximately one year of age. This study found that 38.2% (99/259) of VLBW (< 1500 gm) infants were hospitalized in the first year of life (4.5 times the rate for normal birth weight infants). The presence of congenital anomalies or neurodevelopmental delay was a major determinant of rehospitalization for all weight ranges.

Maternal hospitalization during pregnancy, prolonged postnatal stay of the infant, low socioeconomic status, and receiving Medicaid, using hospital clinics as usual source of care or participating in special programs or clinics were associated with increased risk of hospitalization for infants with or without congenital anomalies or developmental delay.

A further study of this same population found that young maternal age and low maternal education predicted significant illnesses (greater than 30 days or requiring hospitalization) in the first year of life (22).

A number of articles in the neonatal literature have considered risk of rehospitalization in VLBW infants with specific disease entities, particularly respiratory distress syndrome (RDS) and bronchopulmonary dysplasia (BPD).

Outerbridge, in Montreal, published a follow-up study of 53 infants with RDS (23). Although apparently showing clinical and radiologic evidence of resolution of the disease prior to nursery discharge, 11 of the 53 required 33 subsequent hospitalizations over approximately a two year period.

One hundred and seventy-nine infants with BPD discharged from the Foothills Hospital Calgary NICU 1975-1980 were described in a case-control study by Sauve (24). Fifty-nine percent were hospitalized in the first year of life and 49% in the second year of life.

II. Other Medical Service Use by VLBW Infants

Some studies have addressed increased use of other medical services by VLBW infants.

Morgan's Liverpool study showed a two-fold increase in attendance at the pediatric children's hospital outpatient clinics by VLBW infants in the first year of life.

McCormick reported that the average number of physician visits in the first year of life was 14 to 16 for infants <1500 grams (2). The average number for normal birth weight infants was 10.

In Sauve's Calgary based study, infants with BPD on home oxygen had 12.25 outpatient visits (Emergency Room and physician visits) in their first year of life (25). In their second and third year of life outpatient visits were 6.71 and 4.45 respectively.

Porter, in 1986 described medical care utilization by infants discharged from a neonatal intensive care unit in New York (8). She found that a substantial proportion of NICU graduates required and used a combination of follow-up medical services. Infants with most serious medical conditions diagnosed at birth were more likely to use multiple medical specialists.

III. Impact of VLBW Infants on Health Care Services

In the studies previously described, the impact of VLBW infants on health care services has been addressed by a number of authors. Saigal reported that VLBW infants accounted for 10.7 times the number of hospital days in their first year compared to the average Ontario infant (7). In McCormick's study, 20% of all hospital days for under one-year-olds were accounted for by VLBW infants, who made up 6.4% of the total (6). Morgan described a 16-fold increase in inpatient load in the first year of life accounted for by the VLBW infants.

Greenough, in 1985, looked at the effect of a regional neonatal unit on a general pediatric ward (26). Infants under one year of age, previously cared for in the neonatal intensive care unit, accounted for 42% of the bed occupancy (determined as hospital days) for under one-year-olds. VLBW infants accounted for 12%. The results were possibly misleading because NICU graduates from rural areas were accepted for admission although the hospital's usual catchment area did not include these areas. Also, a small number of NICU infants had prolonged hospitalization.

IV. General Pediatric Literature Risk Factors for Rehospitalization and Medical Service Use

Some articles in the general pediatric literature, not restricted to VLBW infants, have looked at risk factors for rehospitalization and medical service use. Articles of particular relevance to the present study will be briefly presented.

An Oxford study used linked medical records to relate maternal and infant data to later hospitalization records

(9). Low maternal age doubled the frequency of rehospitalizations. Congenital anomalies in infants were the largest single cause of admission.

The use of health services by chronically ill and disabled children has been evaluated. In a case control study by Smyth-Staruch, children with chronic illness used ten times the health services (doctors, physiotherapists, etc.) used by controls (10).

Day care as a risk factor for hospitalization was considered in two studies. Anderson presented a case control study of 102 children admitted to hospitals in Atlanta 1984-1985 with lower respiratory tract infections (27). He found that day care attendance (regular with more than six children) was associated with lower respiratory infection. Wald performed a prospective one year study of children in day care in Pittsburg (28). Children in day care were more likely than controls to have more than four severe illnesses. Twenty-one percent of day care children and 3% of controls required myringotomy tubes.

Life events have been described as associated with increased rates of hospitalization by a number of authors. Beautrais reported on a birth cohort of 1,082 children over three years (as part of the Christchurch Child Development Study; a longitudinal birth cohort study) (29). Hospital visits and G.P. visits increased significantly with increased family life events such as illness in close family members, financial problems, or marital disharmony.

Fergusson, in another portion of the Christchurch Child Development Study, looked at 1265 children over the first five years of life (30). Hospitalization rates were highest in children from socially disadvantaged families and families facing stress. Heisel published results of a case control study of children admitted to medical, surgical or psychiatric services and children with chronic illnesses (31). Children in any of these patient populations had more life events in the year before illness than control (healthy) children.

Maternal smoking has also been linked to lower respiratory tract illness and hospitalization in the literature. Fergusson, again as part of the Christchurch Child Development Study, showed that lower respiratory illness in the first year of life had a direct linear relation to maternal smoking determined by structured interviews (32). Harlap did a prospective study of 10,670 infants as part of the record linked Jerusalem Perinatal Study (33). Infants of smoking mothers had significantly more hospital admissions for bronchitis or pneumonia than infants of non-smoking mothers.

Sociodemographic factors have been associated with hospitalization in the general pediatric population. McCormick considered infant morbidity in a group of infants born to high risk young mothers (34). Infants of mothers 17 years of age or younger had higher rates of illness requiring hospitalization.

Taylor, in a British study of 1031 children of teenage mothers, found that infants born to and living with teenage mothers were more liable than controls to be hospitalized in the first five years (35). In a recent study, Wilson described rehospitalization of infants born to adolescent mothers (36). Normal birth weight, but not low birth weight, infants of these mothers were noted to have higher rehospitalization rates than controls born to older mothers.

Finally, at a recent Society for Pediatric Research Meeting, Jacobson asked the question, "Does hospitalization in early life lead to later increased use of medical resources?" Hospital and outpatient billing records for 1987, for infants born "healthy" (discharged in less than nine days) October 1984 to December 1985, but subsequently hospitalized in the first three months of life, were examined and compared to those of controls not hospitalized in the first three months (37). Infants with a history of early hospitalization had more medical charges later on (possibly due to changes that early hospitalization has on parental perceptions).

V. Cost of Hospitalization

The cost of hospitalization and use of medical services, emotionally and financially, has been studied. In a case control study Breslau interviewed families of children with chronic disabilities (not linked to low birth weight) in Cleveland (38). Married mothers caring for disabled children spent increased time in housework and child care. Time spent participating in medical procedures and attending physician visits was six times that for parents of a non-disabled children. In a second study, the same author described that in two parent families (particularly black and low income families) care for a disabled child resulted in reduced maternal labor force participation (39).

In 1985, the Committee to Study the Prevention of Low Birthweight from the Institute of Medicine Division of Health Promotion and Disease Prevention Washington D.C. estimated the potential cost savings which could be achieved by reducing the percentage of LBW infants (40). The target population considered was the total national maternal cohort of women 15-39 years of age, on public assistance with less than a twelve year education. If the percentage of LBW infants in this group was decreased from 11.5% to 10%, $1,563,516 would be saved in rehospitalization costs in the first year of life. If it was further reduced to 9%, $2,602,512 would be saved.

VI. Effects of Rehospitalization

A number of studies have described behaviour and learning difficulties in children hospitalized early in life. Most have not considered the association with birth weight. In 1975 Douglas carried out a longitudinal study using the 1946 British National Survey Cohort (11).

interview data had been collected at two year intervals over 26 years. Prolonged or repeated hospitalizations before five years of age increased the risk of later behavioural disturbance, reading difficulty and delinquency.

In 1976, Quinton tried to replicate the findings of Douglas (12). Two randomly selected samples of disturbed and non-disturbed 10 year old children from school screenings of children with homes on the Isle of Wight were obtained. Information regarding past hospitalizations was obtained from interviews with mothers. Again repeated hospitalizations were significantly associated with emotional disorder and conduct disorder in later childhood.

Shannon in 1984 reported on a six year longitudinal study of the relationship between duration of hospital stay in the preschool years and behaviour at six years in a birth cohort of New Zealand children (13). He demonstrated a slight but consistent trend of increased behaviour problems with increased length of hospital stay; however, the association was statistically significant only in children from socially disadvantaged homes.

One recent Canadian study looked at cognitive outcomes in VLBW infants. Seventy VLBW (<1500 gm) infants were evaluated cognitively at a mean age of 88 months (14). Children who had been hospitalized following NICU discharge had significantly lower cognitive scores than those who had no rehospitalizations. Severity of neonatal illness, birth weight, and socioeconomic status were not different in the two groups.

VII. Modification of Risk

In the perinatal literature, several studies have proposed the use of cumulative risk indices to predict developmental outcome. The concept is attractive because it acknowledges the biological pliability of children: i.e., the potential for transiently abnormal findings in children who subsequently develop normally, and the potential for early normal assessments in children later confirmed to have neurodevelopmental abnormalities.

Field, in 1978, described a process of formulating a cumulative risk index, including perinatal and outcome factors (15). Multiple developmental assessments were carried out in the first year of life for medically at risk infants and normal controls. Discriminant function analysis was used to find the most efficient early predictors and later discriminators for continuing risk of developmental delay. Parmalee and Sigman described a similar risk score system for infants at high risk for mental, motor and sensory handicaps (16). They used a strategy of multiple short-term predictors scoring prenatal and perinatal factors, neurodevelopmental reassessment of the infant in the first months of life and finally behavioural assessment later in the first year of life. In this study, follow-up factors enhanced risk prediction.

Aylward and Kenny proposed a Risk Routes Model (17). In their model infants are serially assessed in medical/biological, environmental/psychosocial and behavioural/developmental areas. The scores at each time and over time are added to determine ongoing level of risk for developmental abnormalities. This model has not yet been extensively studied.

More recently Gordon and Jens proposed a Moving Risk Model. Their model involves multiple assessments over time. However, at different times weighting changes for different aspects (e.g., medical factors of more importance perinatally, psychosocial factors of more importance later). In addition, their model, unlike those previously mentioned, allows an infant to move out of risk on the basis of normal test results (18).

Most of these models have shown themselves to be useful scientifically, achieving statistical significance in prediction of outcome. Their clinical usefulness in predicting patient outcomes has not been well demonstrated.

VIII. Limitations of Previous Studies

The previous studies described have been U.S. or British and with the exception of McCormick's eight geographic region study have used specific clinic or narrow geographically defined populations. These have tended to be populations characteristic of large cities with a large percentage of low income families as well as young and single mothers. It would be difficult to generalize the results of such studies widely.

Data collection in McCormick's large study, as in some of the others described, relied on interviews with mothers for information regarding hospitalizations, raising the possibility of error due to poor recall. Some of the studies used record linkage to follow a birth cohort. Again there is a likelihood of error in this method.

Where models have been proposed to predict risk, they have been constructed by choosing from many potential variables. Those variables which look most useful on initial inspection are incorporated or alternately those which perform least well are removed in a step wise fashion from multiple regression models. This method of model construction limits the statistical validity of inferential statements made from the model (41).

CHAPTER 3

PILOT STUDIES

I. Impact of NICU Graduates on Alberta Children's Hospital Admissions

A) Methods

Names and birthdates of children less than one year, one to two years, and two to three years, hospitalized at ACH in 1990 were obtained (1354 admissions). Names and birthdates of infants cared for in Foothills NICU 1987 to 1990 were also obtained (2766 infants). The records were linked manually by matching on birthdate and name. In any case where doubt existed (e.g., in the case of twins not yet named at discharge from Foothills) the ACH hospitalization record was checked to confirm matching.

B) Results

Table 3-1 shows total admissions, patient days and lengths of stay for children 0-1, 1-2, and 2-3 years of age admitted to ACH in 1990. Numbers and percentages who were NICU graduates and numbers and percentages who were VLBW infants are also shown.

TABLE 3-1
ACH Admissions 1990

Age (yrs)		TOTAL	ALL NICU Grads	% NICU Grads	VLBW NICU Grads	% VLBW NICU Grads
0-1	Admissions	1354	210	16	67	5
	Patient Days	9188	2425	26	962	10
	Average Length of stay in days	6.8	11.5		14.3	
1-2	Admissions	624	72	12	20	3
	Patient Days	3392	844	25	261	8
	Average Length of stay in days	5.4	11.7		13.1	
2-3	Admissions	412	33	8	8	2
	Patient Days	1907	164	9	37	2
	Average length of stay in days	4.6	4.97		4.6	

NICU graduates would represent approximately five percent of the pediatric population of Calgary (12,000 births annually, 600 NICU admissions yearly) and a smaller percentage of the neonatal and pediatric population of the Southern Alberta catchment area for ACH and FHH (Foothills Hospital). These infants, however, account for 16% of hospital admissions of children under age one and 26% of patient days in this age group. The VLBW infants are represented proportionately to their representation in the overall NICU population (i.e., approximately 30%). Average length of stay for the NICU graduates (11.5 days) is approximately twice that for the non-NICU graduates (5.9 days).

In the second year of life, NICU graduates make up 12% of admissions but still represent 25% of patient days. Length of stay remains approximately twice that of non-NICU graduates.

In the third year NICU patients are only 8% of ACH admissions and 9% of patient days. Length of stay is no different from average length of stay for non-NICU graduates.

C) Discussion

NICU graduates make up a disproportionate number of ACH admissions and patient days in the first two years of life. In the third year this overrepresentation diminishes markedly and length of stay is shortened. This finding is not different from what has been cited in the literature for other populations. It is important for health care institutions to recognize the disproportionate need for hospital care experienced by these children in their early years. It is also important to explore the factors that predispose individual infants to increased medical care needs.

II. <u>Pilot of Data Collection</u>

A) Method

Twenty-five charts of infants weighing 500 to 1250 grams cared for in Foothills NICU in 1988 and followed through the Perinatal Follow-up Program were pulled at random. A menu driven program was written to obtain information on selected patients from Team-up, the Perinatal Clinical Data Base (42). Data collection forms were used to record additional information from the Perinatal Clinic Research Chart as well as the ACH Clinical Record. Hospitalizations were confirmed on the ACH Computer Data Base (Health Care Management System) (43). Descriptive statistics were compiled for these cases.

B) Results

Only 18 of the above patients survived to discharge from the NICU. Only information for the first year was available on the computer data base for most patients. (18-month visits for five patients had been entered.) Fourteen of the 18 patients were rehospitalized in the first year of life (77%). They had an average of 9.4 outpatient visits. Actual dates of hospitalization were not available for 8 of the 16 admissions. On 5 of the 18 charts dates of discharge from hospitals to which infants were transferred were unavailable. Independent variables at NICU discharge were examined to determine if the appropriate information was being assessed.

C) Discussion

This pilot project suggested the modification or deletion of some variables (e.g., the definition of 'pulmonary insufficiency' was too inconsistent to make it a useful parameter). Certain parameters coded 'other' in the data base would need clarification from the clinical record. While frequencies of the independent variables were previewed, no deletions were made based on the findings because of the very small sample size involved. The entire process of data collection was streamlined by experience doing the pilot. Data collection forms were modified. It was anticipated, based on the pilot, that information regarding dates of hospitalization and discharge from hospital of transfer might not be available for some files.

The pilot information was briefly reviewed for content validity in terms of whether this population appeared representative of VLBW infant populations in the literature. The frequency of hospitalization was high and the number of outpatient visits low for the first year for these patients (compared to the literature). The sample size was very small so these may not be truly representative. It is also possible that some hospitalizations (e.g., O_2 saturation monitoring) at this centre could be considered outpatient visits at other centres. Also this study does not include public health clinic visits (e.g., for immunizations) in other medical service use.

An initial look at reliability of data obtained was done as part of the pilot study. Sixteen admissions were recorded. All were confirmed on the ACH chart and/or on the ACH computer data base. No hospitalizations were found which had not been recorded.

CHAPTER 4

METHODS

I. Study Design

This is a retrospective cohort study to identify factors predicting and modifying rate of rehospitalization, duration of rehospitalization and medical service use by VLBW infants.

A) Study Population

The study population is all infants weighing 500 to 1250 grams who survived to discharge from Foothills Hospital NICU in 1986 and 1987 and were routinely followed through the Alberta Children's Hospital Perinatal Follow-up Program.

B) Ethical Approval

Ethical approval for the study was obtained from the Conjoint Medical Ethics Committee of the University of Calgary (Appendix II).

II. Data Base

Data was collected on these infants at NICU discharge and at follow-up clinic assessments. At nursery discharge, a Perinatal Follow-up clinic research assistant reviewed the nursery file and abstracted relevant information. Copies of data collection forms are included in Appendix III. All data base parameters had clearly stated definitions and codes. Information was entered into the perinatal data base on the University of Calgary Multics Computer System. The data base management system was MRDS (Multi Relational Data

Store) (44). Infants returned to the Perinatal Follow-up Clinic at ACH at 4, 8, 12, 18 and 36 months adjusted age. They were seen by a nurse coordinator as well as a multidisciplinary team of therapists. Each team member recorded relevant information and assessment results. The Follow-up clinic research assistant reviewed all clinic reports and abstracted relevant information for entry into the computer data base.

Data needed for this study was obtained by writing a menu driven program in Team-Up System Query Language. This provided all relevant variables at the time of discharge and for each follow-up visit for each infant. Mr. L. Guyn (part-time computer programmer and research assistant in the Follow-up Program) assisted by aggregating the follow-up visit data so that each variable was represented by one value (e.g., total outpatient visits 0-12 months, day care attendance recorded at any visit 0-12 months etc.) The aggregation of data was done using SPSS. (45).

A) Further Data Collection

Further information was obtained from the Perinatal Follow-up Clinic Research files (clarification of variables coded 'other' in the data base and Foothills Hospital Labor and Delivery Record giving mother's smoking status and perinatal care). Hospitalizations were confirmed by the ACH clinical record which also provided dates of hospitalization, diagnoses, family address, primary care physician, and information regarding day care attendance.

The ACH Health Care Management System Computer data base also provided information regarding dates of hospitalization.

For 25 files, information regarding dates and duration of rehospitalization(s) or dates of discharge from hospital to which the infant was transferred after birth, was unavailable. As these missing values affected both independent and dependent model variables an effort was made to complete the data. Fourteen letters were sent to other hospital medical record rooms (Appendix 1). Thirteen hospitals replied providing almost complete information for these variables.

III. Data Preparation

The following operational definitions were used in collection and preparation of the data for analysis. In some cases, as indicated, continuous variables were converted to dichotomous variables for some analyses.

A) Outcome Variables

Hospitalization(s)	-	exact number of hospitalizations
	-	dichotomous yes/no
Duration of Hospitalization(s)	-	date of admission subtracted from date of discharge
Medical Service Use	-	total number of visits to G.P., pediatrician or other specialist, outpatient clinics, or emergency room

B) NICU Discharge Variables

Birth Weight	-	recorded in the nursery in grams
	-	dichotomous <750gm/ ≥750 gm
Gestation	-	recorded in the nursery in weeks
Acute Stay	-	days hospitalized after birth (including hospitals to which infant was transferred)
	-	dichotomous < median ≥ median
Prenatal Care	-	yes/no 'no prenatal care' indicated on Foothills Hospital Labor and Delivery Record
Maternal Age	-	age of biological mother at delivery
	-	dichotomous <18 years/ ≥18 years
Maternal Education	-	total years in school for sociological (current caretaking) mother
	-	dichotomous <12 years/ ≥ 12 years
Single Parent	-	any arrangement other than a mother and father figure in the home (whether married or not)
Siblings	-	yes/no including all living children whether or not in home and adopted children
Blishen	-	socioeconomic index for sociological father's occupation
	-	dichotomous <30/ ≥30 (46)

Income	-	compared to median Canadian family income set at 100 (from census data based on postal code) (47)
	-	dichotomous < median/ ≥ median
Rural	-	living in community with population less than 25,000
Smoking	-	mother designated 'smoker' on Foothills Labor and Delivery record
Seizures	-	more than one seizure noted in nursery
IVH	-	intraventricular hemmorhage none/Grade 1/ ≥Grade 2
Congenital anomalies	-	described individually
IPPV days	-	days on a positive pressure ventilator
RDS	-	diagnosed as having respiratory distress syndrome or hyaline membrane disease
PDA	-	diagnosed as having patent ductus arteriosus
PFC	-	diagnosed as having persistent fetal circulation
BPD	-	diagnosed as having bronchopulmonary dysplasia and on oxygen at 28 days

Pneumothorax	-	having had at least one pneumothorax during nursery stay
Breast-fed	-	breast-feeding primary method at discharge

C) Variables in First Year of Life

Care by G.P. vs Pediatrician	-	physician(s) indicated by parents at 12-month clinic visit as providing primary care
Day Care	-	attendance at day care, day home, or cared for with more than four other children at least twice weekly
Foster Care	-	cared for in foster home
Family Disruption	-	significant life events (e.g., new parent, separation or divorce, death or severe illness in family, caretaking parent to work, birth of sibling, etc.)
Neurologic Disability	-	mild to severe cerebral palsy (CP), mental retardation, or seizure disorder
Neurodevelopmental Abnormality	-	suspect, abnormal or profoundly abnormal on Amiel Tison longitudinal neurodevelopmental assessment

Gross Motor Function Abnormality	-	classified abnormal on physiotherapy assessment of tone, gross motor function and reflex development
Fine Motor Function Abnormality	-	classified as abnormal on occupational therapy assessment of fine motor function
Nutritional Abnormality	-	requirement for intensive nutritional support (e.g., parenteral feeding or gastrostomy feeds) and/or marked deviation from growth velocity curve
Cognitive Function Abnormality	-	classified abnormal (< 72) on Bayley assessment of cognitive function (usually done at 8 months)
Family Social Function	-	assessment of family function by clinic social worker
Continuing Breast Feeding	-	partial or complete breast-feeding

Following collection of the data it was decided that certain parameters were not appropriate for further analysis. Only one infant was in foster care, one had seizures in the neonatal period and two were diagnosed as having persistent fetal circulation. Occupational therapy assessment for fine motor function was not done in the majority of infants in the first year of life. The social work assessment of family social function provided an assessment of the need for further intervention but not a standard measure for comparison.

Follow-up clinic visits were scheduled at 4, 8 and 12 months adjusted age but did not always take place at the exact ages. For purposes of this study, visits up to 15 months were considered as reflecting events of the first year. Similarly some "36-month" visits occurred up to 42 months adjusted age. The outcome variables hospitalization and duration of hospitalizations were corrected to reflect exactly 0-12 months and 12-36 months (by actual dates of hospitalization). Outpatient visits were, however, used as reported at the clinic visits.

IV. Data Analysis

The dependent variables in this study are hospitalization(s), duration of hospitalization, and other medical service use from 0-36 months and from 12-36 months. Multiple independent variables from the time of NICU discharge and the first year of life are considered. In the original study design variables were preselected for inclusion in multiple regression and logistic regression models. Selections were based on previous findings in the literature as well as considerations of the unique nature of this population.

A) Descriptive Analysis

Independent variables were described and their relationship to the dependent variables evaluated by graphs, contingency tables, correlation matrices and simple linear regressions. The statistical software used for all of these analyses was Minitab (48). Correlation of variables was further evaluated by testing equality of group means in the statistical software programme BMDP (49).

B) Multiple Regression Models

At NICU discharge, neonatal hospital stay, BPD and neurologic events (intraventricular hemorrhage or seizures) were selected as the most likely medical factors to predict the outcome variables. Seizures were so rarely reported (once) that this variable was limited to IVH. After much discussion, family income compared to median Canadian family income was selected as the most likely variable to differentiate lower and upper socioeconomic status in this population (other variables such as single mother were likely to be represented by too few individuals to be useful in the model). In the first year of life, the event of being hospitalized and a diagnosis of cerebral palsy, mental retardation or seizure disorder were the medical variables selected. Attendance at a day care and family distress were chosen as environmental influences described in the pediatric literature to increase risk of subsequent illness and hospitalization. They had not previously been studied in VLBW infants. Multiple regression models were fit in Minitab.

C) Logistic Regression Models

Independent variables selected for use in the logistic regression models were the same as those used in the multiple regression models. The outcome variables were hospitalization 0-36 months (yes/no) and hospitalization 12-36 months (yes/no). Logistic regression models were done in the statistical software package Glim. (50).

D) Survival Analysis

Life table survival analysis was used to further evaluate the relationship of the independent variables to the outcome measures. This method was selected because it allowed the use of data from cases where full follow-up information was not available. Whether or not an affected individual (for each variable) was more likely to be hospitalized than an unaffected individual was the determination which was clinically relevant. The difference in likelihood was assessed for statistical significance by a Mantel-Cox statistic. The statistical software package BMDP was used for the survival analyses.

E) Modification of Risk

Modification of risk was first evaluated by analysis of stratified contingency tables. This was done in the statistical software package dEpid (51). Multiple regression models using first year variables as well as NICU variables were looked at for their ability to better predict outcome from two to three years.

F) Sample Size

A power analysis had been carried out as part of the research proposal. It was assumed that 40% of the study population would have BPD. VLBW infants with BPD would be twice as likely to be hospitalized over three years as those without. A three year hospitalization rate of 33% was assumed for infants without BPD. To attain 80% power, a total sample size of 85 would be required to assess BPD as a predictive factor for rehospitalization. This sample size was achieved for the initial regression models. It was exceeded for the survival analyses and later regression models (looking at hospitalization as a percentage of time under observation).

CHAPTER 5

RESULTS

I. Data Availability

One hundred and forty-five infants survived to discharge from Foothills NICU in 1986 and 1987. Fourteen of these infants were not seen in follow-up (four died shortly after NICU discharge, ten were lost to follow-up). Descriptive statistics and survival analysis utilized data from the remaining 131 infants. Complete three year follow-up information was available for 90 infants. These were included in the initial regression models. Descriptive statistics done on the regression subgroup indicated this population was not different from the larger study population (n=131).

II. Data Reliability

The outcome 'hospitalization' was confirmed for ACH admissions by the ACH clinical record and by the HCMS (Health Care Management System) computer data base at ACH. Some information regarding previously unrecorded hospitalizations elsewhere was obtained when record rooms responded to the request for dates of specific hospitalizations. The magnitude of changes made to the data base for this outcome variable was unexpected. Thirty-three of 131 files had changes made. Twenty-eight changes involved hospitalizations recorded but not confirmed. Thirty-two changes involved hospitalizations which had not been recorded. Some errors could be accounted for by past clinic recording practices. Scheduled hospitalizations for O_2 saturation monitoring had not been recorded during the earlier part of this study. At the 36-month visit parents were asked about hospitalizations "in the preceding year" possibly missing hospitalizations which occurred between the 18-month visit and 24 months. Three individual data entry errors accounted for the largest number of errors. Lack of parental recall in reporting hospitalizations was also important. Table 5-1 summarizes errors found. In addition to the errors noted, 15 additional hospitalizations were added to the data base by information from the ACH clinical record, ACH computer data base, or information from other hospitals. These were hospitalizations of children who were no longer seen through the Follow-up clinic.

III. Description of Population

One hundred and thirty-one infants survived to discharge from Foothills NICU in 1986 and 1987 and received follow-up care through the ACH Perinatal Follow-up Clinic.

A) Morbidity

Fifty-seven infants (44%) had been rehospitalized by one year of age and 63 (48%) by three years of age. Figures 5-1 and 5-2 are survival curves for rehospitalization in the whole population 0-12 months and 13-36 months respectively. The mean duration of rehospitalization 0-12 months was

TABLE 5-1
Errors in Outcome Variable Hospitalization

Hospitalization Recorded in Error

Error	#
Data Entry Errors	22
Same hospitalization recorded twice	2
Long hospitalization or transfer recorded as two	2
Surgery done as outpatient	1
Unknown	1
TOTAL	28

Hospitalization Omitted

Error	#
Oxygen Saturation	5
18-24 Months	6
Recorded on 'partial assessment' but not in data base	5
Not reported by parents	16
TOTAL	32

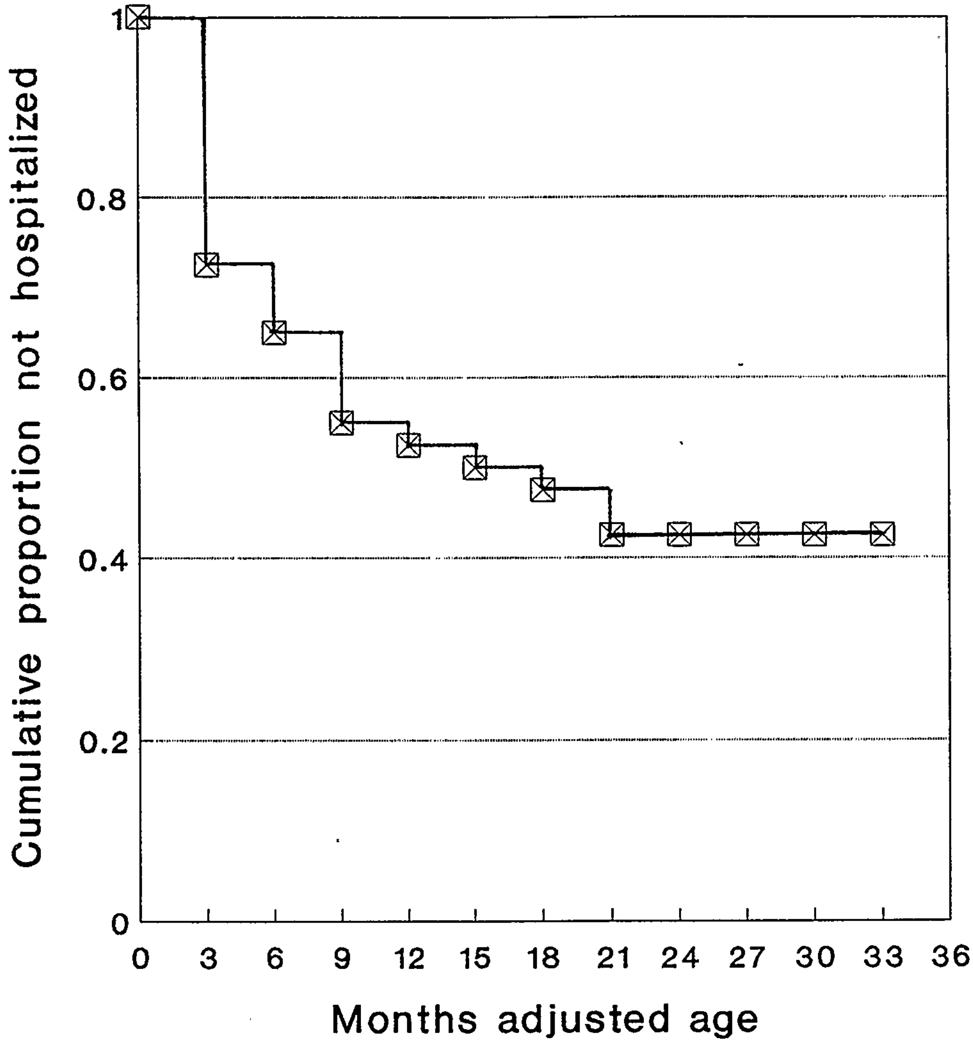


FIGURE 5-1

Survival curve of hospitalization 0-36 Months

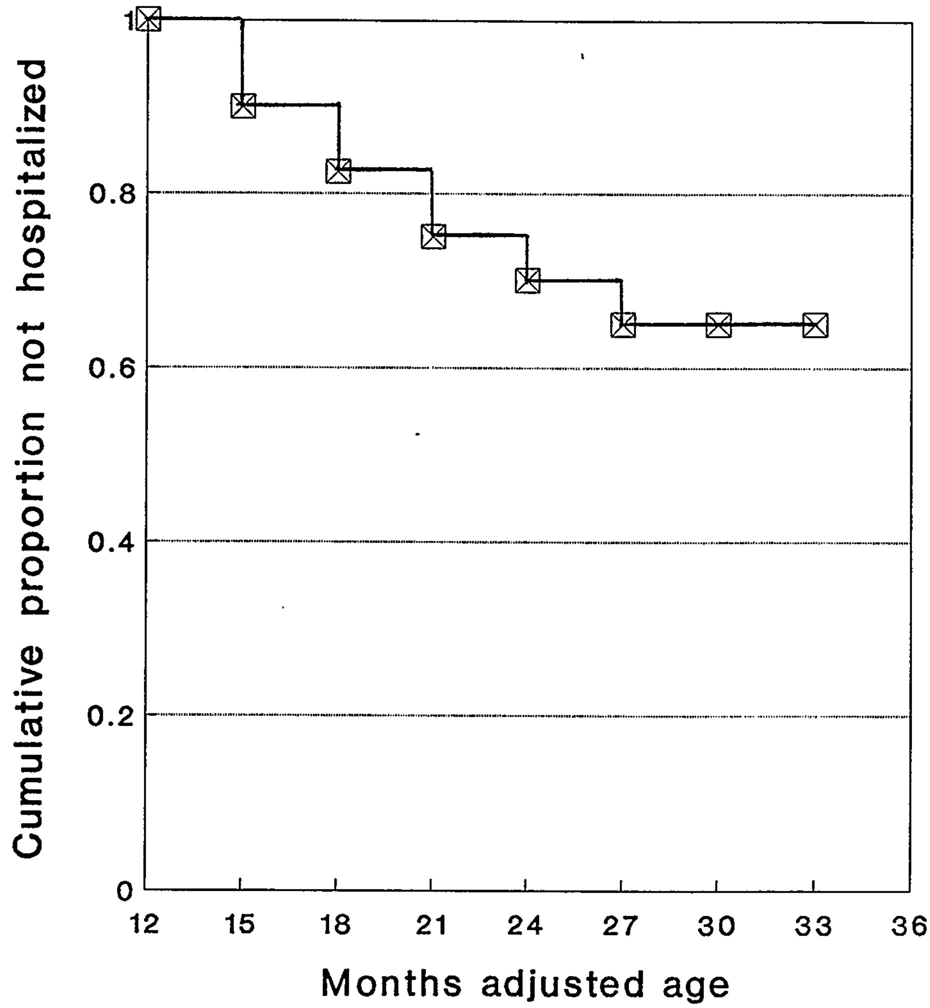


FIGURE 5-2

Survival Curve of Hospitalization 12-36 Months

12 days and 12-36 months was 3 days. The average number of outpatient visits in the first year was 12 and from 1 to 3 years was 8. These numbers are comparable to what has been previously reported in the literature.

Table 5-2 summarizes the independent study variables at NICU discharge. Table 5-3 summarizes variables for the first year of life.

B) NICU Discharge Variables

1) Medical Factors

The mean birth weight of study infants was 937 grams and the mean gestation 28 weeks. The average acute length of hospital stay after birth was 90 days (median 85 days). The mean duration of ventilation was 22 days (median 12 days). Sixty-six percent of the infants were diagnosed as having respiratory distress syndrome and 53% as having patent ductus arteriosus. Sixty-two percent of infants had BPD. Eighteen percent had at least one pneumothorax during their nursery stay. Twenty-one percent had Grade 1 intraventricular hemorrhage and nine percent had Grade 2 or greater intraventricular hemorrhage. Only one infant had a serious congenital anomaly (transposition of the great vessels). Twenty-one percent were noted to have inguinal hernias and nine percent of infants were breast-fed at the time of discharge.

The prevalence of serious congenital anomalies in the population initially appeared very low compared to expected overall rate in newborns. It is, however, comparable to

TABLE 5-2
Description of Independent Variables
at NICU Discharge for Study Population

	Number Affected	N	Percent Affected
MEDICAL FACTORS			
BPD	81	131	62
RDS	86	131	66
PDA	69	131	53
Pneumothorax	24	131	18
IVH Grade 1 ≥Grade 2	27 12	131 131	21 9
Serious Congenital Anomaly	1	131	<1
Inguinal Hernia	28	131	21
Breast-feeding	12	130	9
SOCIODEMOGRAPHIC FACTORS			
Maternal Age <18 years	2	131	1.5
Maternal Education <12 years	17	131	13
Single Parent	16	131	12
Sibling(s)	62	127	49
No Prenatal Visits	0	131	0
Maternal Smoking (during pregnancy)	45	131	34
Rural Address	40	129	32
Income < Canadian Median	41	128	32
Blishen Index <30	21	104	20

TABLE 5-3
Description of Independent Variables in First Year for Study Population

	Number Affected	N	Percent Affected
MEDICAL FACTORS			
Neurologic Disability	6	129	5
Nutritional Abnormality	17	124	14
Cognitive Function Abnormality	11	109	10
Neurodevelopmental Assessment			
Suspect	10	122	29
Abnormal	15	122	8
Gross Motor Function Abnormality	15	114	13
Breast-fed	15	126	12
SOCIODEMOGRAPHIC FACTORS			
Primary Care by			
Pediatrician	71	118	61
GP & Pediatrician	29	118	25
Day Care Attendance	10	123	8
Family Disruption	29	124	22

what has been noted previously in a (< 1250 gm) population from Foothills Hospital NICU reported by Sauve (52). It may be that severe congenital anomalies are incompatible with life in such a low birth weight population.

2) Sociodemographic Factors

Thirteen percent of mothers had less than 12 years education and 10% were single parents. Forty-nine had at least one other child. Only two mothers were under the age of 18. All mothers received some prenatal care. Thirty-four percent of mothers smoked during pregnancy. Thirty-one percent of mothers lived outside urban centres. Thirty-two percent of families had less than the median Canadian family income (estimated from census data based on postal codes). Eight fathers were students. Of the remaining 104 families for whom information was available, 20% had a Blishen socioeconomic index less than 30. The mean Blishen index for the population was 43, which is at the mean for Canadians.

C) First Year Variables

1) Medical Factors

Five percent of infants were diagnosed as having cerebral palsy, mental retardation, or seizure disorder in the first year of life. Fourteen percent had nutritional abnormalities. Ten percent were considered to have abnormal cognitive function. Neurodevelopmental assessment was suspect for 29% and abnormal for 8% of infants, 13% had abnormalities of gross motor function. Twelve percent of infants were receiving some breast milk.

2) Sociodemographic Factors

Eighty-five percent of infants had a pediatrician identified as involved in primary care (61% were cared for only by a pediatrician and 25% by a family doctor and a pediatrician). Eight percent of children attended day care or day home programs. Twenty-two percent of families were experiencing family disruption.

Initially the percentage of infants in group care facilities seemed very low. A current figure for all infants under 12 months in "licensed day care" in Calgary obtained from Alberta Family and Social Services was 355 (which would represent less than 5% of under one-year-olds). This figure would not include infants in dayhomes and unlicensed group care arrangements but does suggest that infants under one year are not commonly cared for in day cares. In addition, parents of infants at high risk for respiratory illness may have been counselled to avoid group care.

IV. Comparison to Other Populations in the Literature

This clinic population differs from those previously described in the literature. It is the first Canadian population looked at in this way. Table 5-4 summarizes findings for the study population and other populations reported, for which similar parameters were available. The infants in this study are smaller and less mature. Their period of hospitalization after birth is longer. The mothers are older, better educated and less often single parents. Overall socioeconomic status is higher (measured by a number of parameters). All mothers in this population received some prenatal care. Frequency of rehospitalization, duration of hospitalization and number of outpatient visits are similar to those reported in other studies.

TABLE 5-4
Comparison of Study Population to Other Populations in the Literature

Parameters	Study Pop.	Combs-Orme[3]	Hack[5]	McCormick[6]
Population	<1250gm	<1500gm	<1500gm	≤1500gm
Mean birth weight (gms)	936.9	1233.4	1200	
Mean gestation (weeks)	27.7	31.8	29.5	
Mean Hospitalization after birth (days)	90.28	53.5	63	
MATERNAL AGE				
Mean (yrs)	27.9	22.1		
%<18 years	2		12	19.8
MATERNAL EDUCATION				
Mean (yrs)	13.5	11.6		
% < High School	13.0		41	21.7*
% Single Mothers	12	67.1	39	25.2*
Income	41/128 < Canadian median 21/112 Blishen <30		52% on medicaid or no insurance	family income 23.7% < $8,000*
Prenatal Care	100% prenatal care	65.8% fewer than 5 prenatal visits		21.1% in 3rd trimester or none*
Rehospitalization % of population	44% 0-1 yr 48% 0-3 yr	31.6% 0-2 yr	33% 0-1 yr 10% 1-2 yr 10% 2-3 yr	38.2% 0-1 yr

* these parameters on all infants ≤2,000 gm

CHAPTER 6

ANALYSIS

In this chapter results of primary analysis and exploratory analysis are presented. A p-level of 0.05 is used to determine statistical significance. Where significance is demonstrated p-levels and regression output are given. Regression output is presented in tabular form as shown in Table 6-1, a generic table.

TABLE 6-1
Regression of Variable 1 and Variable 2 on Outcome Variable

Predictor	Coefficient	Standard Deviation	T-ratio	P-value
Constant	A			
Variable 1	B_1			
Variable 2	B_2			

The regression equation can be taken from the tabular output:

$$\text{Outcome variable} = A + B_1 + B_2$$

Predictions are based on estimates for corresponding stratum means (given by the regression coefficients B_1 and B_2) and are rounded to the nearest clinically relevant unit.

I. Primary Analysis

The "initial research question" addressed was whether in a population of VLBW infants factors could be identified at the time of NICU discharge, which predict rehospitalization(s) in the first three years, duration of rehospitalization and other medical service use. Variables for inclusion in the regression models had been preselected based on previous findings in the literature as well as unique considerations related to this study population.

Independent Variables
Hospitalizations in the First Year
Day Care
Family Distress
Neurologic Disability

A) Rehospitalization in the First Three Years

Model variables were initially looked at by means of scatterplots and contingency tables. On this inspection only neonatal stay appeared likely to predict subsequent hospitalizations (Figure 6-1), (Table 6-2).

A correlation matrix for the model variables (Table 6-3) indicates low correlation between the outcome variable hospitalizations 0-36 months and each of the independent variables listed above. Moderate correlation is noted between neonatal stay and BPD and between IVH and BPD.

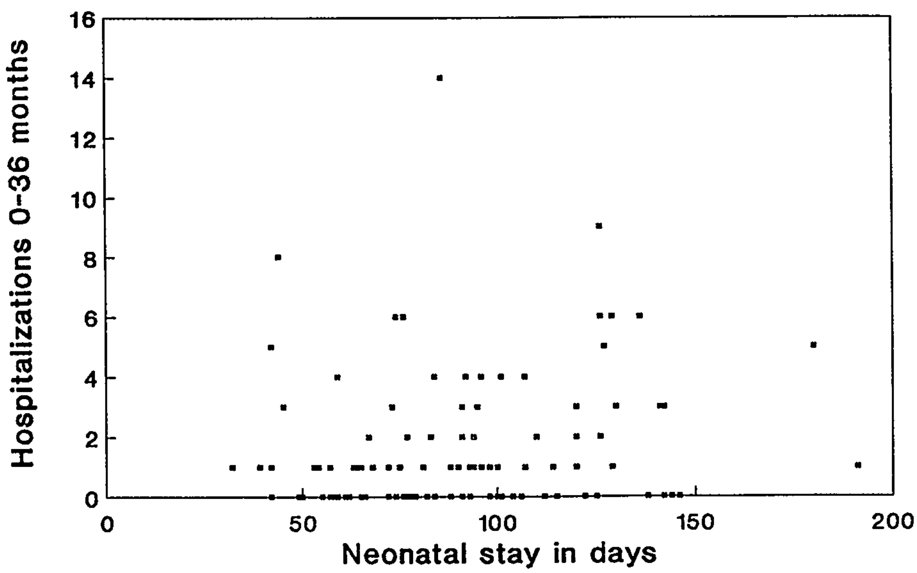


Figure 6-1

Neonatal Stay in Days and

Hospitalizations 0-36 Months

TABLE 6-2
Hospitalization 0-36 Months and Neonatal Stay

Hospitalization 0-36 mos	Neonatal Stay <Median	Neonatal Stay ≥Median	TOTAL
yes	24 (46%)	38 (68%)	62
no	28 (54%)	18 (32%)	46
TOTAL	52	56	108

(Chi square = 5.194; p = 0.0227)

The correlation between neonatal stay and BPD was also assessed by determining the difference in the mean length of neonatal stay for BPD and non-BPD patients. Significance was assessed using a t-test (Table 6-4).

TABLE 6-3
Correlation Matrix for Model Variables

	Hospitalizations 0-36 mos	Neonatal Stay	Income Centile	IVH
Neonatal Stay	0.181			
Income Centile	0.037	0.048		
IVH	-0.094	0.217	-0.103	
BPD	0.115	0.508	-0.045	0.423

TABLE 6-4
Mean Length of Neonatal Stay for BPD and Non-BPD Patients

	BPD (n = 52)	NON BPD (n = 38)
Mean Neonatal Stay	103.9808	70.0526
Standard Deviation	28.3054	22.2139

t test = -6.13, $p<0.0001$

Hospitalizations (0-36 months) was regressed separately on the four independent variables and none of the regressions were found to be significant. The full four variable multiple regression model was also fit and was not significant ($F=0.7399$ $p=0.5676$).

Logistic regression models were then fit using each independent variable and hospitalization 0-36 mos (yes, no) as the dependent variable. None were significant. The four factor logistic regression model was also not significant. ($\Delta=2.5$ $p=0.7764$).

Finally survival analysis (life table method) was used to look at individual model variables. For this assessment neonatal stay was considered as a simple dichotomous variable: short stay (less than the median) and long stay (greater than or equal to the median). The outcome event was first rehospitalization. The time to first hospitalization was not the most clinically relevant outcome; however, the use of survival analysis allowed inclusion of an additional 41 individuals (for whom only partial follow-up information was available). By this method neonatal stay (Figure 6-2) and BPD (Figure 6-3) were seen to be significantly associated with rehospitalization.

Forty percent of infants who had long neonatal stay had been readmitted by three months adjusted age. Only 27% of infants who had short neonatal stay had been rehospitalized. After this initial difference was observed, the rate of rehospitalization for each group was similar. At 18 months adjusted age, 67% of long stay and 45% of short stay infants had been readmitted to hospital.

Similarly, 32% of patients with BPD were rehospitalized by three months adjusted age compared to 20% of patients without BPD. By 18 months, 67% of BPD infants and 42% of non-BPD patients had been readmitted.

B) Duration of Rehospitalization 0-36 Months

Model variables were again looked at by scatterplots and contingency tables. Neonatal stay (Figure 6-4) and BPD (Figure 6-5) appeared to predict duration of hospitalization.

A correlation matrix of model variables demonstrated a low degree of correlation between the independent variables and duration of hospitalization (Table 6-5).

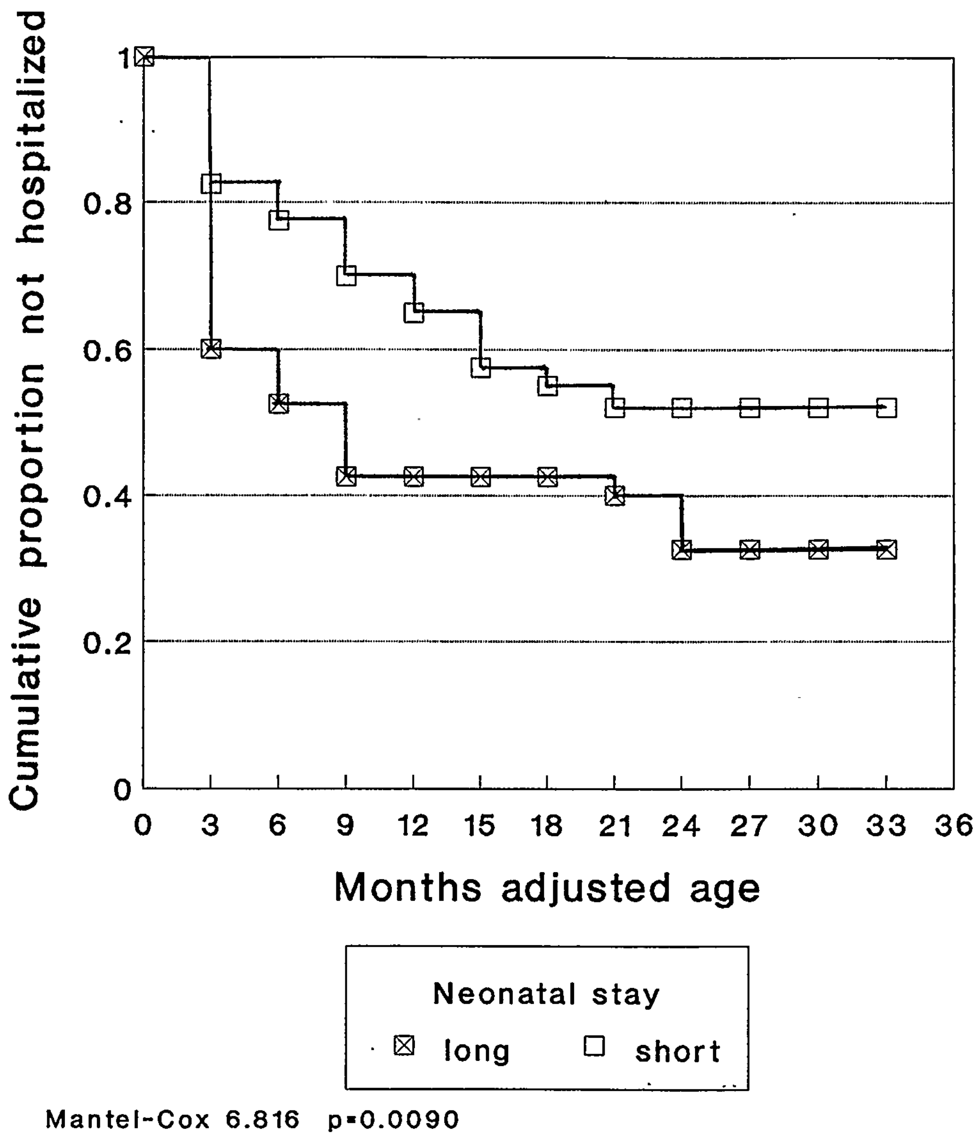


FIGURE 6-2

Survival Curve of Hospitalization 0-36 Months

Comparison by Neonatal Length of Stay

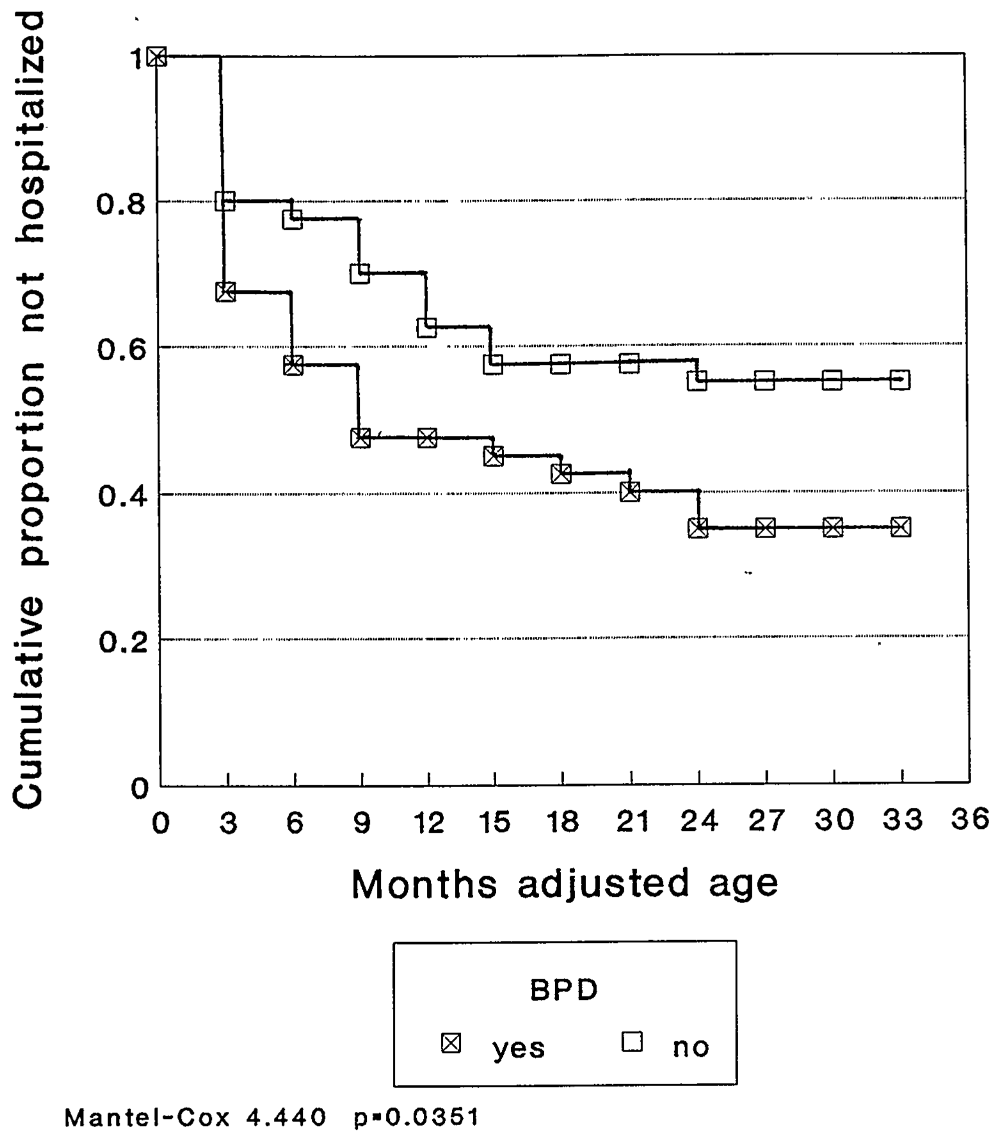


FIGURE 6-3

Survival Curve of Hospitalization 0-36 Months

Infants with BPD

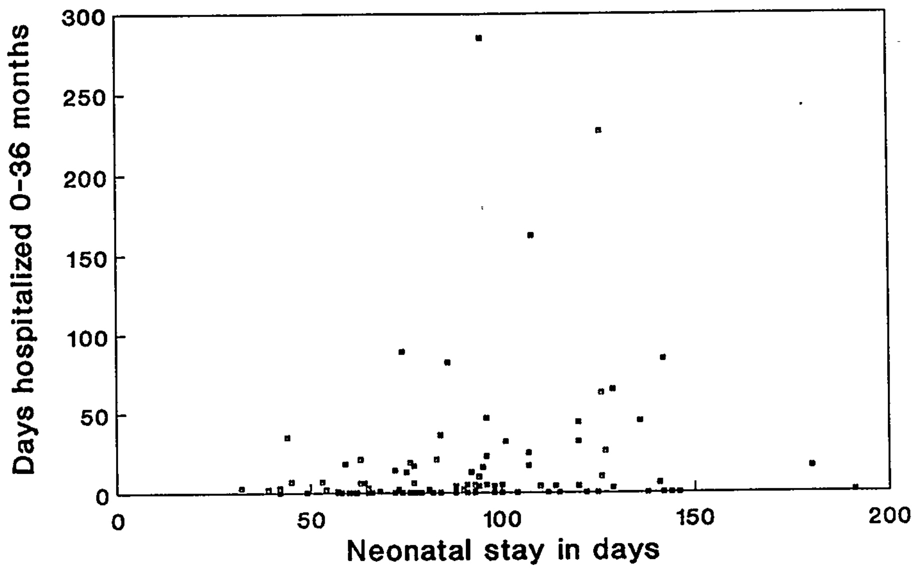


FIGURE 6-4

Neonatal Stay in Days and Duration

of Hospitalization 0-36 Months (in days)

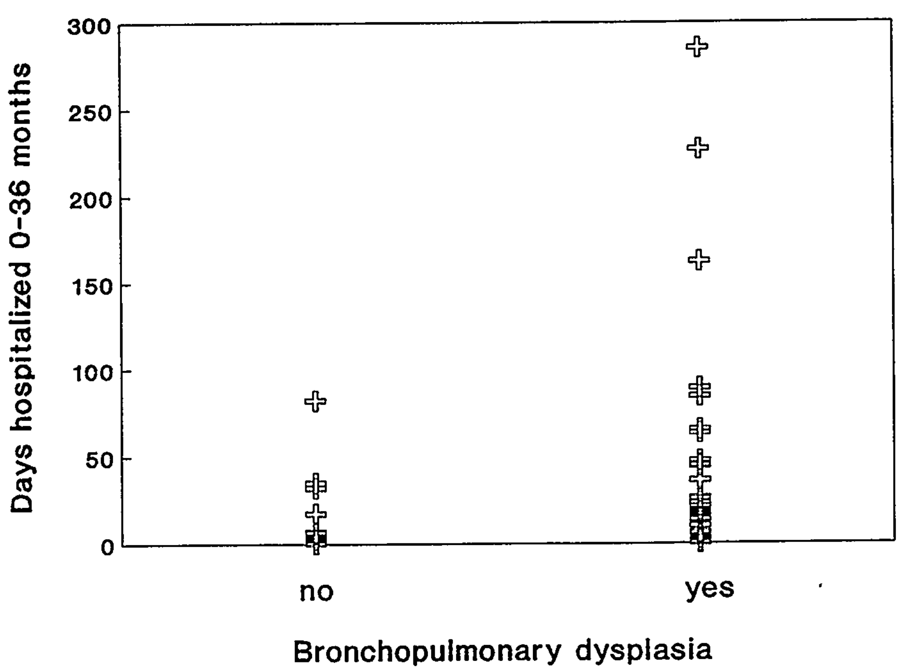


FIGURE 6-5

Bronchopulmonary Dysplasia and Duration

of Hospitalization 0-36 Months (in days)

TABLE 6-5
Correlation Matrix for Model Variables

	Duration of Hospitalization 0-36 mos	Neonatal Stay	Income Centile	IVH
Neonatal Stay	0.198			
Income Centile	-0.014	0.048		
IVH	0.063	0.217	-0.103	
BPD	0.197	0.508	-0.045	0.423

When duration of hospitalization was regressed on each independent variable, none of the regressions were significant. The four factor multiple regression model was also not significant (F=0.9349 p=0.4481).

C) Other Medical Service Use

When graphs and tables were initially inspected neonatal stay (Figure 6-6) and BPD (Figure 6-7) appeared useful to predict other medical service use.

A correlation matrix of model variables indicated a moderate degree of correlation between neonatal stay and other medical service use and a lower degree of correlation between BPD and other medical service use (Table 6-4). Neonatal stay and BPD were correlated with each other.

The outcome variable (other medical service use) was regressed on each independent variable and both neonatal stay and BPD were found to be significant: neonatal stay (t=4.10 p < 0.0001) BPD (t=2.25 p=0.0135). Using the equation derived from the neonatal stay model (use of services = $A + B_1$ [NS]) an infant hospitalized for 40 days

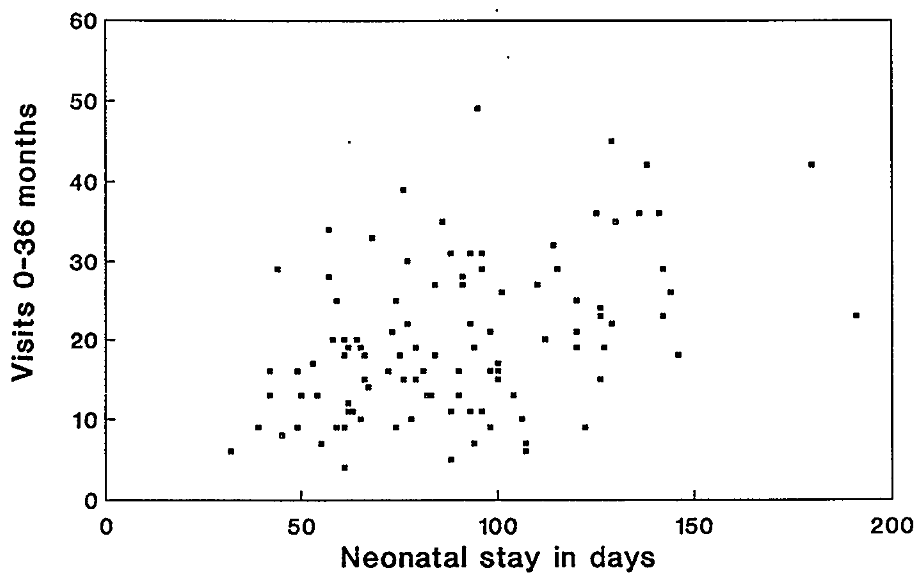


FIGURE 6-6

Neonatal Stay in Days and Other Medical

Service Use 0-36 Months (number of visits)

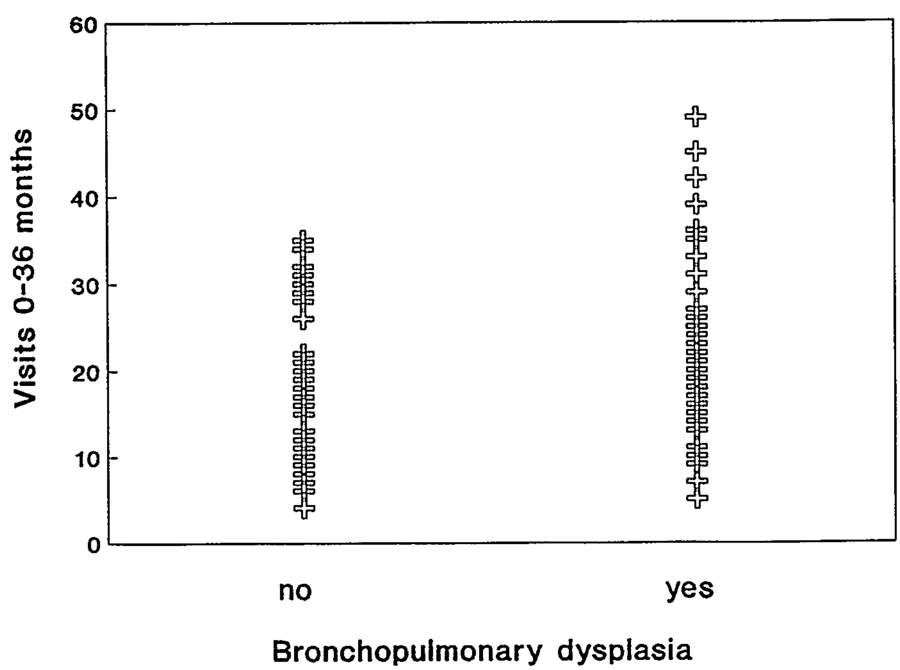


FIGURE 6-7

Bronchopulmonary Dysplasia and Other Medical

Service Use 0-36 Months (number of visits)

TABLE 6-6
Correlation Matrix for Model Variables

	Other Medical Service Use 0-36 mos	Neonatal Stay	Income	IVH
Neonatal Stay	0.422			
Income Centile	-0.159	0.048		
IVH	0.019	0.217	-0.103	
BPD	0.234	0.508	-0.045	0.423

after birth would be predicted to have 15 visits to other medical services compared to 32 for an infant hospitalized for 160 days (mean difference 15.12, standard error 3.71).

The model for BPD predicts that an infant without BPD would have 18.2 medical service visits 0-36 months compared to 22.87 for the infant with BPD (mean difference 4.67, standard error 1.56). The ability of these models to predict is not very precise (95% Prediction Interval ± 18 contacts).

When neonatal stay and BPD were incorporated into a regression model the overall model was significant (F=8.30 p=0.005). However the only significant individual factor in the model was neonatal stay. Table 6-7 shows the complete output for this regression model. This would suggest that neonatal stay was the better predictor of other medical service use 0-36 months.

TABLE 6-7
Regression of Other Medical Service Use
on Neonatal Stay and BPD

Predictor	Coefficient	Standard Deviation	T-ratio	P-value
Constant	9.598	3.000	3.20	
Neonatal Stay	0.12379	0.03739	3.31	0.0007
BPD	0.318	2.365	0.13	0.4484

A full four variable multiple regression model was also fit which was significant ($F=4.577$ $p=0.0022$). Neonatal stay remained the only variable individually significant in this model ($t=3.28$ $p=0.008$).

The "secondary research question" was whether additional factors identified in the first year of life would allow more accurate prediction of rehospitalization, duration of rehospitalization and medical service use from 12 to 36 months. Initially, the variables from the first year were assessed to see if they predicted the outcome variables. Again, model variables had been preselected on the basis of existing literature and unique considerations in this population.

Independent Variables
Hospitalizations in the First Year
Day Care
Family Distress
Neurologic Disability

Because only two patients diagnosed as having neurologic disability were available for inclusion in the regression models, this variable was excluded from these models. Five patients diagnosed as having neurologic disability were available for inclusion in survival analyses and the variable was, therefore, retained for these analyses. This difference is due to structural aspects of the Perinatal Follow-Up Program, in that, infants with neurologic disabilities are followed primarily through other clinics at ACH once their diagnoses have been confirmed and treatment initiated.

D) Rehospitalization from 12-36 Months

The only variable which appeared, on initial inspection, to predict hospitalization after one year was rehospitalization in the first year (Figure 6-8) (Table 6-8).

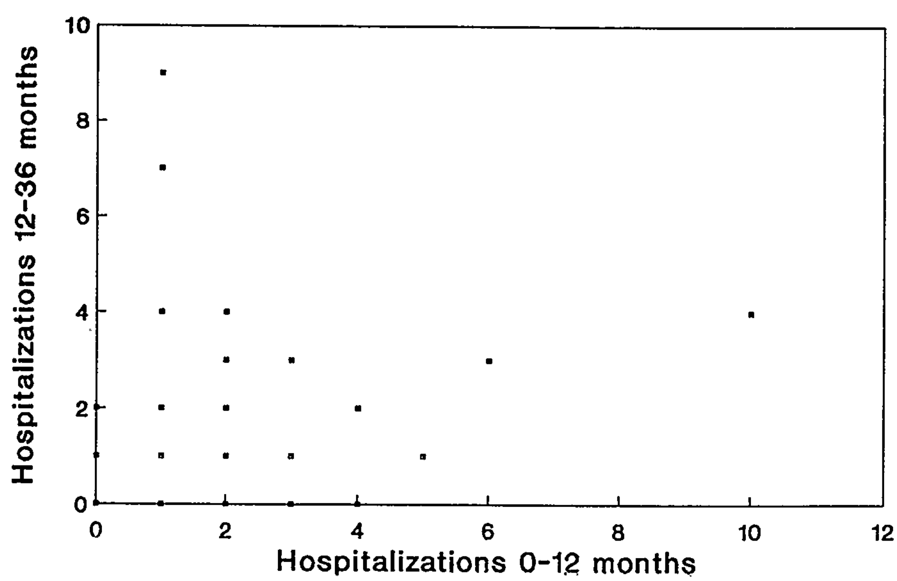


FIGURE 6-8

Hospitalizations 0-12 Months and Hospitalizations 12-36 Months

TABLE 6-8
Hospitalization 12-36 Months and
Hospitalization 0-12 Months

Hospitalization 12-36 mos	Hospitalization 0-12 Mos		TOTAL
	Yes	No	
yes	24 (46%)	11 (19%)	35
no	28 (54%)	46 (81%)	74
TOTAL	52	57	109

Chi square = 8.997; p = 0.0027

A correlation matrix for model variables indicated moderate correlation between hospitalizations in the first year and hospitalizations after one year. Day care attendance and family distress were negatively correlated with hospitalizations after one year (Table 6-9).

TABLE 6-9

Correlation Matrix for Model Variables

	Hospitalizations 12-36 mos	Hospitalizations 0-12 mos	Day Care	Family Dis-tress
Hospitalizations 0-12 mos	0.455			
Day Care	-0.064	-0.109		
Family Distress	-0.032	-0.086	0.132	
Neurologic Disability	0.046	0.055	0.070	0.154

When hospitalizations 12-36 months was regressed on each independent variable only hospitalizations 0-12 months was significant (t=5.06 p<0.0001). An infant hospitalized once in the first year would be predicted to have one hospitalization 12-36 months. An infant hospitalized eight times in the first year would be predicted to have three hospitalizations 12-36 months (mean difference 2.72, standard error 0.54). The ability of this model to predict hospitalizations was not very precise (95% Prediction Interval ± 2 hospitalizations). The three factor model was also significant (F=5.07 p=0.0001). In that model the only individually significant variable was hospitalization 0-12 months (t=3.24 p=0.0009).

Logistic regression models were fit using each variable individually and hospitalization 12-36 months (yes or no) as the dependent variable. None were significant. A three factor model was also not significant (Δ=5.9 p=0.1166).

On survival analysis, hospitalization 0-12 months and neurologic disability were significantly associated with hospitalizations 12-36 months (Figure 6-9 and Figure 6-10). Infants who had been hospitalized in the first year were more likely to be hospitalized subsequently than those who had not required hospitalization in the first year. The former group were also hospitalized at a greater rate than the later group. At 18 months adjusted age 90% of infants who had been hospitalized 0-12 months and 92.5% of infants who had not remained unhospitalized. By 33 months 52.5% of infants with first year hospitalizations and 77.5% of infants without were still unhospitalized.

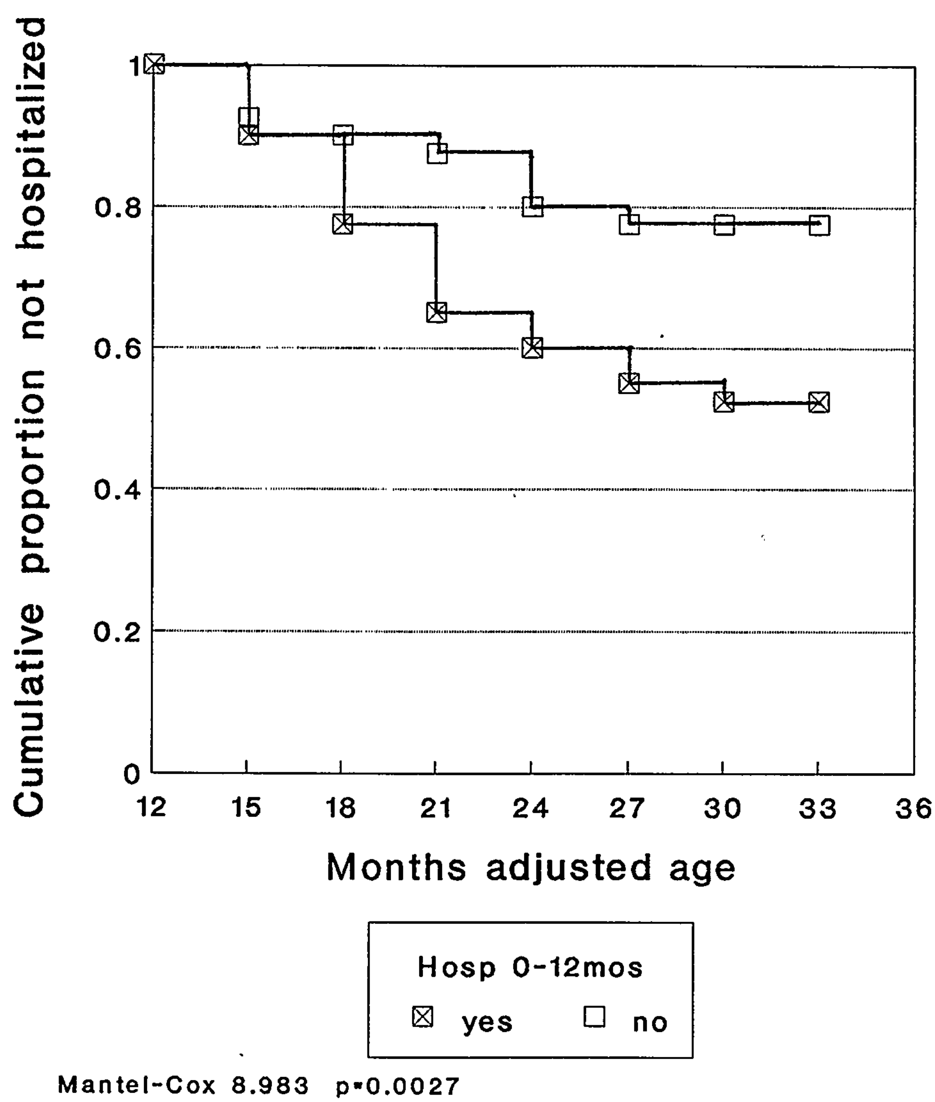
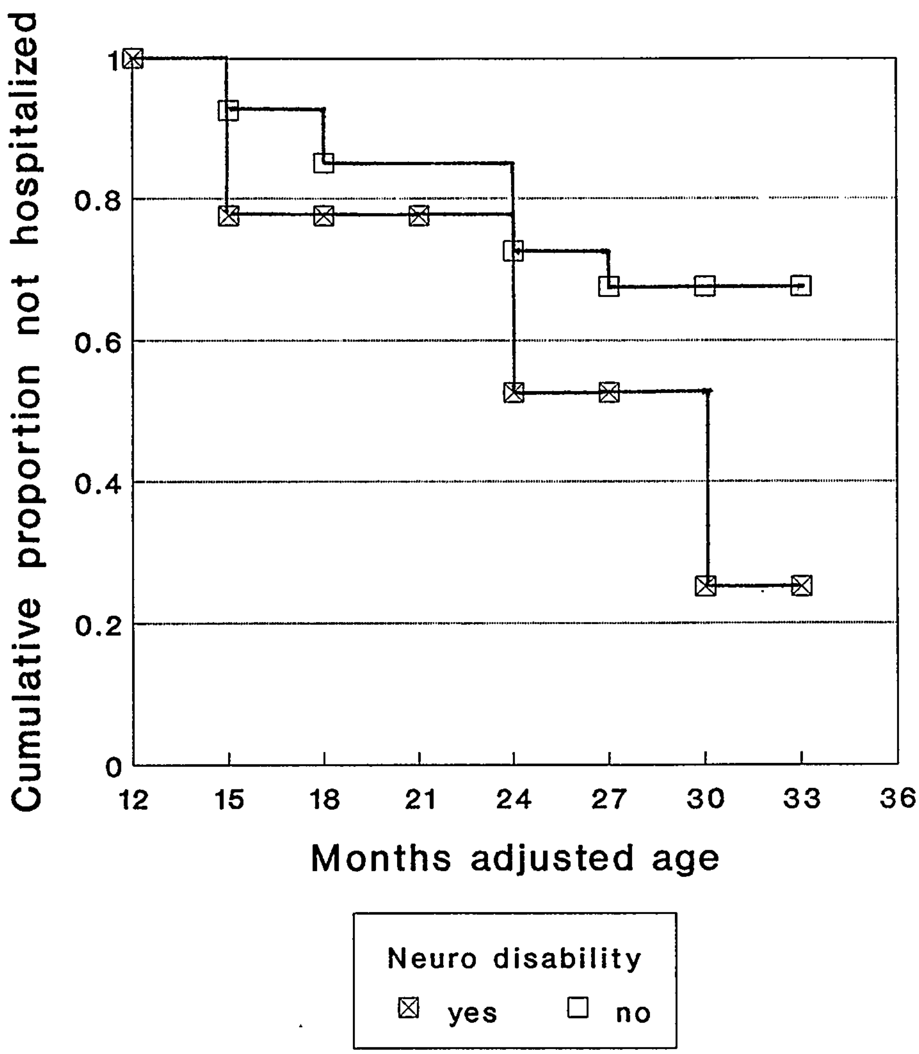


Figure 6-9

Survival Curve of Hospitalizations 12-36 Months

Infants Hospitalized 0-12 Months



Mantel-Cox 5.800 p=0.0160

FIGURE 6-10

Survival Curve of Hospitalization 12-36 Months

Infants with Neurologic Disability

When neurologic disability was considered it was found that by 18 months adjusted age 22.5% of affected children and 15% of unaffected children had been rehospitalized. At 33 months 75% of those with neurologic disability and 32.5% of those without neurologic disability had been re-admitted. It should be noted in interpretation of these percentages that the total number of children with neurologic disability was five.

E) Duration of Rehospitalization 12-36 Months

Hospitalization in the first year appeared to predict duration of rehospitalization 12-36 months on inspection of graphs (Figure 6-11). A correlation matrix of variables indicated correlation between hospitalization 0-12 months and duration of hospitalization 12-36 months. Attendance at day care and family distress were negatively correlated (very low degree of correlation) with the outcome variable (Table 6-10).

Table 6-10
Correlation Matrix for Model Variables

	Duration of Hospitalization 12-36 mos	Hospitalizations 0-12 mos	Day Care	Family Dis-tress
Hospitalization 0-12 mos	0.349			
Day Care	-0.030	-0.091		
Family Distress	-0.036	-0.008	0.132	
Neurologic Disability	0.178	0.099	0.070	0.154

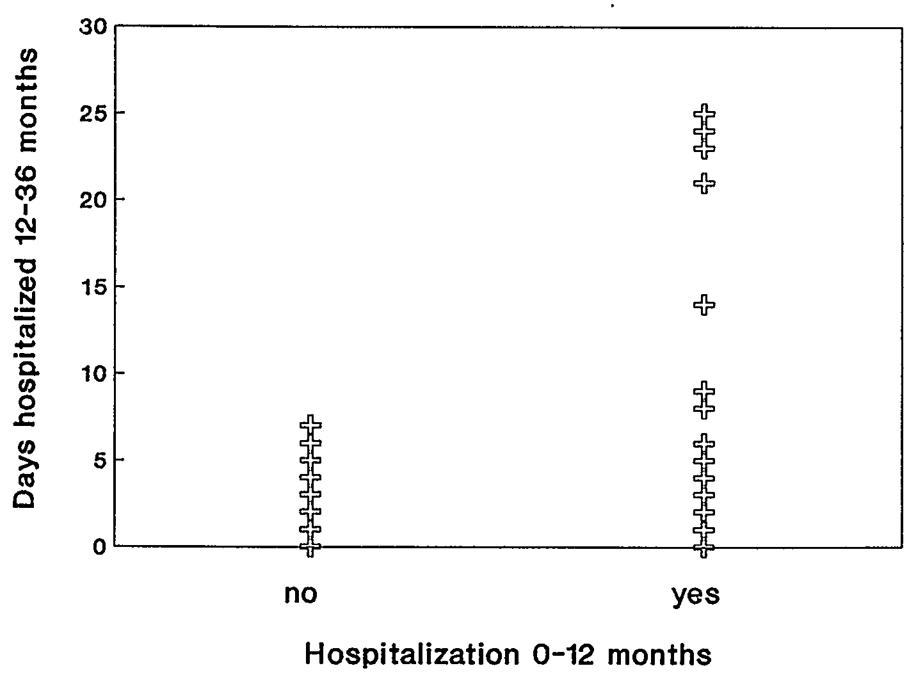


Figure 6-11

Hospitalization 0-12 Months and Duration of Hospitalization 12-36 Months (in days)

When duration of hospitalization was regressed on each independent variable only hospitalization 0-12 months was significant (t=3.33 p=0.0006). By this model, predicted duration of hospitalization 12-36 months for an infant not hospitalized in the first year would be 0.8 days; for an infant hospitalized before age one, 4.1 days (mean difference 3.39, standard error 1.02) (95% Prediction Interval ± 9 days). The three factor multiple regression model was also significant (F=3.64 p=0.0161). In that model only hospitalization 0-12 months was individually significant (t=3.29 p=0.007).

The regression output for the three factor model is shown in Table 6-11.

Table 6-11
Regression of Duration of Hospitalization 12-36 Months on Hospitalization 0-12 Months, Day Care, and Family Distress

Predictor	Coefficient	Standard Deviation	T-ratio	P-value
Constant	0.3247	0.1515	2.14	
Hospitaliz. 0-12 mos	0.40156	0.07923	5.07	<0.0001
Day Care	-0.0821	0.4071	-0.20	
Family Distress	-0.2736	0.2952	-0.93	

F) Other Medical Service Use 12-36 Months

On initial inspection the only variable which appeared to predict medical service use after one year was the absence of family distress (Figure 6-12).

A correlation matrix of model variables demonstrated the negative correlation of family distress with other medical service use (Table 6-12).

TABLE 6-12
Correlation Matrix for Model Variables

	Other Medical Service Use	Hospitalizations 0-12 mos	Day Care	Family Dis-tress
Hospitalization 0-12 mos	0.097			
Day Care	0.138	-0.091		
Family Distress	-0.189	-0.008	0.132	
Neurologic Disability	-0.079	0.099	0.070	0.154

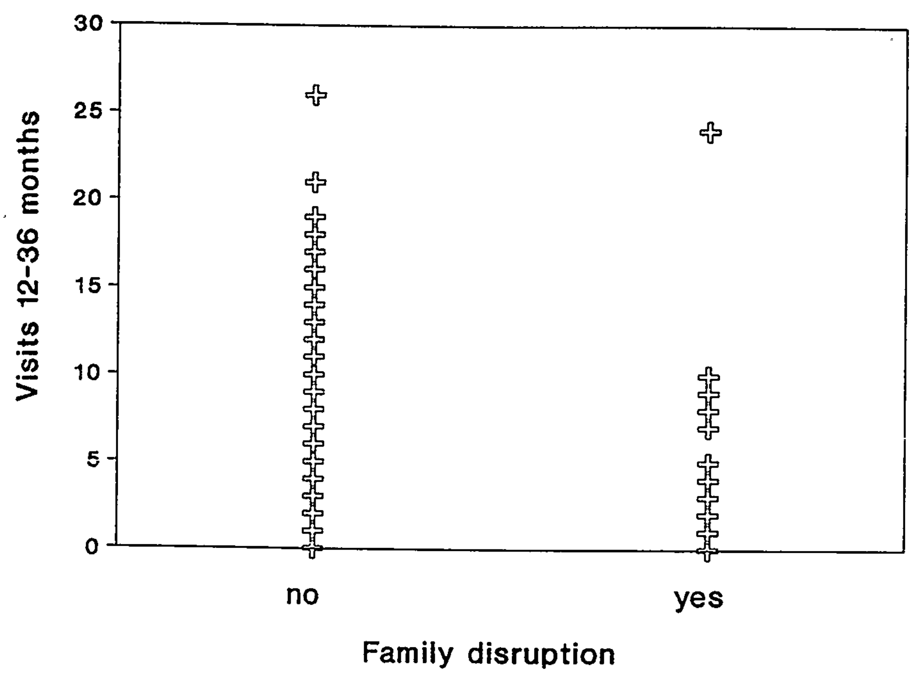


FIGURE 6-12

Family Disruption and Other

Medical Service Use 12-36 Months (number of visits)

When other medical service use was regressed on each independent variable, family distress was significant in predicting a lack of medical service use ($t=-2.06$ $p=0.0213$). By this model an infant in a family experiencing family distress would be predicted to have six medical service visits in the second and third year of life while an infant in a family without this experience would be predicted to have nine (mean difference 3, standard error 1.46) (95% Prediction Interval for model ± 11 visits). A three factor model was not significant ($F=1.998$ $p=0.1208$).

G) Data Modification

Recognizing that in the foregoing analyses the larger population available for the survival analyses allowed better prediction of the outcome variables of hospitalization (0-36 months and 12-36 months) further regression models were fit using duration of hospitalization expressed as a percentage of the total time the infant was under observation. This allowed the use of data for individuals with only partial follow-up.

H) Hospitalization 0-36 Months as Percentage of Time Observed

Hospitalization 0-36 months (expressed as percentage of time observed) was regressed on individual variables neonatal stay, income, IVH and BPD. Only BPD was significant ($t=2.20$ $p=0.0148$). An infant with BPD was predicted to be hospitalized 2% of the time observed and an infant without BPD 1% of the time observed (mean difference

0.01, standard error 0.007). The four factor model was not significant ($F=1.465$ $p=0.2171$).

I) Hospitalization 12-36 Months as Percentage of Time Observed

Hospitalization 12-36 months (expressed as a percentage of time observed) was regressed on individual variables hospitalization 0-12 months, day care, family distress and neurologic disability. Both hospitalization 0-12 months and neurologic disability were significant singly: hospitalization 0-12 months ($t=3.65$ $p=0.0002$) neurologic disability ($t=3.46$ $p=0.0004$). An infant hospitalized in the first year would be predicted to be hospitalized 0.5% of the time observed 12 months to 36 months and an infant not hospitalized in the first year 0.1% of the time observed (mean difference 0.004, standard error 0.001). An infant with neurologic disability would be predicted to be hospitalized 1% of the time observed and an infant without neurologic disability .2% of the time observed (mean difference 0.01, standard error 0.003). When the two factors were combined in a regression model, the model was significant ($F=13.079$ $p<0.0001$) and each individual factor remained significant (Table 6-13).

TABLE 6-13
Regression of Hospitalization 12-36 Months as Percentage of Time Observed on Hospitalization 0-12 Months and Neurologic Disability

Predictor	Coefficient	Standard Deviation	T-ratio	P-value
Constant	0.0004572	0.0007121	0.64	
Hospitaliz. 0-12 mos	0.003788	0.001055	3.59	0.0002
Neurologic Disability	0.008692	0.002553	3.40	0.0005

A four factor model remained significant (F=6.4052 p= 0.0001) with only hospitalization 0-12 months and neurologic disability individually significant.

J) Modification of Risk

The question of whether additional factors identified in the first year of life would allow more accurate prediction of rehospitalization, duration of rehospitalization and medical service use was approached in two ways. First contingency tables were used to look at the risk of hospitalization 0-36 months for infants with and without BPD (Table 6-14) and those who were classified as long or short neonatal stay (Table 6-15).

The risk for hospitalization 12-36 months was then assessed for BPD patients (Table 6-16) and long neonatal stay patients (Table 6-17) with and without the added finding of hospitalization 0-12 months.

The risk for hospitalization 0-36 months in an infant with BPD is 0.63 compared to 0.49 in an infant without BPD.

TABLE 6-14
Risk of Hospitalization 0-36 Months and BPD

		BPD Yes	No	Total
Hospitalized 0-36 mos	Yes	42	21	63
	No	24	22	46
	Total	66	43	109

Parameter	Point Estimate	Standard Deviation	95% Confidence Interval Test-Based	
Risk Ratio	1.303	0.182	0.927	1.832

TABLE 6-15
Risk of Hospitalization 0-36 Months and
Neonatal Stay Long or Short

		Neonatal Stay Long	Short	Total
Hospitalized 0-36 mos	Yes	38	24	62
	No	18	28	46
	Total	56	52	108

Parameter	Point Estimate	Standard Deviation	95% Confidence Interval Test-Based	
Risk Ratio	1.470	0.176	1.054	2.051

TABLE 6-16
Risk of Hospitalization 12-36 Months in BPD Patients with and without Hospitalization in the First Year

		Hospitalized 0-12 Months Yes	No	Total
Hospitalized 12-36 mos	Yes	19	7	26
	No	16	24	40
	Total	35	31	66

Parameter	Point Estimate	Standard Deviation	95% Confidence Interval Test-Based	
Risk Ratio	2.404	0.367	1.171	4.935

TABLE 6-17
Risk of Hospitalization 12-36 Months in Long Stay Patients with and without Hospitalization in the First Year

		Hospitalized 0-12 Months Yes	No	Total
Hospitalized 12-36 mos	Yes	17	6	23
	No	15	18	33
	Total	32	24	56

Parameter	Point Estimate	Standard Deviation	95% Confidence Interval Test-Based	
Risk Ratio	2.125	0.391	1.051	4.297

An infant with long neonatal stay has a risk of 0.68 for hospitalization in the first three years compared to 0.46 for an infant with short neonatal stay.

The risk of hospitalization 12-36 months for a BPD patient who has been hospitalized in the first year is 0.54 compared to 0.23 for a BPD patient with no hospitalizations in the first year.

The risk of hospitalization after the first year for infants with long stay and hospitalization before 12 months is 0.53 compared to 0.25 for the long stay infant without first year hospitalization.

Finally, a multiple regression model was built using the outcome variable hospitalization 12-36 months (expressed as a percentage of time observed and independent variables; neonatal stay, hospitalization 0-12 months, and neurologic disability. This three factor regression model was significant ($F=11.358$ $p<0.0001$). Each of the variables was significant (Table 6-18). Using this model an infant with long neonatal stay and neurologic disability, hospitalized in the first year would be predicted to be hospitalized 2% of the time observed 12-36 months. An infant with short neonatal stay, no neurologic disability and no hospitalizations in the first year would be expected to be hospitalized 0% of the time observed 12-36 months (95% Prediction Interval for this model $\pm$ 1%).

TABLE 6-18
Regression of Hospitalization 12-36 Months as a Percent of Time Observed on Neonatal Stay, Hospitalization 0-12 Months and Neurologic Disability

Predictor	Coefficient	Standard Deviation	T-ratio	P-value
Constant	-0.003242	0.001544	-2.10	
Hospitaliz. 0-12 mos	0.003351	0.001029	3.25	0.0008
Neurologic Disability	0.008973	0.002468	3.64	0.0002
Neonatal Stay	0.00004249	0.00001590	2.67	0.0044

Adding BPD to the model did not improve the model (generalized F test for the reduced model compared to the full model 0.00548 p=0.9411).

It was not possible to improve prediction of other medical service use by adding factors from the first year of life to neonatal stay in a regression model.

II. EXPLORATORY ANALYSIS

The other variables at NICU discharge and for the first year of life were looked at descriptively by scatterplots and contingency tables to see if they were likely to predict the outcome variables. Hospitalization(s), duration of hospitalization and other medical service use as well as hospitalizations (expressed as percentage of time under observation) were the outcome variables. They were regressed on the independent variables. Dichotomous variables were entered into survival analyses (life table method) with hospitalization as the outcome event. A p-level of 0.05 was used to determine statistical strength. Where results were statistically significant the relevant contingency tables, regression models, and survival curves are presented with p-levels.

A) NICU Discharge

Neither birth weight nor gestational age predicted subsequent hospitalization, duration of hospitalization, or medical service use. This is in contrast to some previous literature (3,6). Infants whose mothers had less than 12 years education, were single parents or had other children were not more likely to be hospitalized or to use more medical services. (Single parent families actually had shorter hospitalizations and used fewer medical services than two parent families (non significant difference). None of the outcome variables were predicted by Blishen socioeconomic index or by rural address. Prematurity, RDS, PDA and pneumothorax were not useful to predict subsequent hospitalization or medical service use.

Infants with inguinal hernias were more likely to be hospitalized 0-36 months as demonstrated by simple linear regression ($t=2.53$ $p=0.0063$). On survival analysis (see Figure 6-13) the difference in hospitalization for these children was statistically significant on a Breslow test (which reflects early differences) but not on the Mantel Cox (which reflects differences over the entire time course). The difference in hospitalization for these two groups is

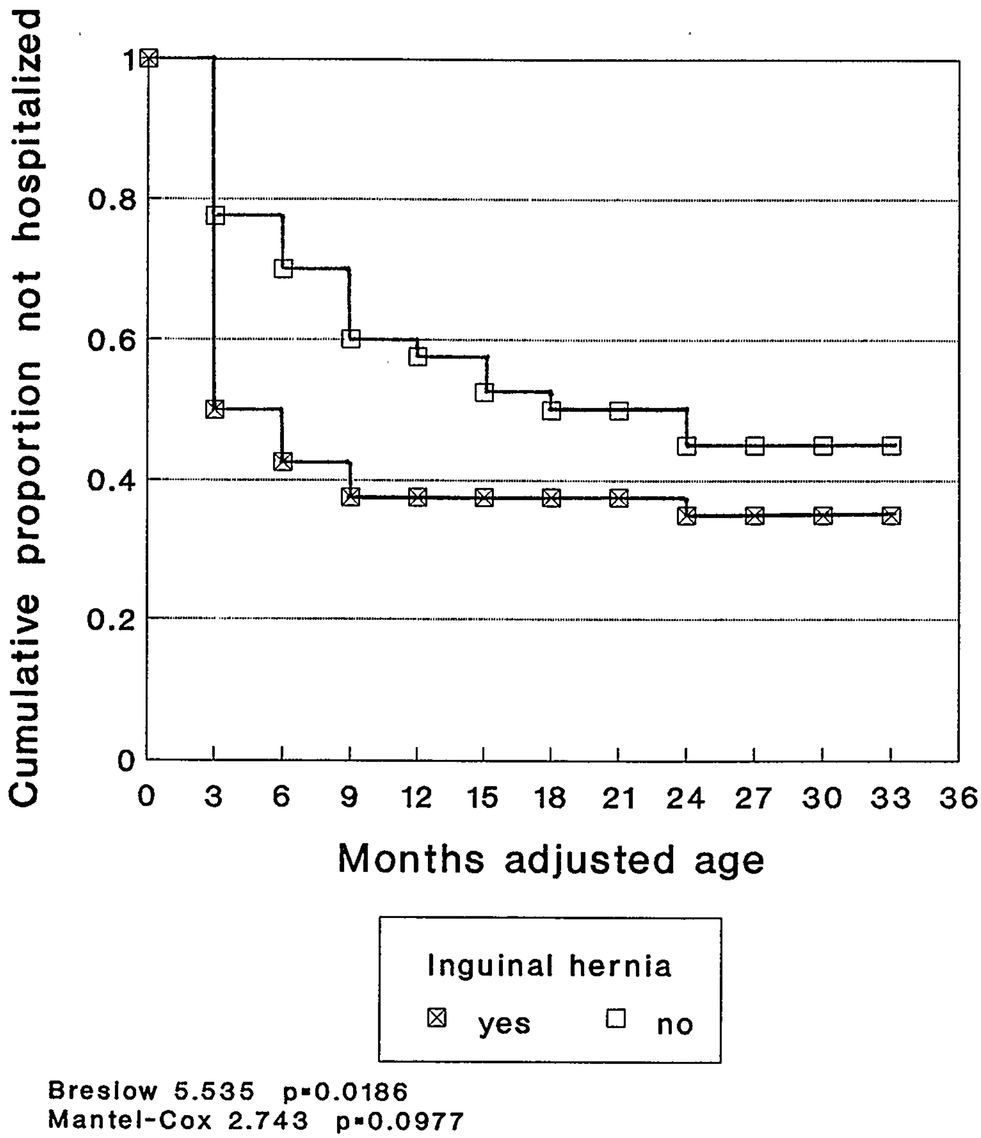


FIGURE 6-13

Survival Curve of Hospitalization 12-36 Months

Infants with Inguinal Hernia

probably explained by the fact that infants with inguinal hernias not repaired prior to NICU discharge would be readmitted for surgery shortly after discharge. Breast-feeding at discharge did not affect any of the outcome variables. Maternal smoking did not predict hospitalization or increased medical service use.

B) First Year Variables

On simple linear regression duration of hospitalization 0-12 months predicted duration of hospitalization 12-36 months ($t=6.09$ $p=0.0001$). An infant hospitalized five days 0-12 months would be predicted to have a total of two days hospitalized 12-36 months. An infant hospitalized 30 days 0-12 months would be predicted to be hospitalized 12 days 12-36 months (mean difference 9.7, standard error 1.9).

Medical service use during the first 12 months predicted medical service use from 12 to 36 months ($t=3.93$ $p=0.0088$). An infant having ten other medical service visits 0-12 months would be expected to have 7.4 medical service visits 12-36 months. In contrast an infant who had 20 other medical service visits 0-12 months would be expected to have 11 medical service visits 12-36 months (mean difference 3.6, standard error 0.9).

When hospitalization expressed as a percentage of time under observation was used as the outcome variable both duration of hospitalization ($t=6.18$ $p=0.001$) and medical service use ($t=2.96$ $p=0.0019$) were useful to predict. In these models prediction of hospitalization as percentage of time observed could be made within 1% for duration of hospitalization and 2% for other medical service use.

Source of primary medical care (pediatrician, G.P. or both) had no effect on the outcome variables. Breast feeding was also not a useful predictor of later hospitalization.

The assessment results of a number of follow-up clinic assessments were useful to predict hospitalization expressed as percentage of time observed. For simple linear regressions these were: abnormality of gross motor function on physiotherapy assessment ($t=2.09$ $p=0.0195$); nutritional abnormality on dietary assessment ($t=3.43$ $p=0.0004$); and abnormal cognitive function on psychology assessment ($t=2.32$ $p=0.0112$). Contingency tables are shown for each of these variables and hospitalization 0-36 months (yes/no) (Tables 6-19, 6-20, 6-21).

Survival analysis was also significant for these three variables and neurodevelopmental abnormality on the Amiel Tison Neurodevelopmental Assessment (see Figures 14, 15 and 16 and 17). For each of these variables survival curves showed an increasing rate of rehospitalization for affected children from 12-36 months adjusted age.

At 24 months adjusted age 65% of children with abnormalities of gross motor function had required rehospitalization. Only 25% of children without such abnormalities had been re-admitted.

TABLE 6-19
Hospitalization 12-36 Months and
Gross Motor Function

Hospitalization 12-36 mos	Gross Motor Function		TOTAL
	Abnormal	Normal	
yes	5 (71%)	30 (29%)	35
no	2 (29%)	72 (71%)	74
TOTAL	7	102	109

Chi square = 5.305; p = 0.0213

TABLE 6-20
Hospitalization 12-36 Months and
Nutritional Abnormality

Hospitalization 12-36 mos	Nutritional Abnormality		TOTAL
	Yes	No	
yes	9 (74%)	24 (40%)	33
no	6 (26%)	68 (60%)	74
TOTAL	15	92	107

Chi square = 6.954; p = 0.0084

TABLE 6-21
Hospitalization 12-36 Months and
Cognitive Function

Hospitalization 12-36 mos	Cognitive Function		TOTAL
	Abnormal	Normal	
yes	5 (62.5%)	26 (30%)	31
no	3 (37.5%)	60 (70%)	63
TOTAL	8	86	94

Chi square = 8.997; p = 0.0027

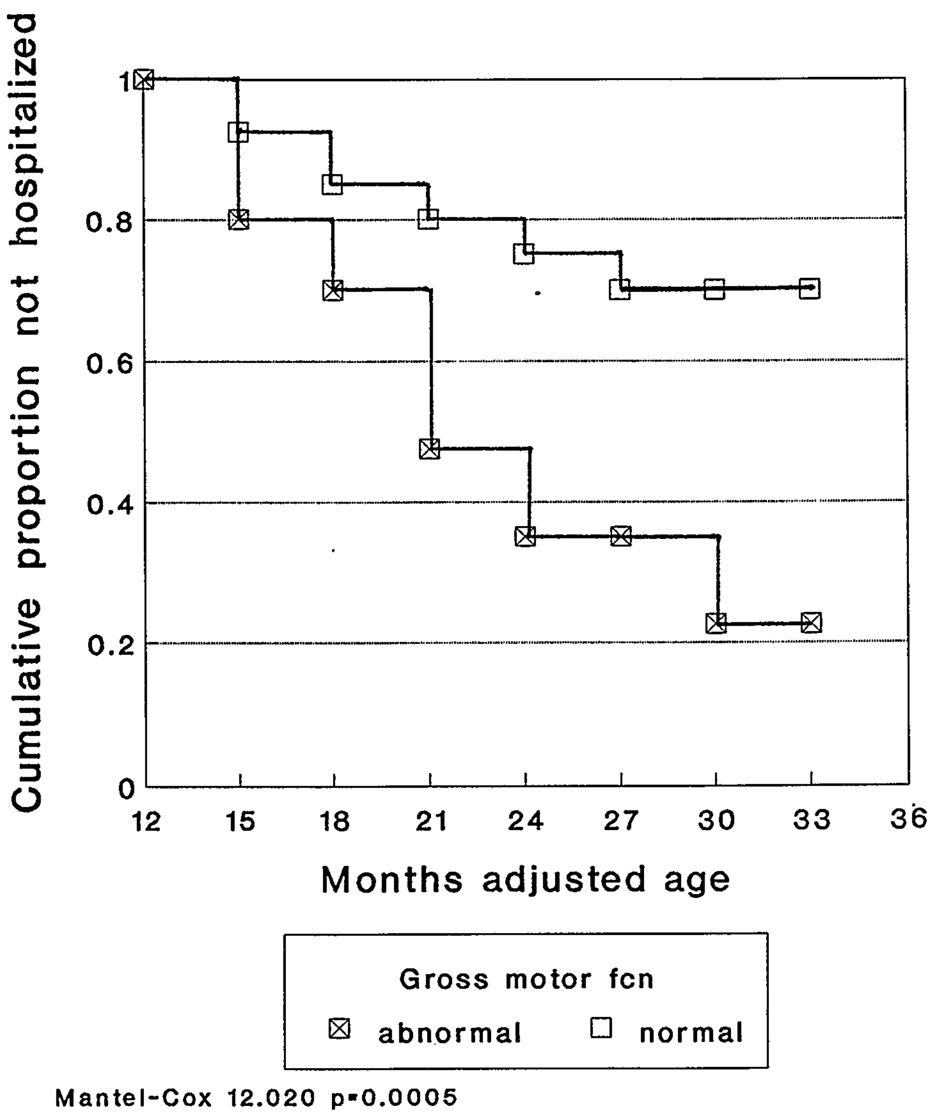
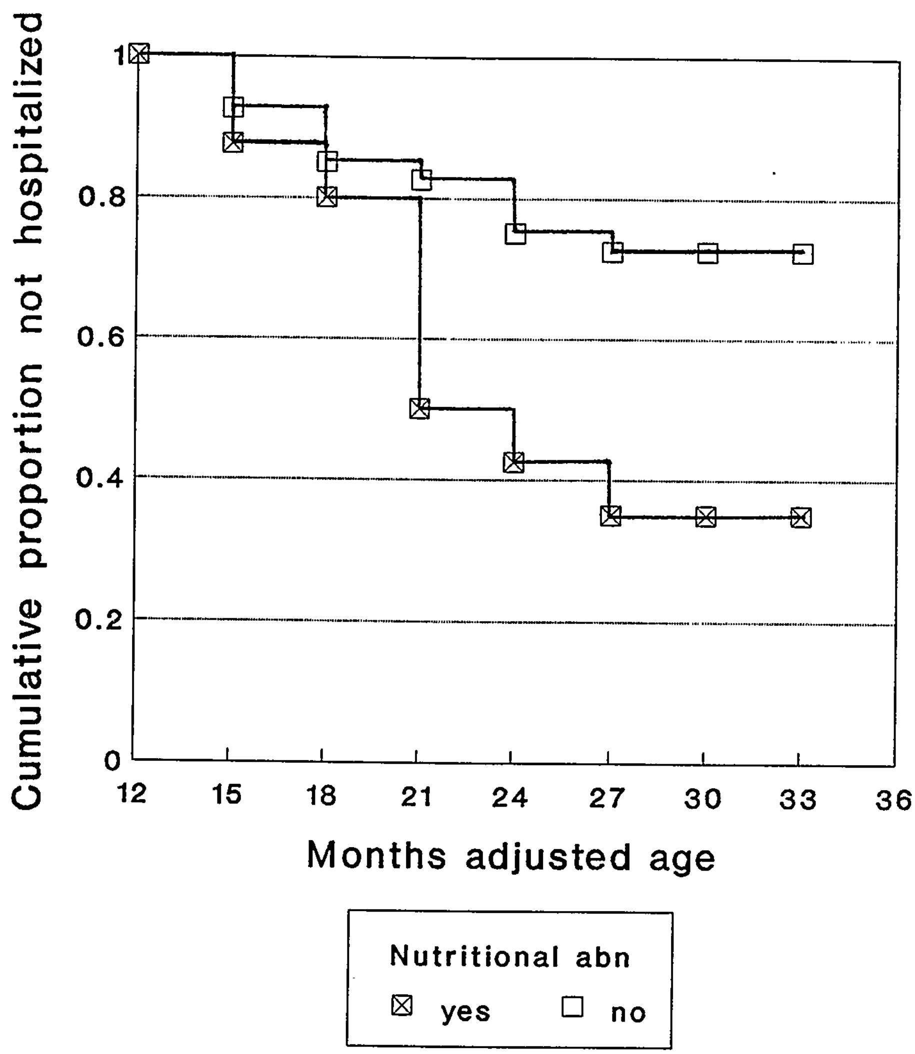


FIGURE 6-14

Survival Curve of Hospitalization 12-36 Months

Infants with Gross Motor Function Abnormality



Mantel-Cox 6.380 p=0.0115

FIGURE 6-15

Survival Curve of Hospitalization 12-36 Months

Infants with Nutritional Abnormality

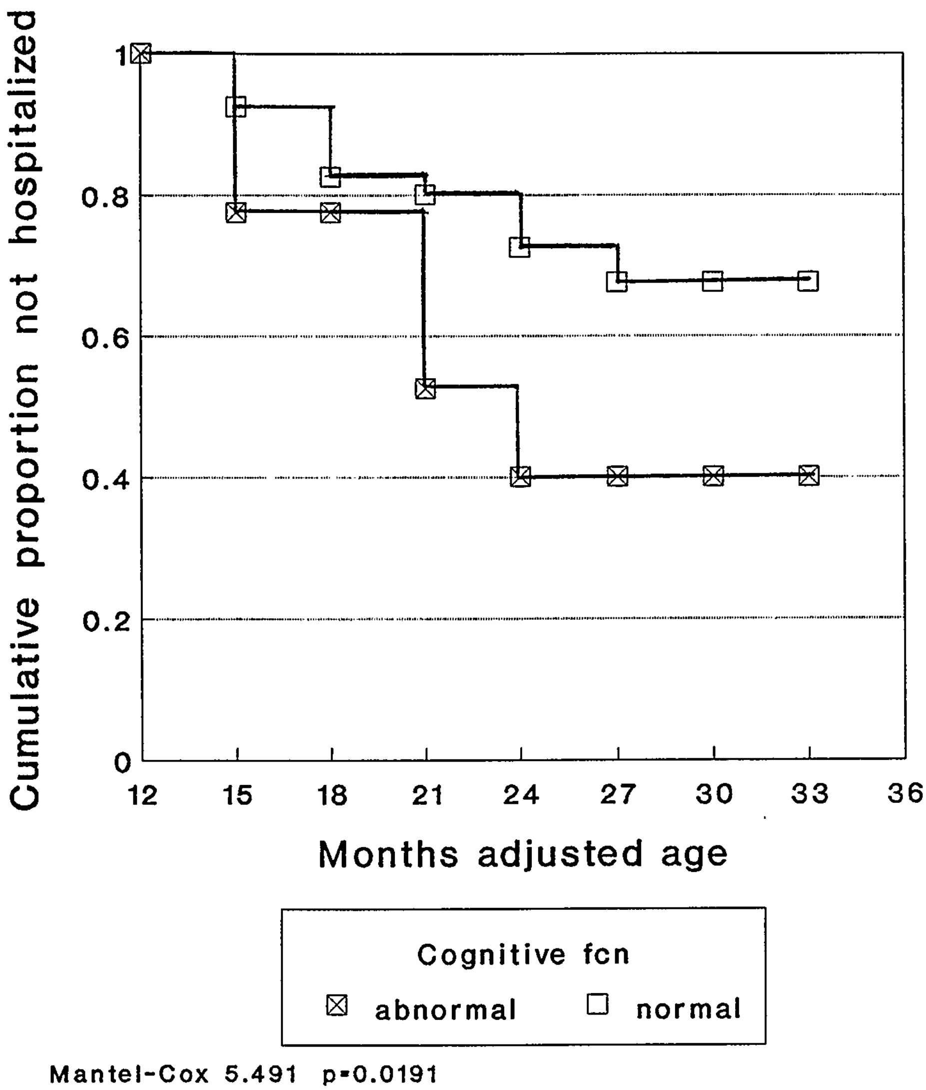


FIGURE 6-16

Survival Curve of Hospitalization 12-36 Months

Infants with Cognitive Function Abnormality

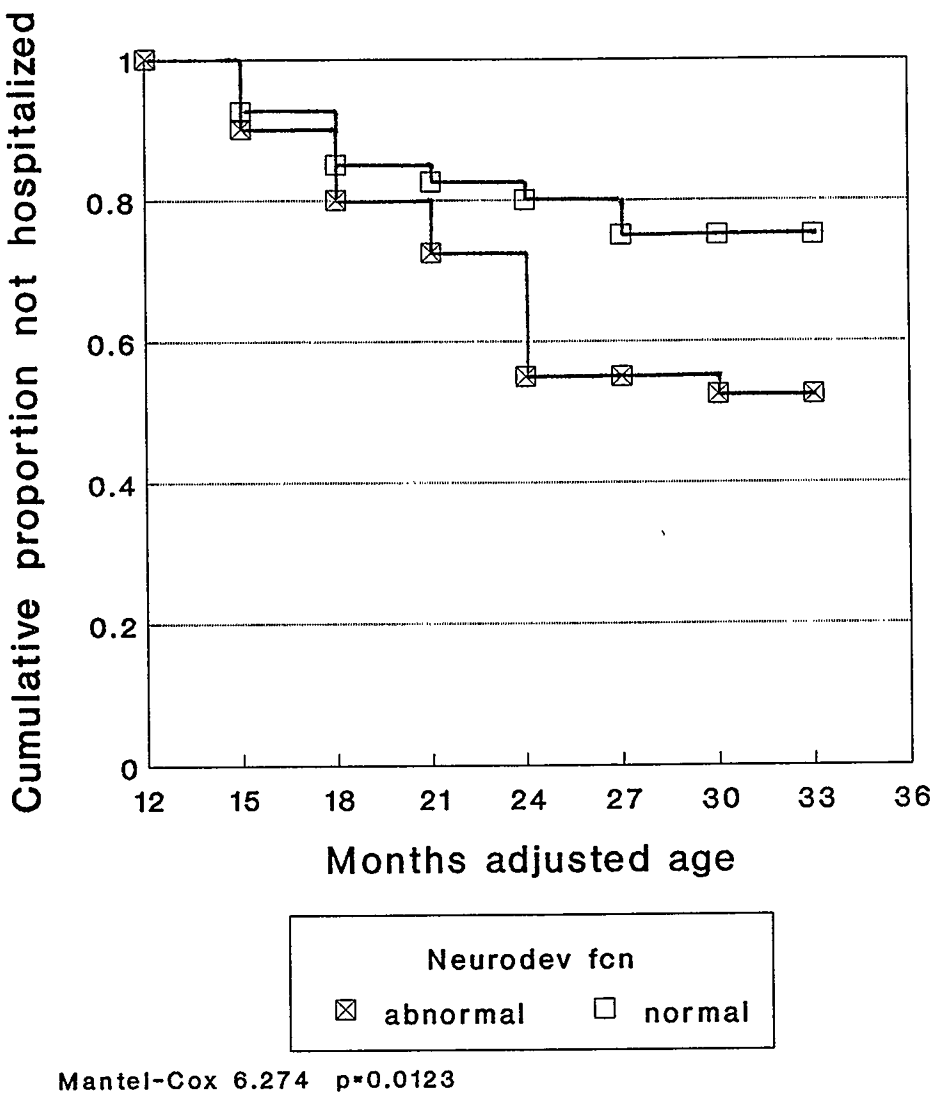


FIGURE 6-17

Survival Curve of Hospitalization 12-36 Months

Infants with Neurodevelopmental Abnormality

Fifty-eight percent of children with nutritional abnormalities had been re-admitted by 24 months of age compared to 25% of those without these abnormalities. Infants who were felt to have cognitive abnormalities were more likely to have been rehospitalized by 24 months adjusted age (60%) than those without cognitive abnormalities (28%).

Twenty-eight percent of infants judged to be neurodevelopmentally suspect or abnormal on the Amiel Tison neurodevelopmental assessment had required rehospitalization by 24 months compared to 18% of those judged to be normal on this assessment.

A correlation matrix demonstrates correlation among these four variables and neurologic disability (Table 6-22).

TABLE 6-22
Correlation Matrix

	Neurodev Abnorm	Gross Motor Abormality	Nutritional Abnormality	Neurologic Disability
Gross Motor Abnormality	0.410			
Nutritional Abnormality	0.271	0.154		
Neurologic Disability	0.292	0.633	0.129	
Cognitive Abnormality	0.344	0.50099	0.424	0.341

CHAPTER 7

DISCUSSION

In this chapter the results previously presented will be discussed. Strengths and weaknesses of this study as well as recommendations for practice and future research will be considered.

I. Rehospitalization, Duration of Rehospitalization and Other Medical Service Use 0-36 Months

A) Medical Factors

Factors were identified at NICU discharge which predict rehospitalization, duration of rehospitalization and other medical service use by VLBW infants in the first three years of life. The two factors shown to be related to hospitalization and use of medical services were length of neonatal stay and BPD. BPD also predicted duration of hospitalization.

The length of time an infant is hospitalized after birth reflects the severity of illness. This finding is consistent with previous studies which have used a variety of parameters to capture the most medically vulnerable infants. McCormick found prolonged postnatal stay of the infant was associated with increased risk of hospitalization (6). Hack described the reason for the majority of rehospitalizations as "chronic complications resulting from severe neonatal disease". In the present study, as in the others, the most affected neonates are the most likely to be rehospitalized and to use more medical services (5).

Bronchopulmonary dysplasia also predicted the outcome variables. It was correlated with long neonatal stay which is not unexpected as these infants usually have prolonged ventilator dependence and therefore stay longer in the nursery. The finding that infants with BPD are hospitalized more often was also not unexpected. Sauve, studying a population from the same NICU from which the current study population was drawn had found rates of rehospitalization 59% first year; 49% second year (11).

Clearly neonatal stay and BPD together define the most "at risk" group of neonates in this population in terms of subsequent hospitalization and medical service use.

In addition to the correlation previously noted between neonatal stay and BPD, IVH was moderately correlated with BPD. IVH, itself did not predict the outcome variables.

B) Sociodemographic Factors

Maternal smoking, a parameter linked to hospitalization and lower respiratory disease in the general population (32,33) did not discriminate hospitalization outcome in this population. This could be because the determination of maternal smoking status was made based on pregnancy history. Sauve (53) showed in a previous study that for the general population smoking status does not change significantly pre and postnatally. It is still possible these mothers of high risk infants may have been counselled about the potential dangers of smoking and may have stopped.

Certain factors shown by others to be important in predicting rehospitalization were so infrequent in this population that they could not be studied (e.g., congenital anomalies, mothers under age 18).

Some of the sociodemographic parameters assessed at NICU discharge would have been expected, based on previous literature, to predict the outcome variables. The socioeconomic measures (below median income, low socioeconomic index) failed to discriminate in this population. It had been anticipated that this might be the case because of two factors. Overall the socioeconomic status of this clinic population is much higher than that of populations previously described. The socialized health system in Canada may also change the effect these measures have on health service use. This is supported by the 100% attendance at prenatal care.

Single mothers were few in number in this population 17/131 (13%). Overall infants of these mothers had fewer hospitalizations, shorter hospitalizations, and less medical service use (non significant difference). It would be useful to look at these differences in the future. There could be a factor of poor compliance resulting in decreased clinic attendance. It may also be that medical service use was underreported by this group.

II. Rehospitalization Duration of Rehospitalization and Other Medical Service Use 12-36 Months

A) Medical Factors

Hospitalizations in the first year of life predicted increased hospitalizations in the second and third year. Similarly longer hospitalizations and increased medical service use prior to 12 months predicted similar patterns subsequently. Infants with first year hospitalizations, longer hospitalizations, and increased medical service use were likely infants with the greatest severity of illness.

One previous study looked at whether early hospitalizations predict later medical service use. In a 'healthy' general pediatric population hospitalization in the first three months predicted subsequent increased health care billing (over the first three years) (37). Increased hospitalizations in the first year in the present study predicted longer duration of later hospitalization but did not predict increased other medical service use. It is possible that the early experience of hospitalization sets an expectation for future needs.

Infants diagnosed as having neurodevelopmental disorders (cerebral palsy, mental retardation, or seizures) in the first year were more likely to be hospitalized in the second and third year. These were a small number of children 6/131 (5%). The finding of increased rate of hospitalization in this group is consistent with previous descriptions in the literature (5,6).

Infants diagnosed in the first year to have neurodevelopmental, nutritional, gross motor function and cognitive function abnormalities were at increased risk for subsequent hospitalization. These factors were correlated with each other and with neurologic disability. McCormick's large U.S. study found developmental delay to be a major predictor of rehospitalization (6).

Children judged to have nutritional abnormalities are often those who need intensive feeding intervention; gastrostomy tubes, gavage feeds, etc. It is not unexpected that they would require hospitalization in relation to their feeding methods. Nutritional abnormality manifest by profound growth failure might also necessitate hospital assessment and management.

B) Sociodemographic Factors

Some factors from the first year which might have been expected to discriminate did not. Day care attendance in the general pediatric population has been linked to increased hospitalization. In this population only 10/131 (8%) were reported as attending day care. The children in this study who were in day care had fewer hospitalizations (non significant difference). It may be that they represented a healthier subgroup. One would anticipate that for children with significant respiratory disease a recommendation would have been made to avoid care with a group of children. In files examined it was noted that some infants were taken out of group care settings because of frequent upper respiratory tract infections.

An interesting, unexpected finding, was that children in families experiencing disruption (for example, severe illness in family, caretaking parent returning to work, divorce) were less likely to have increased other medical service use. This is contrary to what has been shown in the general pediatric population (11,12,13). It is possible that compliance is what is really being reflected in this study. These infants are scheduled for many follow-up assessments and perhaps families experiencing difficulties do not attend as many as those where there are fewer ongoing disruptions. This finding should be studied further.

III. Modification of Risk

Risk of hospitalization was modified by factors determined in the first year of life. Infants who had long neonatal stay and those with BPD were shown to be at increased risk for subsequent hospitalizations if they were hospitalized in the first year. The first year hospitalization(s) likely identified those infants with more severe medical problems.

IV. Usefulness of Results and Models

The demonstration of factors that increase hospitalizations and other medical service use and factors that modify risk for hospitalization in this VLBW population is itself useful clinically. These findings have not been previously demonstrated in a Canadian population. Modification of risk for hospitalization in VLBW infants has not been addressed previously in the literature.

Single factor and multiple regression models constructed using preselected variables were shown to predict hospitalization, duration of hospitalization and medical service use. The clinical usefulness of these models, however, is questionable when one looks at the accuracy with which they predict subsequent events. The models which were most useful were those where outcome was expressed as hospitalization as a percentage of time under observation (allowing the inclusion of patients for whom only partial follow-up information was available). In the case of single variables, neonatal stay and BPD, prediction of subsequent hospitalization (as a percentage of time observed) was possible only within ±7%. This would not be a useful clinical tool for health care decision making regarding individual patients. It could be useful in planning health resource use. When neonatal stay, hospitalization 0-12 months and neurologic disability were combined in a model prediction of subsequent hospitalization improved to ±1%.

V. Strengths and Weaknesses

A retrospective cohort design is a useful way to study "rare exposure" (e.g., VLBW infants). It is efficient in that data collected over time is available at the time of study. The major limitation of this design is that validity of results can be affected by losses to follow-up (54). Incomplete data for some of the study population was a concern in this study.

The well established and maintained Perinatal Follow-up Clinic Data Base available for this study provided an excellent core of information. Data obtained from a pre-existing data base may not contain the precise information needed for a secondary analysis (55). This potential problem was minimized because the data base used was created for research purposes although not specifically for this study. At times it was necessary to aggregate data prior to analysis (e.g., any record of day care attendance 0-12 months; all visits to doctors' offices, outpatient clinics and emergency rooms 0-12 months).

Access to hospital records, the computerized patient care information system and information from other medical record rooms made it possible to check and confirm data as well as add to it when appropriate. The virtually complete ascertainment of neonatal stay and duration of hospitalizations was a strength of this study. Sample size (as determined by prior power calculation) was at least adequate for the analyses undertaken.

The errors in hospitalizations as recorded in the data base were of concern. Whenever interview techniques are the method of data collection there will be error of recall. The assessment of other medical service use unlike hospitalizations, could not be confirmed by direct access to records. There may well have been errors of recall for this information.

The use of preselected variables in construction of regression models adds validity to the inferences made from these models (in comparison to models constructed in a step-wise fashion).

VI. Suggestions for Practice and Further Research

It would be very useful to study this population prospectively so that the factors that have been shown to be associated with the outcome variables could be looked at in more detail. It would be particularly interesting to look at some of the factors that affect medical service needs in the general pediatric population but were not shown to be useful to predict these needs in the study population (e.g., maternal smoking, day care).

Family dysfunction in the families of study infants also needs to be looked at prospectively. If poor compliance is found to result in decreased attendance at scheduled clinic assessments this should be addressed clinically.

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APPENDIX I

THE UNIVERSITY OF CALGARY
Health Sciences Centre
3330 Hospital Drive N.W., Calgary, Alberta, Canada T2N 4N1

Faculty of MEDICINE
Department of Community Health Sciences

Telephone: (403) 220-4286
FAX: (403) 283-4740

1991-06-25

Medical Records Department

To Whom It May Concern:

I am currently completing a research project for my Master's degree under the direction of Dr. R.S. Sauve, Department of Community Health Sciences at The University of Calgary. We are looking at the factors which predict rehospitalization(s) and duration of rehospitalization(s) of very low birthweight infants cared for in the Foothills Hospital NICU during 1986 and 1987. I am hoping that you will be able to supply me with the admission and discharge dates of the following children admitted to your hospital: (I have listed the patients name, birthdate, mother's name, and any information I have regarding the approximate time of admission and the diagnosis).

NAME	DATE OF BIRTH	MOTHER'S NAME	APPROXIMATE TIME OF ADMISSION AND DIAGNOSIS

I enclose a copy of the ethical approval of the study from the Conjoint Medical Ethics Committee of The University of Calgary and Foothills Hospital. The children and hospitals involved will not be individually identified in the thesis or in any publications which may arise from this work.

Thank you very much for your assistance in this matter.

Sincerely,

D. Morrison, MD
Dept of Community Health Sciences

R.S. Sauve, MD
Professor
Dept of Community Health Sciences

DM/jck
encl.

APPENDIX II

THE UNIVERSITY OF CALGARY
Health Sciences Centre
3330 Hospital Drive N.W., Calgary, Alberta, Canada T2N 4N1

Faculty of MEDICINE
DEAN'S OFFICE
MEDICAL BIOETHICS
Telephone (403) 220-7990

1991-03-08

Dr. E. J. Love, Head
Department of Community Health Sciences
Faculty of Medicine
The University of Calgary
Calgary, Alberta

Dear Dr. Love:

Re: Rehospitalization and Use of Medical Services by Very Low Birth Weight Infants: Factors in the First Year of Life that Modify Risk

Student: Dr. D. Morrison

Degree Program: M.Sc.

The above-noted thesis proposal has been submitted for Committee review and found to be ethically acceptable.

Yours sincerely,

T D Kinsella

T. D. Kinsella, M.D.
Assistant Dean (Medical Bioethics),
and Chairman, Conjoint Medical
Ethics Committee

TDK:smh

c.c. Dr. R. S. Sauve (information)
Dr. R. B. Church (information)

APPENDIX III

DATA COLLECTION FORMS

Copies of Perinatal Follow-up clinic data collection forms for NICU discharge data and for follow-up data follow. The variables used for this study are indicated below.

NICU Discharge Summary

Card 01: 9-12, 24-26, 27-29, 30-32, 43, 44, 45-46, 47, 51-52. 55-56, 66

Card 02: 27-28, 30-35, 75

Card 04: 39, 44, 54-55

Card 05: 16-18, 23, 24, 25, 26, 27, 30, 31, 33, 36-37, 38-39, 42, 45, 46, 49, 51, 52, 53, 54, 55, 56, 69.

Foothills Hospital Delivery Record: smoker

no prenatal care

Follow-up Data

Adjusted age (AA)

Physical Examination

Other physical abnormalities

Amiel Tison

Neurodevelopmental

Mental retardation

Cerebral Palsy

Seizure Disorder

Other Disorder

Institutionalization

Health History

- Hospitalized Respiratory Problem
- Other Hospitalizations
- Visits GP/Ped
- Visits to Specialist
- Outpatient Visits
- Community/School Involvement
- Family Disruption
- Foster Care

Physiotherapy

Dietary

Psychology

Social Work

Occupational Therapy

1.

N.I.C.U. DISCHARGE SUMMARY

Name: ______
I.D.#: ______
B.D.: ______
B.W.: ______

Baby's Name: ______
Last First Middle

GENERAL DATA

F.H. Hosp. # or assigned #	☐☐☐☐☐☐	(1-6)
Card	0 1	(7-8)
Birthdate (Yr-month)	☐☐☐☐	(9-12)
*Follow-Up Criteria	☐☐☐☐☐	(13-17)

*0 = none
1 = low birth weight
2 = compl. ventilator course
3 = congenital infection
5 = neuro disorders
6 = other ______ specify
7 = ROP
8 = special study
9 = unknown

*Birthplace	☐	(18)
*Where Hospitalized	☐	(19)
Age at admission (hrs)	☐☐☐	(20-22)
Transported	☐	(23)
*Days hospitalized: Acute	☐☐☐	(24-26)
: Other ICN	☐☐☐	(27-29)
: Other hospital	☐☐☐	(30-32)

*000 = none
001 = $\leqslant$ 24 hrs.
002 = 2 days, etc.
999 = unknown

*Disposition	☐	(33)

*1 = home
4 = other hospital ______ specify
5 = died
8 = other
9 = unknown

Autopsy?	☐	(34)

Basic Codes

0 = no 4 = suspect
1 = yes 9 = unknown
(Code changes denoted by *)

*Place Codes

*1 = Foothills Hospital
2 = Other Calgary Hospital
3 = Other Alberta Hospital
4 = Out of Province Hospital
5 = Non-Hospital (eg. home, ambulance)
6 = Other ______

BASIC METHOD FOR DETERMINING # OF DAYS

The number of days are determined by subtracting the date of commencement of treatment (or date of admission) from the date of termination of treatment (or date of discharge), or, in other words, by counting calendar days and subtracting one day. If treatment begins and ends on the same day, count as 1 day. Otherwise the above method applies.

e.g. Ventilation begins on July 7 and stops July 9: number of days = 2

Admitted to Acute care July 7 and died July 7: Days hospitalized = 1

Admitted to Acute care July 7, transferred to Prem II on July 10, discharged home on August 3: Days in Acute = 3; days in Prem II = 24

Phototherapy begins July 7, stops July 10, recommences July 12, stops July 14: Total days on phototherapy = 5

Date Completed: ______

Rev: 1984-04-01

2.

*Cause of Death (35-38)

*0000=not applicable (39-42)
9999 = unknown
Use H - ICDA codes for causes
________________ specify
________________ specify

*Sex (43)
*1 = Male
2 = Female

*Multiple Birth (44)
*0 = singleton
1 = twins
2 = triplets or greater

DEMOGRAPHIC DATA
Maternal:
Name: ________________

Age at delivery (Yrs): (45-46)

*Marital Status (47)
*1 = two parent family
2 = single parent family
9 = unknown

*Race (48)
*1 = Caucasian
2 = Black
3 = Canadian Indian/Metis
4 = Other ________ specify
9 = unknown

Transported PTD? (49)

*If so, hospital of origin: (50)
*0 = N/A
Use place codes

*Total years in school (51-52)
*99 = unknown

Paternal:
Name: ________________

Age at delivery (yrs) (53-54)

Occupation: ________________

*Blishen Index (55-56)
*(see manual)
*Total years in school (57-58)
*99 = unknown
*Midparent height (cm) (59-61)
*999 = unknown

*Mother's Obstetrical History (Biological)
(T) # of previous term births (62)
(P) # of previous pre-term births (63)
(A) # of spontaneous abortions (64)
(A) # of therapeutic abortions (65)
(L) # of living children (66)
(not counting this one)
* 8 = $\geq$ 8
9 = unknown

LABOUR AND DELIVERY
Drugs in Labor & Delivery

Antibiotics (67)
Steroids (68)
Analgesics (69)
Drugs to arrest labor (70)
Antihypertensives (71)
Sedatives (72)
Prostaglandins (73)
Other ________ (74)
(specify)

*Anaesthesia for Delivery (75)
*0 = none
1 = pudendal, local, paracervical
2 = caudal
3 = epidural
4 = spinal
5 = general
9 = unknown

Meconium staining? (76)

*Rupture of Membranes (77)
*1 = < 24 hrs PTD
2 = $\geq$ 24 hrs PTD
9 = unknown

Monitor? (78)

*Presentation at Delivery (79)
*0 = vertex
1 = breech
8 = other
9 = unknown

3.

CARD 2
Duplicate columns (1-6)
Card | 0 | 2 | (7-8)

C - Section (9)

*If so, indications (10-12)
*0 = n/a
1 = fetal distress
2 = breech presentation
3 = abnormal lie
4 = failure to progress
5 = APH
8 = Other ______ (specify)
9 = Unknown

PERINATAL INFECTION
Foul smelling liquor (13)

Maternal fever (14)

Other evidence of maternal infection ______ (specify) (15)

*Risk Score (Coopland's) (16)
*0 = average
1 = increased
9 = unknown

*Resuscitation Required (17)
*0 = none
1 = 0_2 ± bag and mask
2 = intubation
3 = cardiac massage
4 = yes, type unknown
9 = unknown

*Apgars: 1 minute (18-19)

5 minutes (20-21)
*99 = unknown

*Admission temp. (22-24)
(rectal °C)
*34.9 = too low to record
99.9 = unknown

*B.P. on admission (mmHg) (25-26)
*99 = unknown

Gestational Age (wks) (27-28)

*Intrauterine Growth Status (29)

*1 = SGA
2 = AGA
3 = LGA
9 = unknown

*MEASUREMENTS *Percentiles

Birthweight (gms) (30-35)
Birthlength (cm) (36-40)
Head Circ. (cm) (41-45)
Chest Circ. (cm) (46-48)

*9's = unknown
04 = < 5th percentile
96 = > 95th percentile

*Ponderal Index (49-50)
*9.9 - unknown

NUTRITION

Minimum Wt. (gms) (51-54)

Total Wt. lost (gms) (55-57)

% b.w. lost (58-59)

*Age b.w. regained (days) (60-61)
*01 = birthdate or Day 1
97 = ≥ 97 days
98 = not regained prior to discharge
99 = unknown

Discharge Wt. (gms) (62-65)

Parenteral (days) (66-67)

*Age all feeds taken p.o. (68-70)
*001 = birthdate or Day 1
998 = not prior to discharge
999 = unknown

*Formula Used (71-74)
*0 = none
1 = EBM
2 = BBM
3 = 20 cal. formula
4 = 24 cal. formula
5 = Prosobee
6 = Pregestimil
7 = Nutramigen
8 = Other ______ (specify)
9 = unknown
(List in order of frequency of use - i.e. in box 71 enter most frequent; in box 74 least frequent)

4.

*Formula at Discharge (75)
*Codes as above
(2 = breast feeding)

CARD 3
Duplicate columns (1-6)
CARD 0 3 (7-8)

Feeding Problems
- Blood in Stools (9)
- Frequent Regurgitation (10)
- Amino Aciduria (tyrosinemia) (11)
- NEC (12)
- Late Edema (13)
- Rec. Abd. Distention (14)
- Other ________ (specify) (15)

*DRUG UTILIZATION
*0 = not used
1 = used once
2 = used > once
9 = unknown if used

- Penicillin (16)
- Ampicillin (17)
- Cloxacillin (18)
- Gentamycin (19)
- Kanamycin (20)
- Other antibiotic or antifungal ________ (specify) (21)
- Mycostatin (22)
- Steroids (23)
- Digoxin (24)
- Lasix (25)
- Other diuretic ________ (specify) (26)
- Indocid (27)
- Atropine (28)
- Pavulon (Pancuronium) (29)
- Dopamine (30)
- Priscoline (31)
- Morphine (32)
- Codeine (33)
- Phenobarbital (34)
- Dilantin (35)
- Theophylline (Aminophylline) (36)
- $NaHCO_3$ (37)
- Iron (38)
- Multivitamins (39)
- Vitamin E (40)
- Calcium (p.o) (41)
- NaCl (p.o.) (42)
- MCT (43)
- Polycose (44)
- *Other (45-46)
  *Specify number used
  00 = none
  01 = one, etc.
  99 = unknown

Total Drugs Used (47-48)

*Adverse drug reactions (49)
*0 = none
1 = yes, BPD +/or ROP, RLF only
2 = other than BPD, ROP, RLF
3 = combination of 1 & 2 above
9 = unknown

HEMATOLOGY
*Blood Products (times given)
- Packed rbc &/or whole blood (50-51)
- Plasma (52-53)
- Platelets/WBC (54-55)

*00 = not given
99 = unknown

Hematocrit: max. (SI) (56-58)
: min. (SI) (59-61)

5.

Partial Exchange (62)

*Clotting Disorder (63)
*0 = none
1 = thrombocytopenia only
2 = DIC (Incl. Thrombocytopenia)
8 = Other ________ (specify)
9 = unknown

JAUNDICE (64)

Days on phototherapy (65-66)

Exchange Transfusion (67)

*Etiology (68)
*0 = n/a
1 = blood group incompatibility
2 = other
9 = unknown

Max. bili: total(SI Units) (69-71)

: conj.(SI Units) (72-74)

CARD 4
Duplicate columns (1-6)
CARD 0 4 (7-8)

SEPSIS? (9)

Sepsis Work-ups
More than 2? (10)

*Work-ups on Day of Delivery
Blood (11-12)

CSF (13-14)

Stool (15-16)

Urine (17-18)

Auger/Trachea (19-20)

Skin (21-22)

Other ________ (specify) (23-24)

*First Postnatal Work-up
Blood (25-26)

CSF (27-28)

Stool (29-30)

Urine (31-32)

Auger/Trachea (33-34)

Skin (35-36)

Other ________ (specify) (37-38)

*Work-up codes
00 = not done
01 = no growth
02 = staph. albus/epidermidis/coagulase neg
03 = stap. aureus/coagulase pos
04 = E. Coli 05 = Klebsiella
06 - pseudomonas
07 = Bacteriodes
08 = Proteus
09 = Group A Strep
10 = Group B Strep
11 = Strep fecalis/gamma strep
12 = Other ________ (specify)
13 = Other ________ (specify)
99 = no report

NEUROLOGIC
*Seizures (39)
*0 = no
1 = yes, one only
2 = yes, more than one
9 = unknown

*Onset (40)
*0 = N/A
1 = ≤ 4 days
3 = > 4 days
9 = unknown

*EEG (41)

________ (Interpretation)

*CT Scan (42)

________ (Interpretation)

*CUS (43)

________ (Interpretation)

*0 = not done
1 = normal
2 = abnormal
4 = suspect
9 = unknown if done

6.

*APNEA (44)
*0 = no apnea
1 = apnea, no treatment
2 = apnea, drug treatment
3 = apnea, vent. treatment
4 = apnea, drug, & vent. treatment
6 = apnea, unknown if treated
9 = unknown

*Age of onset (days) (45-47)

*Age resolved (days) (48-50)
*000 = n/a
001 = birthdate or Day 1
998 = not prior to discharge
999 = unknown

VENTILATORY ASSISTANCE (51)

*Age of Onset (52)
*0 = N/A
1 = < 1 hour
2 = 1 to 24 hours
3 = > 24 hours
9 = unknown

Type and Duration
Pos. press. vent.? (53)

*Number of days (54-55)
*00 = N/A
01 = $\leq$ 24 hrs
02 = 2 days, etc.
98 = $\geq$ 98 days
99 = unknown

Other (CPAP-ET, CPAP-prongs,CNP)? (56)

*Number of days (57-58)
*00 = N/A
01 = $\leq$ 24 hrs.
02 = 2 days etc.
98 = $\geq$ 98 days
99 = unknown

Tracheostomy (59)

Orotracheal Tube (60)

Nasotracheal Tube (61)

*Max. insp. pressure (cm) (62-63)
*00 = N/A
*Max. end exp. pressure (cm) (64-65)
*00 = N/A
art. pO_2's > 100 (66-67)

cap. pO_2's > 50 (68-69)

Complications During Vent. Asst.
Atelectasis (70)

Prolonged Hypoxia (pO_2 art < 50) (71)

Prolonged acidosis (pH < 7.2) (72)

Nasal narrowing (73)

Post-extubation airway obstruction (74)

Pneumopericardium (75)

Emphysema (76)

Other extrapleural air (77)

Other ______________ (78)
(specify)

CARD 5
Duplicate Columns (1-6)
Card 0 5 (7-8)

Vessel Catheterization and Duration

Umbilical artery cath. (9)

*Days Catheterized (10-11)
*00 = N/A
01 = $\leq$ 24 hrs.
02 = 2 days, etc.
98 = $\geq$ 98 days
99 = unknown

Other artery Cath. (12)

*#Days catheterized (13-14)
*00 = N/A
01 = $\leq$ 24 hrs.
02 = 2 days, etc.
98 = $\geq$ 98 days
99 = unknown

*Complications of Catheterization (15)
*0 = none
1 = vasc. trans.
2 = vasc. perm.
8 = other
9 = unknown

Total days in O_2 (16-18)

Days in O_2 $\bar{s}$ art. line (19-21)

>1 episode vent. support (22)

DIAGNOSES

Cardiovascular

*PDA (23)
*0 = no
1 = yes, treated surgically
2 = yes, not treated surgically
4 = suspect
9 = unknown

VSD (24)

Persistent Fetal Circulation (25)

*Other (26)
*0 = none
1 = ASD
2 = pulmonic stenosis
3 = transposition
4 = coarctation
8 = other ______ (specify)
9 = unknown

Pulmonary

RDS (27)

Meconium aspiration (28)

Atelectasis (29)

*Pneumothorax - right (30)

- left (31)

*0 = no
1 = yes, spont. with tube
2 = yes, post-op. with tube
3 = yes, spont. no tube
4 = yes, post-op. no tube
9 = unknown

Transient Tachypnea (32)

Pulmonary insufficiency of prematurity (33)

~~BDP~~ BPD (34)

Emphysema (35)

*Other (36-37)
*0 = none
1 = aspiration, not meconium
2 = hypoplastic lung
3 = pulm. hemorrhage
4 = pneumonia, pneumonitis
5 = bronchial stenosis
8 = other ______ (specify)
9 = unknown

*Gastrointestinal (Congenital) (38-39)
*0 = none
1 = Inguinal hernia
2 = diaphragmatic hernia
3 = TE fistula
4 = gastroschisis or omphalocele
5 = small bowel obst.
6 = large bowel obst.
7 = mec. plug
8 = other ______ (specify)
9 = unknown

*Gastrointestinal (Acquired) (40-41)
*0 = none
1 = obstruction
2 = perforation
8 = other ______ (specify)
9 = unknown

*Genitourinary (Congenital) (42)
*0 = none
1 = cryptorchidism
2 = ambiguous genitalia
3 = neurogenic bladder
4 = hydronephrosis
5 = hypoplastic kidney
6 = polycystic kidney
7 = hypospadias
8 = other ______ (specify)
9 = unknown

*Genitourinary (Acquired) (43-44)
*0 = none
1 = UTI
2 = hematuria
3 = renal failure
8 = other ______ (specify)
9 = unknown

Neurology

Peripheral Nerve Injuries (45)

*Malformations of CNS (46)
*0 = none
1 = anencephaly
2 = hydrocephalus with ICH
3 = hydrocephalus without ICH
4 = microcephaly
5 = hydranencephaly
6 = meningomyelocele
7 = encephalocele
8 = other ______ (specify)
9 = unknown

8.

Hemorrhages
- Subarachnoid (47)
- Cerebral (48)
- *Intraventricular (49)
  - *0 = no
  - 1 = grade 1 (mild)
  - 2 = grade 2 (moderate)
  - 3 = grade 3 (moderate)
  - 4 = grade 4 (large)
  - 8 = yes, grade unknown
  - 9 = unknown

Hypoxic Ischemic Encephalopathy (50)

*Musculoskeletal Abnormalities (51)
- *0 = none
- 1 = CDH/hip click
- 2 = club foot
- 3 = supernumary digits
- 4 = cong. amputation
- 8 = other ______ (specify)
- 9 = unknown

*Mouth, Larynx, Trachea Abnormalities (52)
- *0 = none
- 1 = cong. stridor
- 2 = subglottic stenosis
- 3 = cleft palate &/or lip
- 4 = supraglottic/glottic acquired abnormalities
- 8 = other ______ (specify)
- 9 = unknown

Miscellaneous
- Dysmorphic Features not listed elsewhere (53)
- Choanal atresia (54)
- *Trisomy (55)
  - *0 = no
  - 1 = yes, 21
  - 2 = yes, other
  - 3 = yes, type unknown
  - 4 = suspect
  - 9 = unknown
- Other syndrome ______ (specify) (56)

ASSESSMENTS IN N.I.C.U.

EYE
- Ophthalmologic consult (57)
- Vascularization Complete? (58)
- *Cong. Abnormality (59)
  - *0 = none
  - 1 = cataract, unilateral
  - 2 = cataracts, bilateral
  - 8 = other
  - 9 = unknown
- Chorioretinitis (60)
- Conjunctival hemorrhage (61)
- Retinal hemorrhage (62)
- Vitreous hemorrhage (63)
- *Retinopathy of prematurity (64)
  - *0 = no
  - 1 = yes, grade 1
  - 2 = yes, grade 2, etc.
  - 3 = yes, grade 3
  - 4 = yes, grade 4
  - 6 = yes, grade 3+
  - 8 = yes, grade unknown
  - 9 = unknown
- *Retrolental fibroplasia (65)
  - *0 = no
  - 1 = yes, grade 1
  - 2 = yes, grade 2
  - 3 = yes, grade 3
  - 4 = yes, grade 4
  - 8 = yes, grade unknown
  - 9 = unknown
- Cryopexy? (66)

PHYSIO
- *Gest. age at assess. (wks) (67-68)
  - *41 = > 40
  - 99 = unknown
- *Outcome (69)
  - *0 = normal
  - 1 = profoundly abnormal
  - 2 = abnormal
  - 4 = suspect
  - 9 = unknown
- *GM Reflex (months) (70-71)
  - *99 = unknown
- *Tone - upper (72)
  - lower (73)
  - trunk (74)
  - *0 = normal
  - 1 = increased
  - 2 = decreased
  - 9 = unknown
- *Primitive Reflexes (75)
  - *0 = normal
  - 1 = abnormal
  - 4 = suspect
  - 9 = unknown

*N.I.C.U. HEARING (76)
- *0 = normal
- 1 = abnormal
- 4 = suspect
- 9 = unknown

DISCHARGE SUMMARY FORM # 2 (77)

FOOTHILLS HOSPITAL ADMISSION CATEGORIZATION - LABOUR AND DELIVERY

Scoring System General Data

	1	Age < 17	
	2	Age > 35	
	1	Obesity (>91 kg)	
	1	Height (<152 cm)	
	1	Smoker	
		Diabetes	
	1	Diet only	
	3	Insulin	
		Heart Disease	
	1	Asymptomatic (no affect on daily living)	
	3	Symptomatic (affects daily living)	
	2	Renal Disease	
		Hypertension	
	2	140/90+	
	3	Hypertensive drugs	
	1	Uterine surgery	
		PAST OBSTETRIC HISTORY	
	3	Neonatal death	
	3	Stillbirth	
	1	Abortion (12-20 weeks)	
	1	Preterm labour (20-37 weeks)	
	1	Difficult forceps delivery	
	2	Caesarean section	
	1	Small for dates (<2.5 kg)	
	1	Large for dates (>4 kg)	
	1	Rh iso imm unaffected infant	
	3	affected infant	
	1	Major cong. anomaly	

FOOTHILLS HOSPITAL ADMISSION CATEGORIZATION - LABOUR AND DELIVERY contd.

		PROBLEMS IN CURRENT PREGNANCY FROM PRENATAL	
	2	Large for dates from prenatal	
	3	Small for dates from prenatal	
	2	Hydramnios	
	3	Twins, triplets	
	3	Malpresentations	
	1	Uterine activity (prenatal)	
	2	Premature rupture of membranes	
Average risk <3 Increased risk >4	1	Bleeding 0-20 weeks	
	3	Bleeding 20-40 weeks	
	2	BP > 140/90	
TOTAL SCORE =	1	Proteinuria (+)	
	1	Abn. GTT	
	3	Rh Antibodies	
	1	Anemia (<100 g per L)	
	1	Bacilluria	
	1	Poor weight gain from prenatal (< 9 kg at term)	
	3	No prenatal care	

NAME: ____________________
DATE OF BIRTH: ____________________
DATE OF ASSESSMENT: ____________________
DATE OF COLLECTION: ____________________

FOLLOW UP DATA
OUTCOME I/II

ID #
BIRTHWEIGHT
CA (MOS)
AA (MOS)
MONTHS SINCE LAST REPORT
DATE OF ASSMT/DEATH (Yr/Mo)
REPORT # OVERALL
REPORT # FISCAL YEAR
SOURCE OF INFO
CAUSE OF DEATH ____________________

AUTOPSY?

PHYSICAL EXAMINATION

Head Shape
Ears
Nose
Mouth
Teeth
Chest Shape
Breath Sounds
Retractions
Heart Murmur
BP-Systolic
-Diastolic
Abdomen
Umbilicus
Hernia(Inguinal)/Genitalia
Hips
Upper Extremities
Lower Extremities
Scars - Scalp
- Chest/Abdomen
- Extremities
Skin
Other physical abnormalities

PULMONARY

OTHER DIAGNOSES

AMIEL TISON

Tone - Upper Extremities
- Lower Extremities
- Trunk
Deep Tendon Reflexes
Primitive Reflexes

NEURODEVELOPMENTAL

Mental Retardation
Cerebral Palsy
Seizure Disorder
Other Disorder
Institutionalization

GROWTH

Weight (kg)
Height (cm)
Head Circ (cm)
Chest Circ (cm)

HEMOGLOBIN

HEALTH HISTORY

URI's
LRI's
Otitis
Hosp. Resp. Prob.
Other Infectious Processes
System Abnormalities
Other Hospitalizations
Visits to GP/Ped
Visits to Specialist
Outpatient Visits
Standard Nutritional Suppl.
Fluoride
Current Meds

Comm/School Involvement
Pulmonary Follow Up
In Treatment Program
Referred to Treatment Program
Family Disruption
Foster Care

Rev. Eff. Apr 1.88

MCDI/MIDI

CD
CM
FM
EL
CC
SC
SH
PS

PHYSIOTHERAPY

PT Test Used
Gross Motor
Tone - Upper Extremities
- Lower Extremities
- Trunk
Primitive Reflexes
Intervention
Fine Motor

DIETARY

Feeding Problems

Special Diet
Non-standard Supplements
Breast Fed (per day)
Energy Intake
Intervention

Arm Circ (cm)
Triceps (mm)
Subscapular (mm)
AM Area (cm^2)

OPHTHALMOLOGY

Visual Acuity
Refraction
External Ocular Exam
Strabismus
ROP - Rt. Eye
- Lt. Eye
RLF - Rt. Eye
- Lt. Eye
Treatment

SPEECH

Expressive Language
Receptive Language
Articulation
Other
Intervention

HEARING

Screening
Audiometry
TM Mobility
Hearing Aid

PSYCHOLOGY

Psych Test Used
Cognitive Index

SOCIAL WORK

Characteristics of Parent
Pregnancy/Birth
Attachment/Caretaking Probs
Discipline/Temper Probs.
Support
Treatment Recommendations

OCCUPATIONAL THERAPY

Tests Used
MAP/BO/EDPA
Beery
MAC
DC -
PMDS
Intervention
Feeding