BACK TRANSPORT OF INFANTS FROM NEONATAL INTENSIVE CARE UNITS FOR CONVALESCENT CARE: IS IT SAFE?

by

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ABSTRACT

This retrospective study compared the clinical courses of 55 back-transported infants with those of 49 infants who remained within regional perinatal center for convalescent care. Although the mean birth weight and mean gestational age of the back-transported infants were significantly less than that of the nontransported infants ($p < 0.05$), the two groups did not differ in the incidence of respiratory disease, infectious complications, hyperbilirubinemia, patent ductus arteriosus, intraventricular hemorrhage, or necrotizing enterocolitis. The mean daily weight gain of the back-transported infants was significantly greater than that of the nontransported infants ($p < .001$). The back-transported infants exhibited a significantly greater number ($p < .05$) of new cardiovascular problems after transport. Following transfer, the back-transported infants did not demonstrate increased oxygen needs, increased incidence of feeding intolerance, or change in the frequency or nature of episodes of apnea and bradycardia. A comparison of the incidence of new respiratory, gastrointestinal, metabolic, neurologic, infectious, and miscellaneous problems revealed no statistical difference between the two groups.

TABLE OF CONTENTS

LIST OF TABLES

Table | Page

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CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

The infant mortality rate of a nation has been utilized as a measure of the quality of perinatal care provided in that nation (Chamberlain, 1979; Swyer, 1970). Despite technological advances, the infant mortality rate in the United States has remained consistently greater than that of other developed countries (U.S. Department of Health and Human Services, 1980). This trend has prompted efforts directed towards improving pregnancy outcome. Regional programs for the delivery of perinatal care have been established with the intention of assuring that all pregnant women and their newborns receive quality care.

The most commonly utilized model for regionalized perinatal care consists of a three-tiered scheme comprised of Level I, Level II, and Level III hospitals (Committee on Perinatal Health, 1977). Level I units provide care for uncomplicated obstetrical clients and well newborns. Level II units possess the capability to care for clients with most obstetrical and neonatal problems. In addition, Level II centers are expected to provide care for clients without complications.

Regional perinatal centers (Level III or tertiary centers) serve a surrounding geographic area in a multitude of ways. Responsibilities of regional centers include: provision of intensive

care for pregnant women and neonates, consultation, transport, education, evaluation, and research (Committee on Perinatal Health, 1977).

The provision of neonatal intensive care is only one responsibility of a perinatal center, albeit a significant one. Pregnant women may be transferred to a regional center for antepartum care or for delivery, if a need for neonatal intensive care is anticipated. Neonates may require the services of an intensive care unit for the treatment of conditions associated with complications occurring prenatally, during the intrapartum period, or for the evaluation and management of problems identified following birth.

In order to ensure optimal utilization of intensive care beds, the regional system must plan for the care of convalescing infants, those newborns who have recovered from the acute phase of illness and who no longer require intensive care. As the demand for neonatal intensive care has increased, overcrowding of neonatal intensive care units (NICUs) has become a problem (Sims, Wynn, & Chiswick, 1981; Zarif, Rest, & Vidyasagar, 1979). Retransfer, or back transport, of infants from neonatal intensive care units (NICUs) to the hospital of birth or to a hospital that is closer to an infant's home is one method of increasing the availability of neonatal intensive care (NICU) beds.

Research studies which have investigated back transport of newborns from intensive care units to intermediate-care or newborn nurseries are limited. Insufficient evidence exists to support the belief that infants are receiving quality care after back transport to referring or community hospitals.

Purpose

The purpose of this investigation was to determine whether the clinical courses of back-transported infants were comparable to those of infants who recover in a tertiary center following hospitalization in a neonatal intensive care unit (NICU).

Problem Statement

The problem to be investigated in this study is the effect of care provided in newborn and intermediate-care nurseries on the continued clinical improvement of newborns who have required hospitalization in a neonatal intensive care unit.

Conceptual Framework

The objectives of regionalization of perinatal care are: 1) accessible and quality care to all pregnant women and their newborns, 2) maximal utilization of highly skilled perinatal personnel and intensive care facilities, and 3) cost effectiveness (Committee on Perinatal Health, 1977). These goals are consistent with the aims of maternal and child health nursing practice.

> Reducing reproductive wastage occurring at any point on the continuum, Continuously improving the quality of care in Maternal and Child Health Nursing Practice, and Reducing inequalities in the delivery of health care services (American Nurses' Association, 1973, p. 2).

A regional program provides a framework within which the provision of quality nursing care becomes possible.

In order for a regional program to function effectively, coordinated efforts by all facilities within the region are necessary. Regionalization may be viewed within the confines of a systems model

(von Bertalanffy, 1968). A system is defined as a "set of units or elements that are actively interrelated and that operate in some sense as a bounded unit" (Baker, 1970, p. 4). The region served by a perinatal center is bounded according to local geography or population demographics. The component elements of the system are all those individuals and institutions which provide perinatal care. All institutions are interdependent. The regional center provides services which are unique within its sphere of responsibility. Smaller hospitals are the recipients of services provided by the regional center and assume their own responsibilities in the delivery of maternal and newborn care. For example, a major responsibility of personnel in Level I hospitals is the identification of high-risk mothers as early as possible in the pregnancy (American Academy of Pediatrics, 1977; American Academy of Pediatrics & American College of Obstetricians and Gynecologists, 1983; Butterfield, 1973; Committee on Perinatal Health, 1977; Russell, 1973). Early identification of risk factors that may endanger the health of the mother, the fetus, or the newborn permits consultation with and possible transfer of the mother to an institution which is capable of providing highly skilled assistance. The goal of this integrated approach is the provision of quality perinatal care and improved pregnancy outcome.

When one views regionalization within a systems model, it is apparent that all nurses within the region who participate in perinatal care contribute to the overall operation of the system. Professionals who firmly advocate that each newborn is entitled to

the opportunity to fulfill his or her genetic potential may contribute to the attainment of that goal through prenatal instruction of women about their pregnancies and the importance of adequate nutrition during pregnancy, through the identification of antepartum and intrapartum risk factors, and through early recognition of clinical problems in the neonate. Nurses may also be influential in assuring that the family unit is healthy by assessing the quality of interaction between parents and their newborns and by intervention when the social environment is less than desirable.

Brann (1974) and Callon (1975) have proposed that utilization of nurses in expanded roles is an integral part of a regional program. Sugarman (1978) has indicated that proponents of regionalization have failed to recognize the potential impact of nurse midwives and nurse practitioners upon the delivery of perinatal care.

Although the roles of nurses within a regional perinatal program are diversified, ranging from primary care providers in antenatal clinics to specialists in neonatal intensive care, from transport nurses to educators, and from staff nurses to administrators, the goal of improving pregnancy outcome is common to all.

Review of the Literature

Historical Background

Although the infant mortality rate in the United States has steadily declined since the year 1900, the United States has continued to lag behind other developed nations when comparisons are made according to this index (U.S. Department of Health, Education,

and Welfare, 1974; U.S. Department of Health and Human Services, 1981). As population characteristics across the United States are not homogeneous, patterns of infant mortality have varied accordingly. In a majority of states, mortality rates have consistently been higher for nonwhites than for Caucasians (U.S. Department of Health, Education, and Welfare, 1974; U.S. Department of Health and Human Services, 1981). In 1969, the infant mortality rate in the United States was 20.9 deaths per one thousand live births. However, the mortality rate for Caucasians was 18.4 deaths per thousand live births while, simultaneously, 32.9 deaths per thousand live births were reported for nonwhite populations. In the states of Idaho, Mississippi, and Wyoming, the infant mortality rate for nonwhites was in excess of 40 deaths per thousand live births (U.S. Department of Health, Education, and Welfare, 1974). Inadequate access to health care may have accounted for these discrepancies (Reis, 1967).

Swyer (1970) outlined a plan for the regional organization of neonatal care in Canada. This plan proposed that a three-tiered system be established for the delivery of neonatal care. This hierarchy, which was dependent upon institutional capability, proceeded from district hospitals to community hospitals, and, finally, to regional obstetric-neonatal centers.

In 1971, the American Medical Association expressed its approval for the establishment of regional perinatal programs:

> Application of recent advances in scientific knowledge and skills in the intensive care management of high-risk pregnant women and high-risk newborn infants will result in reduction of present maternal and infant

> mortality. A major contribution to such a program is the development of a centralized community (or regional) hospital-based newborn intensive care unit (American Medical Association, cited in 66th Ross Conference on Pediatric Research, 1974, p. 90).

The American Medical Association enumerated goals for regional perinatal programs and also made recommendations for the implementation of programs (American Medical Association, cited in the 66th Ross Conference on Pediatric Research, 1974).

The Committee on Perinatal Health was formed in 1972 and was composed of individuals representing the following organizations: the American Academy of Pediatrics, the American Academy of Family Physicians, the American College of Obstetricians and Gynecologists, and the American Medical Association. With the assistance of the National Foundation - March of Dimes, recommendations for the development of regional programs were published in a document entitled Toward Improving the Outcome of Pregnancy (Committee on Perinatal Health, 1977). This treatise described a model for perinatal care delivery which consisted of three levels of care, Levels I, II, and III (or primary, secondary, and tertiary levels). The responsibilities of the facilities at each level were delineated.

In 1973, the American College of Obstetricians and Gynecologists proclaimed as one of its goals a reduction of infant mortality over a 10 year period to 10 deaths per thousand live births (Russell, 1973). Regionalization of perinatal care has been a recurrent theme in recommendations for the delivery of neonatal care (American Academy of Pediatrics, 1977; American Academy of Pediatrics &

American College of Obstetricians and Gynecologists, 1983).

Financial support for regionalized perinatal care has originated from a variety of sources. In 1975, the Robert Wood Johnson foundation funded eight regional programs (Ryan, 1977; Shapiro, McCormick, Starfield, Krischer, & Bross, 1980). State health departments have also provided financial backing for regional perinatal programs in Arizona (Giles, Isaman, Moore, & Christian, 1977), Iowa (Hein, Christopher, & Ferguson, 1975), Massachusetts (Ryan, Pettigrew, Fogerty, & Donahue, 1977), North Carolina (Nugent, 1982), and Wisconsin (Callon, 1975). The National Foundation/March of Dimes has provided financial support of efforts to improve perinatal care through the provision of grants for personnel, equipment, and educational materials (Salisbury, 1976).

Regionalization has been supported by legislation at both the federal and state levels which has emphasized the necessity of planning for the provision of maternal and newborn care, consequently avoiding duplication of services. Title V of the Social Security Act has been expanded, requiring that all maternal and child health crippled children's programs include a plan for intensive care of infants (Ferrera & Perrotta, 1976).

Regulations for the provision of newborn care in Massachusetts were instituted in 1970. Emphasis was placed upon the early diagnosis of problems in the newborn, the establishment of special-care and transfer nurseries, and the provision of an effective and safe transport system (Massachusetts Department of Public Health, 1972). Several legislative acts have been promulgated in California with

the intention of improving perinatal care as a result of the establishment of standards of care (Hawes, 1976).

Regionalization

As defined by the Committee on Perinatal Health:

> Regionalization implies the development, within a geographic area, of a coordinated, cooperative system of maternal and perinatal health care in which, by mutual agreements between hospitals and physicians and based upon population needs, the degree of complexity of maternal and perinatal care each hospital is capable of providing is identified so as to accomplish the following objectives; quality care to all pregnant women and newborns, maximal utilization of highly trained perinatal personnel and intensive care facilities, and assurance of reasonable cost effectiveness (Committee on Perinatal Health, 1977, p. 2).

Implicit in the above definition is the importance of planning for regionalization of perinatal care. Attempts at establishing regional programs were not to be made in a haphazard manner. In order to determine the needs of an area to be served by a perinatal center, evaluation of existing facilities, identification of patterns of delivery of perinatal care, and an understanding of the distribution of the population and health care providers were imperative (Butterfield, 1977; Ryan, 1977; Ryan et al. 1977; Swyer, 1970). Ideally, the perinatal center was to serve an area in which eight to twelve thousand deliveries occur annually (Committee on Perinatal Health, 1977). However, in rural areas in which distance between urban centers is a factor which influences access to care, this expectation may be unrealistic.

Butterfield (1972) considered the area served by a perinatal center to be a "region of responsibility" (p. 54). Responsibility

was not exclusively the prerogative of the perinatal center. All institutions within the region were to share responsibilities if efforts directed towards improving pregnancy outcome were to be coordinated. Emphasis was placed upon an integrated approach to the delivery of perinatal care (Butterfield, 1976).

The model created for regionalization of perinatal care in the United States was that of a three-tiered scheme consisting of Level I, Level II, and Level III units (Committee on Perinatal Health, 1977). Level I centers provide care for uncomplicated obstetrical clients and well newborns. Early identification of antepartum risk factors is a major responsibility of Level I units (Committee on Perinatal Health, 1977; American Academy of Pediatrics, 1977; American Academy of Pediatrics & American College of Obstetricians and Gynecologists, 1983). Several tools have been developed for antepartum risk assessment (Goodwin, Dunne, & Thomas, 1969; Hobel, Hyvarinen, Okada, & Oh, 1973; Nesbitt & Aubrey, 1969).

One retrospective study of 320 perinatal deaths concluded that 26% of those deaths were preventable (Harper, Sokol, M. M., Sokol, S., Mastrota, & Davis, 1977). Twenty-two percent of the deaths occurred because women were not correctly identified or managed as high-risk patients. A study of perinatal mortality in Massachusetts concluded that 35% of perinatal deaths were preventable (Perinatal Welfare Committee, cited in Ryan et al. 1977). An objective of the referral of high-risk women to regional centers is the elimination of preventable perinatal deaths.

Staffing at Level I hospitals must be adequate for: 1) resuscitation of all infants born at the institution, 2) management and

stabilization of sick infants prior to transport, 3) care for healthy infants until discharge, and 4) care for infants transferred from Level II and Level III hospitals (American Academy of Pediatrics, 1977).

Level II units possess the capability of caring for uncomplicated mothers and newborns as well as for clients with most obstetrical and neonatal problems. Level II hospitals, in which 1,500 deliveries are expected to occur annually, ideally are the standard for the delivery of perinatal care in all areas, with the exception of rural areas (Pearse, 1979). Hein (1982) has contended that, while planning for the provision of perinatal care in rural areas, knowledge and consideration of regional needs supersede government recommendations. Factors other than number of annual deliveries, for example, geography, road conditions, and weather also must be taken into consideration.

Development of Level II units was to be achieved through the consolidation of small obstetrical services in urban areas (Committee on Perinatal Health, 1977). Level II neonatal units are expected to maintain ongoing communication with the tertiary center for consultation. The availability of Level II units may contribute to improved utilization of intensive care beds when newborns are accepted as transports from the regional center (American Academy of Pediatrics, 1980).

Level III centers, the regional centers, possess the capability, in terms of skilled personnel and technology, of providing care for complicated obstetrical clients and critically ill neonates. The additional responsibilities of a perinatal center are:

consultation, transport, preparatory and continuing education, evaluation of functions and results, and research (Committee on Perinatal Health, 1977).

Availability for consultation on a 24 hour basis allows ongoing communication between the regional center and Level I and Level II units, and may contribute to acceptance of the concept of regionalization within the area served by the perinatal center. The establishment of telephone "hot-lines" has been recommended as one method of providing consultation while assuring the visibility of the regional center (Baum, 1980; Butterfield, 1972; Roy & Kitchen, 1977).

Transport of obstetrical and neonatal clients is an additional function of the perinatal center. Pregnant women may be transferred to a tertiary center for management of concurrent disease states, either preexisting or pregnancy-associated. Transport of the expectant mother may also be accomplished if a need for neonatal intensive care is anticipated. Several investigators have suggested that in utero transport of the newborn is preferable to neonatal transport (Blackburn, Edwards, Fletcher, & Avery, 1974; Pettett, Merenstein, Battaglia, Butterfield, & Elfird, 1975; Souma, 1979; Roy & Kitchen, 1977).

Data have accumulated in the literature as investigators have attempted to evaluate the merits of maternal transport as compared to neonatal transport. A significantly shorter duration of hospital stay has been reported in neonates transported in utero when compared to newborns transported following delivery (Merenstein, Pettett, Woodall, & Hill, 1977). These investigators also observed

that the mortality rate of infants transported in utero was less than that predicted, despite their significantly smaller size. The mortality rate for transported neonates was greater than that predicted.

A significantly reduced cost of hospitalization and length of stay for those infants delivered of women transported prior to delivery has been reported (Anderson, Aladjem, Ayuste, Caldwell, & Ismail, 1981). In addition, in the same study, a significantly improved survival rate was reported for neonates transported in utero weighing 1500 grams or more and with a duration of gestation greater than 35 weeks.

Harris, Isaman, and Giles (1978) concluded that the very-low-birthweight infant benefitted the most from in utero transport. Other authors have reported improved survival rates for infants transported in utero when compared to their outborn counterparts (Harris, Wirtschafter, Huddleston, & Perlis, 1981; Modanlou, Dorchester, Thorosian, & Freeman, 1979). A decreased incidence of intraventricular hemorrhage has been reported in inborn infants (Clark, Lane, Clyman, Sniderman, Roth, & Ballard, 1979).

Despite attention early in the pregnancy to the identification of factors that may place the neonate at risk, all neonates who require neonatal intensive care have not been identified as a result of antepartum risk screening. Hobel and associates (1973) reported that the appearance of risk factors in the intrapartum period contributed to perinatal morbidity and mortality even if the pregnancy was determined to be of low risk at the time of antepartum

screening. Emphasis upon early antepartum risk screening has not eliminated the need for developing neonatal transport systems.

Professionals and consumers must be made aware of the goals of regionalization prior to the expectation of widespread acceptance of a regional program. Professionals must be cognizant of the contributions they make to the overall operation of the regional program. Support for regionalization will exist only if the objectives of regionalization are considered desirable.

Outreach education programs for professionals within the regions have served the dual purposes of clarifying the expectations of professionals within the system and have provided caretakers with skills and knowledge necessary for effective performance. Outreach education has emphasized early referral of high-risk obstetric clients to a perinatal center. Resuscitation and stabilization of the neonate have also been priorities of educational programs (Kattwinkel, Cook, Nowacek, Ivey, & Short, 1979; Oh, Cowett, Clark, & Biester, 1977; Pernoll, 1976).

Arguments Favoring Regionalization

Fragmentation and duplication of services have been identified as problems associated with perinatal care delivery. The American College of Obstetricians and Gynecologists in 1973 proclaimed that a desirable goal of that organization be:

> The assurance that adequate obstetric-gynecologic care is available to all women through a) solutions to the problems of maldistribution of personnel and facilities, and b) reductions in health care costs by the more efficient

> utilization of personnel and facilities (Russell, 1973, pp. 638-639).

Bishop (1970) reported the results of a national survey which determined that 56% of all deliveries occurred in hospitals with fewer than 500 births per year. Underutilization of available maternity beds was identified as a problem in Bishop's study as well as in a report published under the auspices of the Commonwealth of Massachusetts (Ryan et al. 1977). The net result of underutilization of services was increased cost for the consumer.

The perinatal mortality rate has been observed to be inversely proportional to the size of the obstetrical service (Harper et al. 1977); Perinatal Welfare Committed, cited in Ryan et al. 1977; Usher, 1971). For this reason, consolidation of perinatal services, particularly in urban and suburban areas, has been recommended (Committee on Perinatal Health, 1977).

Some institutions may have felt pressured to establish NICUs while operating under the pretense of enhancing institutional prestige. The establishment of multiple NICUs serving a given area has been found to be prohibitive because of the cost of equipment and personnel (Blackburn et al. 1974; Blake, McIntosh, Reynolds, & St. Andrew, 1975; Erickson, 1970).

The utilization of available NICU beds has been questioned by Shearer (1980). This investigator has suggested that, in some institutions, overutilization of NICU beds for use by newborns who may be transferred from the well-baby nursery for observation following delivery through meconium-stained fluid or for other reasons may allow profits to be generated for the hospital because of NICU bed

occupancy. The net result of this practice has been increased cost to the consumer.

Regionalization has offered solutions to some of the above problems through maximizing the use of existing facilities and centralizing and coordinating services throughout the region in efforts directed towards cost reduction.

Regional programs have emphasized the importance of early identification of high-risk pregnancies. The goal of improved pregnancy outcome has become more desirable and beneficial for consumers, as couples consciously choose to have fewer children. Public relations programs initiated by the regional centers have been necessary, permitting visibility of the regional center and contributing to the public's understanding of the aims of regionalization (Butterfield, 1977). Lucey (1973) has stated that "a well informed public can be a powerful, effective ally" in the regionalization process (p. 488).

Proponents of regionalization have argued that maternal transport may be advantageous for the neonate who benefits from the attendance of skilled personnel from the moment of birth. Hospitalization of mother and infant in the same institution may facilitate the maternal-infant attachment process (Klaus & Kennell, 1982). Although separation of mothers and their infants under some circumstances may be inevitable, the separation may influence subsequent patterns of mothering (Klaus & Kennell, 1970; deChateau, 1980).

Arguments Opposing Regionalization

Several voices have been raised in opposition to the development of regional perinatal programs. Physicians have been the most vocal in expressing their concerns regarding the effect of regionalization on their patterns of practice. Obstetricians in Massachusetts felt that loss of privileges would occur as a direct consequence of consolidation of obstetric units. In addition, they argued that increased travel time to facilities providing obstetrical care would be necessary for themselves and their patients (Ryan & Fielden, 1978).

Concern has been expressed by physicians that, as a result of regionalization, consumers would alter their perceptions regarding community hospitals, feeling that they were no longer meeting the needs of the community (Ryan et al. 1977). Physicians feared that community hospitals would no longer provide gynecologic surgery services, further limiting their practices (Brown, 1980; Keettel, in Russell, 1975). Physicians may have perceived that, as a result of the regional center's responsibility for evaluating care, their autonomy as practitioners was threatened (Gluck, Wimmer, Mannino, DeLue, & Feldman, 1976).

Lucey (1973) questioned whether the establishment of regional centers would weaken obstetrical care in some areas. He contended that limited exposure of professionals to high-risk obstetrical clients would subsequently reduce the ability of personnel to respond during emergency situations.

Lack of involvement of the primary caretaker in the management of their patients following transport to a regional center has been

identified as a problem (Russell, 1975). Keettel (in Russell, 1975) argued that obstetricians have feared loss of control over complicated obstetrical patients as a result of maternal referral.

Communication, or lack thereof, between physicians in the community and those at the regional center has been identified as a problem with regionalization. The desirability and importance of direct communication between referring physicians and attending physicians at the tertiary center has been emphasized (Boehm & Haire, 1979; Ewing, 1981). The personnel at the tertiary center may have inadvertently exuded an attitude of superiority over other institutions when a referring physician received information from nurses and/or house staff.

Sugarman (1978) addressed the issue of the lack of humanistic care provided at the regional center. The regional center may have been viewed by some individuals as an impersonal entity, being technology- rather than people-oriented.

Hein (1978) has questioned the rationale for consolidating obstetrical services, arguing that, in rural hospitals in Iowa, the cost for delivery of obstetrical care was lower than that in hospitals with greater numbers of deliveries per year. Hein (1978) also argued that an acceptable quality of perinatal care can be provided in small rural hospitals that are affiliated with a regional program. The investigator contended that unquestioned adherence to recommendations without scrupulous assessment of regional needs may result in a health care delivery system that is less efficient and less economical than the system currently in operation.

Opponents of regionalization have also based their arguments upon literature which has indicated that separation of mothers from their infants may be detrimental to the attachment process (Klaus & Kennell, 1970; deChateau, 1980).

Opponents of regionalization have argued that the emphasis upon the provision of intensive care has resulted in increased cost of care in addition to a diminution of the number of facilities available for delivery of primary care (Shearer, 1980). Increased cost may be the result of the use of technology in efforts to provide more sophisticated care, and to overutilization of procedures (Sugarman, 1978). The average daily-adjusted cost for providing NICU care is greater for nonsurvivors than for survivors (Phibbs, C. S., Williams, & Phibbs, R. H., 1981; Pomerance, Ukrainski, Ukra, Henderson, Nash, & Meredith, 1978). Further economic evaluation of regional perinatal programs weighing cost/benefit analysis has been recommended (Sugarman, 1978).

Effectiveness of Regional Programs

Evaluation of the effectiveness of regional programs has been designated to be the prerogative of the regional center (Committee on Perinatal Health, 1977). This evaluation consists of measuring the effect of regionalization upon morbidity and mortality as well as determining the impact of the regional center upon the region served.

Regionalization may have had little effect upon the actual numbers of facilities that provide obstetrical services. Pearse (1979) reported that, despite the emphasis upon regionalization, the

number of hospitals with obstetrical services increased between the years 1972 and 1977. Only in Massachusetts and California were obstetrical services consolidated sufficiently to impact upon the delivery of perinatal care.

The voices of those opposing regionalization have been heard and attempts have been made to respond to the needs of physicians in community hospitals. Some hospitals have allowed physicians to have partial or complete responsibility for the management of their obstetrical clients who are transferred to a perinatal center for delivery (Knuppel, Cetrulo, Ingardia, Kappy, Kennedy, Kerschel, Aumann, Lake, & Sbarra, 1979; Levy, Noelke, & Goldsmith, 1981).

Ryan and Fielden (1978) completed a survey which addressed questions to obstetricians in Massachusetts who were practicing in hospitals at the time of closure of obstetrical services. These researchers reported that many of the fears expressed by the physicians regarding the effect of consolidation upon their practices were actually unfounded.

With emphasis upon early identification of high-risk pregnancies and following the institution of maternal transport programs, an increase in the volume of in utero transports has been reported (Anderson et al. 1981; Harris et al. 1981; Knuppel et al. 1979). The impact of in utero transport upon neonatal morbidity and mortality has been discussed previously in this review. Modanlou and colleagues (1979) have reported that an additional advantage of maternal transport as compared to neonatal transport was the reduced cost of the transport itself.

Several investigators have reported decreases in perinatal and infant mortality following the development of regional perinatal programs (Brann, 1974; Callon, 1975; Rozier, 1980; Usher, 1977). Although reduced neonatal mortality has been reported to be a consequence of regional perinatal programs, regional programs have have had little impact upon the numbers of low birthweight infants delivered (Bowes, 1981; Heins & Sear, 1982; Lee, Paneth, Gartner, Pearlman, & Gruss, 1980). Regional programs have had little impact upon the fetal death rate (Bowes, 1981; Williams & Chen, 1982).

Additional factors which have been credited with influencing the decline in neonatal and infant mortality have included: increased acceptance of family planning and improved childbirth education (Sinclair, Torrance, Boyle, Horwood, Saigal, & Sackett, 1981), improved intrapartum assessment and the use of fetal monitoring during labor (Rozier, 1980), quality of antenatal care (Gibson & Colley, 1982), increased utilization of nurse midwives (Haire, 1981; Levy, Wilkinson, & Marine, 1971), and the establishment of regional dispatch centers to expedite neonatal referral (Vogt, Chan, Wu, & Hawes, 1981). Educational programs delivered to professionals in community hospitals which have emphasized the prevention of hypoglycemia and hypothermia while stabilizing newborns may have contributed to improved neonatal outcome (Kattwinkel et al. 1979). Adverse effects of the economy upon the infant mortality rate have been reported (Associated Press, 1982).

The utility of the infant mortality rate as an index according to which the effectiveness of regional perinatal programs have been

measured has been questioned (Hein & Brown, 1981; Hoekstra, Fangman, Perkett, Brasel, & Knox, 1981).

Sinclair and associates (1981) have discussed the lack of demonstrated effectiveness of NICUs. These investigators have proposed that when evaluating NICUs, the efficacy, efficiency, effectiveness, and availability of programs must be considered. These investigators have criticized the methodology used in previous studies of outcome evaluations, believing that long-term studies of the morbidity of NICU survivors must be completed.

A plethora of studies have appeared in recent literature which have attempted to evaluate the long-term outcome of NICU graduates, concomitantly justifying the existence of NICUs (Britton, Chir, Fitzhardinge, & Ashby, 1981; Cohen, Stevenson, Malachowski, Ariagno, Kimble, Hopper, Johnson, Ueland, & Sunshine, 1982; Kumar, Anday, Sacks, Ting, & Delivoria-Papadopoulos, 1980; Rothberg, Maisels, Bagnato, Murphy, Gifford, McKinley, Palmer, & Yannucci, 1981; Saigal, Rosenbaum, Stoskopf, & Milner, 1982). Because the subjects of several of these studies have not yet reached school age, definitive conclusions regarding outcome and long-term disability cannot be drawn.

Sinclair and colleagues (1981) have stated that the cost-effectiveness of neonatal intensive care has yet to be documented. Studies completed for the purpose of evaluating the effects of consolidation of obstetrical services in the Commonwealth of Massachusetts reported savings of operating costs as a consequence of redistribution of funds (Maternal-Newborn Regionalization Project, cited in Ryan et al. 1977).

The economic evaluation of neonatal intensive care has received an increased amount of attention in the literature. The average daily-adjusted cost of providing care is greater for nonsurvivors than for survivors. This finding may be attributed to an increased intensity of care provided as a maximal effort over a shorter period of time (Phibbs et al. 1981; Pomerance et al. 1978). Boyle, Torrance, Sinclair, and Horwood (1983) attempted to complete a cost analysis of NICU care and reported that, from an economic standpoint, providing care to heavier infants (greater than 1000 grams) may produce more favorable results. However, the ethical dilemmas surrounding the direction of efforts according to economic considerations have yet to be resolved.

Other investigators have argued that the cost of neonatal intensive care is justified and is balanced by the lifetime contribution to society and the lifetime earning power of an intact individual (Swyer, 1970; Reis, 1967) and by the savings of expenses to society which would have been incurred by an individual requiring long-term rehabilitation or institutionalization.

Back Transport

Newborn nurseries in Level I hospitals have been expected to "provide supportive care for infants transferred back from Level II or III units after their acute problems have been resolved..." (Committed on Perinatal Health, 1977, p. 5). The American Academy of Pediatrics has shared that viewpoint and has designated that, in order to provide adequate care for back-transported infants, the following criteria must be met: 1) a qualified physician who will

assume the responsibility for medical care, 2) adequate numbers of qualified nursing personnel, 3) an infection surveillance program, and 4) a program to allow parents the opportunity to participate in the care of their infant, through the provision of both support and education (American Academy of Pediatrics, 1977).

Advocates of back transport have proposed the following theoretical advantages of retransfer of infants to a hospital that is closer to home: greater opportunity for parents to visit their infants, reduced expense of hospitalization, improved relationships between community hospitals and the perinatal center, and more effective utilization of intensive care beds and specialized personnel (Jung & Bose, 1983; Leake, Loew, & Oh, 1976). Limited data have been reported in attempts to support these contentions.

Meyer, Mahan, and Schreiner (1982) attempted to determine parents' opinions about back transport of their infants to community hospitals. These investigators also attempted to assess the adequacy of preparation received by parents regarding the transfer of their infants. The adequacy of the care provided at the community hospital and the staff's ability to handle problems that might arise in their infants was a cause of concern for 29% of parents who responded in this survey. The authors failed to document that parental contact with their infants occurred more frequently as a result of transport of the infant from the regional center.

Cost effectiveness of back transport has been addressed in the literature to a limited extent. Zarif and associates (1979) reported a 31% decrease in the cost of hospitalization for those infants back-transported to community hospitals when cost

comparisons were made with infants recovering in the regional center. There were no statistically significant differences observed between the two groups when they were compared according to the parameters of birth weight, gestational age, or clinical diagnosis. The total duration of hospitalization was comparable for the subjects in each group. The infants in the group recovering at the regional center were not identified as having been inborn or outborn.

Bose, LaPine, and Jung (unpublished) compared two groups of infants who were matched for weight, caloric intake, route of nutrition, major medical problems, and monitoring needs at the time of transfer. The total cost of convalescent care for back-transported infants was less than that of infants remaining in the regional center; however, this difference did not achieve statistical significance unless the duration of hospitalization at the institution to which the infant was back transported was greater than 2 weeks. Significant differences between the two groups were noted when the average daily total charge and the average daily bed charge were compared. Charges for laboratory tests and medications were significantly greater for the nontransported group than for the back-transported infants. The cost of the transport itself was included in this analysis.

Improved utilization of NICU beds for acutely ill infants has been considered to be an advantage of back transport. Zarif and colleagues (1979) reported a 15% increase in NICU bed utilization following institution of a program for back transporting infants. Jung and Bose (1983) reported a 44% reduction in the need for NICU

personnel, equipment, and facilities as a result of back transporting convalescing infants.

No systematic studies of the care provided to back-transported infants after their discharge from regional centers have appeared in the literature. Meyer and associates (1982) indicated that, of 37 infants transferred to community hospitals, three developed complications. Two infants required an increased amount of oxygen and one infant developed pneumonia. The criteria to be met by the infants prior to back transport were not delineated.

Data presented by Zarif and colleagues (1979) indicated that, of 48 infants discharged to community hospitals, complications occurred in no infants. No deaths occurred among the back-transported infants; no infants required readmission to the NICU. In this series, the expectations of the infants prior to discharge were that they be: 1) breathing room air, 2) not receiving intravenous medications, 3) taking oral feedings in adequate quantities, and 4) demonstrating an upward trend in weight gain. This study primarily emphasized cost effectiveness and improved utilization of NICU beds occurring as a consequence of back transport.

Leake and colleagues (1976) attempted to assess the safety of back transport from an infectious standpoint, reporting that the following problems occurred among 43 infants who were transported to two community hospitals for convalescent care: 1) four infants developed temperature instability (3 episodes occurred while infants were being weaned from Isolettes®), 2) one infant presented a

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positive stool culture for Salmonella, 3) two infants developed monilial diaper rashes, and 4) symptoms of sepsis were reported in two infants, one of whom was returned to the regional center for care. Those infants who were back transported showed no signs of infection at the time of discharge, had negative stool cultures, required a fraction of inspired oxygen less than 0.25, with adequate blood gases for at least 24 hours, and tolerated oral or gavage feedings in amounts sufficient for meeting caloric and nutritional requirements. Those infants who weighed less than 1200 grams at the transfer had no heart murmur at the time of discharge.

In one series of 172 back transported infants, three required readmission to the NICU (June & Bose, 1983). Reasons for readmission were: apnea and bradycardia, gastroesophageal reflux with apnea and bradycardia, and parental dissatisfaction with the infant's care and visiting policies at the community hospital. In the same series, six of 107 infants were readmitted to the NICU from the convalescing nursery in the regional center.

Clarke, Maniscalco, and Emmens (1983) reported that necrotizing enterocolitis was a problem identified among back-transported neonates. Over a two year period of time, four of the nine infants who weighed less than 1300 grams (range 760 to 1170) at the time of back transport developed signs of necrotizing enterocolitis within 60 hours of transfer. Three of those four infants subsequently expired. The authors suggested that the transport itself may have contributed to necrotizing enterocolitis, postulating that some mechanism may have altered intestinal blood flow. However, for three of the four infants, transport was to a facility that was a

20 minute ambulance ride from the regional center. The infants had been tolerating nasogastric feedings for 5 to 17 days prior to transfer, had no history of guaiac-positive stool, had no apnea, and required a fraction of inspired oxygen less than 0.25.

Research Questions

1) Is the clinical improvement of infants who are back-transported from neonatal intensive care units to newborn and intermediate-care nurseries comparable to that of infants who receive convalescent care in the tertiary center?
   a) Do back-transported infants exhibit the following?
      -- A change in oxygen requirements?
      -- A change in the pattern of weight gain?
      -- Evidence of feeding intolerance?
      -- A change in the frequency and/or nature of episodes of apnea and bradycardia?
      -- A change in the ability to maintain body temperature?
2) Are the clinical problems identified in back-transported infants different from those identified in babies recovering in the regional center?
3) Upon identification of clinical problems, is treatment provided in the regional center and the referring hospitals appropriate?
4) Is the therapy that was provided for infants at the regional center altered after the infant's arrival at the community hospital?

Assumptions

Throughout this investigation, the investigator operated under the following assumptions:

1) Charting by personnel at all institutions was complete and accurately reflected the clinical course of the infants studied.
2) Caretakers of back-transported infants possessed the knowledge and skills required for identification of and intervention for clinical problems.

Definition of Terms

1) Regionalized Perinatal Care: A coordinated program established within a designated geographic area for the delivery of perinatal care, which is designed to provide accessible, quality, and economical care through optimal utilization of facilities and personnel.
2) Back Transport: Transfer of infants from a neonatal intensive care unit to newborn or intermediate-care nurseries for convalescent care.
3) Clinical Improvement: Progression from acute illness to discharge home. This includes, but is not limited to:
   a) Development of respiratory and neurologic maturity for sustaining ventilation, with or without supplemental oxygen.
   b) Transition from parenteral to enteral feeding with provision of sufficient calories and fluids for maintenance and growth.

c) Transition from dependence upon environmental regulation for body temperature maintenance to independent temperature control.

4) Convalescent Care: Medical and nursing care that is provided during the transition from acute illness to discharge home. This includes the recognition of signs that may be indicative of clinical deterioration.

5) Critically-ill Infants: Those infants who require hospitalization in a neonatal intensive care unit for the evaluation and treatment of acute illnesses. These infants may have been born at the regional center or transported to the NICU from another institution or home.

6) Acute Illnesses: Those disorders that necessitate hospitalization in a neonatal intensive care unit. Acute illnesses include, but are not limited to, hyaline membrane disease, aspiration syndromes, transient tachypnea of the newborn, sepsis neonatorum, and associated complications of prematurity.

7) Appropriate Treatment: Medical and nursing management of identified problems that meets the accepted standard of care of the Intermountain Newborn Intensive Care Center.

CHAPTER II

METHODOLOGY

Design

The investigator utilized the Nonequivalent Control Group Design (Campbell & Stanley, 1963) for this retrospective study (see Figure 1). Subjects were not randomly assigned to groups; therefore, equivalence of the experimental and control groups was not assumed.

Sample

The sample was drawn from the total population of infants admitted to the Newborn Intensive Care Unit of the University of Utah Medical Center between May 1, 1982 and December 31, 1982. Indications for admission to the NICU included: preterm birth, hyaline membrane disease, aspiration syndromes, transient tachypnea of the newborn, sepsis neonatorum, and persistent pulmonary

Experimental:	Pre-Measurement	Back Transport	Post-Measurement
Control:	Pre-Measurement		Post-Measurement

Figure 1. The nonequivalent control group design. Adapted from Campbell, D. T., & Stanley, J. C. Experimental and quasi-experimental designs for research. Boston: Houghton Mifflin Company, 1963.

hypertension. Both inborn and outborn infants were included in this study.

Infants were excluded from this study if they were: 1) discharged from the NICU to the well baby nursery of the University of Utah Medical Center within 24 hours of admission to the NICU, 2) admitted to the NICU following discharge from the hospital of birth to home after an uneventful nursery course, 3) diagnosed as having a chromosomal abnormality, 4) observed to have multiple congenital anomalies, 5) transported to another center for ventilator management, and 6) transported to another tertiary center in the same city for evaluation and management of congenital heart disease or for surgical correction of congenital defects. Infants who were back transported because of the presence of conditions for which medical or surgical treatment were not available--for example, hypoplastic left heart syndrome--were excluded from this study.

During the interval between May 1, 1982 and December 31, 1982, 307 newborns were admitted to the NICU of the University of Utah Medical Center. Forty-three of those infants expired (Annual Report, Neonatal Transport Services, University of Utah Medical Center, 1982). A computer search of NICU statistics indicated that 97 infants were transported to other hospitals during the study period. Fourteen infants were transferred to facilities with Level II or III capabilities and were considered lateral transports. Eleven infants were transported to hospitals in Montana, Colorado, and New Mexico and were excluded from the sample because of the travel time required for data collection. Nine infants were back transported to hospitals in Utah, Nevada, or Wyoming to which only

one or two infants were transferred. These infants were excluded because of the need for travelling long distances for obtaining data from a limited number of subjects. Six infants who were transported during this time were admitted to the NICU prior to the beginning of the study period. For two back-transported infants, records were unavailable to the investigator at the time of data collection.

After exclusion of infants for the above reasons, a total of 55 infants remained who were back transported to 12 area hospitals, seven in Utah, two in Wyoming, and three in Idaho. The hospital to which the infants were back transported was either the infant's hospital of birth or another institution which was capable of providing the level of care that was required by the infant.

Newborns hospitalized in the NICU for management of acute illnesses who remained at the University of Utah Medical Center for convalescent care comprised the control group. The names of 54 infants were arbitrarily selected from the NICU admission log book. Of those 54 infants, one was eliminated from the study because the chart indicated that the infant had multiple congenital anomalies. This information was not recorded in the admission log. Four infants were excluded when the investigator discovered that they had not met the criteria established for back transport prior to their discharge home.

The control group was made up of the 49 remaining infants. Some of these infants were subjects in an additional study being conducted at the time of hospitalization. Criteria for inclusion into that study were that the infants be "relatively healthy"

preterm infants with birth weights that were appropriate-for-gestational age and within the range of 1000 to 1500 grams.

Instrumentation

The tools utilized for data collection were developed by the researcher (Appendices A, B, and C). A portion of the Neonatal Chart Review form developed at the University of Utah Medical Center was incorporated into Appendix A - Baseline Data.

For the purpose of this study:

1) Oxygen requirements were defined as the amount of oxygen, measured as fraction of inspired oxygen, necessary for the maintenance of the arterial partial pressure of oxygen between 50 and 70 mm Hg (Brody & Gregory, 1979) or of the capillary partial pressure of oxygen (arterialized by warming the extremity from which the blood sample was obtained) between 35 and 50 mm Hg (Usher, 1981).
2) The pattern of weight gain was that change in weight, measured in grams, that occurred over a 24 period of time. Ideally, this growth paralleled the expected intrauterine growth rate, which averages 30 grams per day after 30 weeks' gestation (Usher, 1981). An increase in weight of 20 to 30 grams per day was considered appropriate (Fanaroff & Klaus, 1979).
3) Apnea was defined as cessation of respiration, accompanied by cyanosis and/or bradycardia (Volpe & Koenigsberger, 1981; Stark, 1980). Apnea has been considered to be a reflection of immature neurologic control of ventilation (Ferrara & Harin,

1980; Klaus, Fanaroff, & Martin, 1979; Volpe & Koenigsberger, 1981).

4) Bradycardia was defined as a heart rate less than 100 beats per minute (Ferrara & Harin, 1980; Stark, 1980).

5) Adequacy of ventilation was indicated by the maintenance of partial pressure of carbon dioxide in the blood at less than 50 mm Hg (Stark, 1980). This value was utilized as the standard of measurement for both arterial and capillary blood samples.

6) Temperature control was defined as the maintenance of axillary temperature within the range of 36.5°C to 37.2°C (American Academy of Pediatrics & American College of Obstetricians and Gynecologists, 1983; Kanto & Calvert, 1977). For many infants, temperature control was dependent upon the manipulation of the infant's environment by caretakers.

7) Feeding intolerance was indicated by the appearance of signs and symptoms that demonstrated that digestion or absorption of nutrients, administered by the enteral route, was impaired. Abdominal distention, residuals and emesis were reflective of feeding intolerance (Fanaroff & Klaus, 1979).

8) Parenteral nutrition was defined as the provision of fluids, electrolytes, and nutrients by intravenous or intraarterial (as in the case of umbilical artery catheters) routes. The provision of 120 kilocalories per kilogram per day was considered to be adequate for meeting the nutritional needs of the growing preterm infant (Bell & Oh, 1981; Usher, 1981). Adequate fluid requirements were defined as 140 to 160 cc/kg/day (Fanaroff & Klaus, 1979).

9) A term infant was defined as one born between 38 and 42 weeks gestation. An infant born prior to 38 weeks was considered preterm; infants born after 42 weeks gestation were designated as postterm (Lubchenco, 1981).

10) Appropriate-for-gestational age (AGA) indicated that the subject's birth weight fell between the tenth and ninetieth percentiles when plotted against gestational age. Small-for-gestational age (SGA) indicated that the neonate's birth weight was below the tenth percentile for gestational age. Large-for-gestational age (LGA) indicated that the neonate's birth weight was greater than the ninetieth percentile for gestational age (Lubchenco, 1981).

11) Birth asphyxia was defined as a 5-minute Apgar score less than 6 (Karotkin & Goldsmith, 1981).

Procedure

Following the identification of subjects, charts were obtained from the Department of Medical Records of the University of Utah Medical Center. The Baseline Data form (Appendix A) was completed for all subjects in the study. The date upon which the subject met the criteria for back transport was determined and information was recorded at that time utilizing Appendix B.

The establishment of definitive discharge criteria for back transport of infants was problematic. Timing of discharge was dependent upon the needs of the infant as well as the capabilities of the hospital to which the infant was transferred. Prior to establishing discharge criteria for this study, letters were sent by the

investigator to eighteen directors of NICU's in perinatal centers requesting that the respondents enumerate the discharge criteria utilized in their unit. A 75% response rate was realized. The respondents indicated that the timing of discharge was individualized according to the needs of the infant and hospital capabilities.

The criteria for back transport utilized in this investigation were developed upon consultation with two attending neonatologists at the University of Utah Medical Center. Data extrapolated from the study by Jung and associates (unpublished) were also incorporated into the guidelines established.

For the purpose of this investigation, infants were determined to be eligible for back transport after having met the following criteria:

1) Weight $\geq$ 900 grams
2) Caloric intake greater than or equal to 40 kilocalories per kilogram (enteral + parenteral)
3) Extubated a minimum of 48 hours
4) Fraction of inspired oxygen less than 0.40
5) Absence of evidence of feeding intolerance (more than one of constellation of signs of emesis, abdominal distention, and gastric residuals for 96 hours
6) No apnea and bradycardia episodes requiring bag and mask resuscitation for 96 hours
7) Temperature stable in controlled environment or bassinette
8) If phototherapy required, trend of stable or decreasing bilirubin level for 48 hours

9) No central venous, arterial, or percutaneous catheters (Dolcourt & Bose, 1982) for parenteral nutrition administration.

After criteria for back transport were met, data were collected for each subsequent day of hospitalization, whether the infant was hospitalized at the University of Utah Medical Center or at another institution. Appendix C was utilized for the purpose of recording this data. It was anticipated that a number of infants would remain at the University Hospital for several days after fulfilling requirements for back transport, particularly if they were to be transferred to Level I hospitals.

Prior to data collection, letters were sent to hospitals in Wyoming, Idaho, and Utah which had received more than one infant as a back transport during the study period. These letters allowed informed consent to be obtained from participating institutions and assured that the researcher would have access to the medical records of the back transported infants (Appendix D).

CHAPTER III

RESULTS AND DISCUSSION

Data were analyzed by the Sperry Univac computer at the University of Utah Computer Center utilizing the Statistical Package for the Social Sciences (Nie, Hull, Steinbrenner, & Brent, 1975). The Stat 80 Interactive Statistics Package (Fullerton, 1981) was utilized for the computation of Mantel-Haenzsel Chi-Squares and Pearson Chi-Squares for goodness to fit.

When comparisons between the back transport and non-transport groups were made for data at the interval and ratio levels, the *t*-test for independent means was utilized. In the majority of instances, pooled variance estimates rather than separate variance estimates were performed, as standard deviations from the means of the two groups were comparable. The paired *t*-test was utilized to measure the differences which occurred before and after back transport when measurements were made on the same subject. All *p* values were calculated for two-tailed probability.

Nominal level data were analyzed utilizing chi-square analysis. When appropriate, raw chi-square values were corrected. The Mantel-Haenzsel Chi-Square was utilized to analyze comparisons made within the two groups over time, with back transport being considered as a confounding variable. All calculated means are expressed as mean ± standard deviation.

Demographic Data

The sample consisted of a total of 104 infants, 55 (52.9%) who were back transported and will be designed as Group I, and 49 (47.1%) who remained at the University of Utah Medical Center for convalescent care (Group II). Demographic data are presented in Table 1.

The distribution of males and females within Group I was nearly uniform. Although there were more females than males among the non-transported infants, the two groups did not demonstrate a statistically significant difference in sexual distribution.

Data indicating the gestational ages of the subjects were obtained from the "Newborn Maturity Rating and Classification" (Ballard, Kazmaier, & Driver, 1977). Gestational age examinations were performed on all infants by housestaff rotating through the NICU of the University of Utah Medical Center. The distribution of the maturity ratings of the subjects is presented in Table 1.

One hundred of the 104 infants (96.2%) were classified as being preterm, or less than 38 weeks gestation. A predominance of preterm infants would be expected, as preterm infants comprise the majority of NICU admissions (Neonatal Transport Services, 1982). Four infants were classified as being term. No infants were categorized as being postterm. The limited number of term and postterm infants in the sample may be explained by the nature of referral patterns and the distribution of facilities within the intermountain west. Term infants who may require hospitalization for the surgical correction of congenital anomalies or for the evaluation and management of congenital heart disease are transported to a tertiary

Table 1

Demographic Data - Part One

	Group I (N=55)	Group II (N=49)	χ^2 Value	DF	p Value
Sex					
Male	28 (50.9%)	22 (44.9%)	0.173	1	0.68
Female	27 (49.1%)	27 (55.1%)			
Maturity Rating					
Preterm SGA	8 (14.5%)	4 (8.2%)	4.10	5	0.53
Preterm AGA	45 (81.8%)	42 (85.7%)			
Preterm LGA	0	1 (2.0%)			
Term SGA	1 (1.8%)	0			
Term AGA	1 (1.8%)	1 (2.0%)			
Term LGA	0	1 (2.0%)			

level NICU in a facility that does not provide obstetrical services.

The birth weights of the subjects ranged from 750 to 3720 grams (range = 2970). The mean birth weight of the 104 infants was 1750 (±603) grams. The back-transported infants were significantly smaller at birth than the nontransported infants (Table 2). The lower birth weights may have been a factor that was taken into account when the decision was made regarding back transport, as a longer period of hospitalization would be anticipated. For the larger infants in Group II, back transport may not have been cost effective if expected duration of hospitalization following back transport was less than 2 weeks (Bose, LaPine, & June, unpublished).

Because this was a retrospective study, factors which influenced the decision to back transport could not be assessed. Some of the infants in this study were also subjects in a concurrent study being undertaken in the NICU. Therefore, selection bias may have influenced group composition. No attempts were made to determine whether the infants in Group II were primarily delivered to residents of the metropolitan Salt Lake City area.

The lower birth weights of the infants in Group I may be a function of the significantly lower gestational ages observed in that group when the two groups were compared (Table 2). Anticipated extended hospitalization of these infants because of lower gestational ages may have influenced the decision to back transport.

The Apgar scores at one minute of age were significantly lower among the back transported infants (Table 2). This may be a reflection of the significantly lower birth weights and gestational

Table 2

Demographic Data - Part Two

	Group I (N=55)			Group II (N=49)				
	Mean	S.D.	SEM	Mean	S.D.	SEM	t Value	p Value
Birthweight (Grams)	1614.1	552	74.4	1902.1	626	89.4	-2.49	0.014
Gestational Age (Weeks)	32.0	2.7	0.37	33.1	2.5	0.36	-2.16	0.033
One Minute Apgar	4.38	2.4	0.32	5.53	1.9	0.28	-2.66	0.009
Five Minute Apgar	6.87	1.8	0.24	7.27	1.6	0.23	-1.18	0.242

ages of these infants, which would impair their ability to successfully make the transition from intrauterine to extrauterine existence. Although the Apgar scoring system is nearly universally utilized as a means of assessing the condition of the neonate immediately after birth, individual variations in assigning scores are possible. Caretakers in referring hospitals who may have limited exposure to preterm infants may have some difficulty in applying this assessment tool to immature neonates. The usefulness of the Apgar score for the assessment of the very-low-birthweight infant has been questioned (Epstein, 1984).

There was no statistically significant difference between the two groups when the mean Apgar scores at 5 minutes of age were compared (Table 2). This may be a reflection of successful resuscitative efforts and early intervention to provide cardiopulmonary support. There was no difference between the two groups when compared regarding the incidence of birth asphyxia (Table 3).

Several antepartum and intrapartum factors may have an impact upon neonatal outcome. Birth and pregnancy-associated factors that may have influenced neonatal morbidity are outlined in Table 3.

Seventy-nine (76%) of the subjects were delivered at the University of Utah Medical Center. This may be a reflection of the success of efforts to encourage in utero transports of high-risk neonates. Since preterm labor and/or premature rupture of the membranes are the predominant reasons stated for maternal transport, (Anderson et al. 1981; Souma, 1979) because the need for neonatal intensive care is anticipated, one would expect to observe a large number of preterm deliveries. Analysis of the distribution of

Table 3

Birth-Associated Factors Influencing Neonatal Morbidity

	Group I (N=55)	Group II (N=49)	χ^2 Value	DF	p Value
Birth Hospital					
Inborn	39 (70.9%)	40 (81.6%)	1.1	1	0.29
Outborn	16 (29.1%)	9 (18.4%)			
Birth Asphyxia	19 (34.5%)	14 (28.6%)	0.196	1	0.66
Distribution of Birth Order	16 (29.1%)	12 (24.5%)	6.06	5	0.30
Method of Delivery					
Vaginal	28 (50.9%)	34 (69.4%)	2.95	1	0.09
C-Section	27 (49.1%)	15 (30.6%)			
Malpresentation*	7 (13.7%)	6 (12.2%)	2.31	4	0.68
Prolonged Rupture of Membranes	13 (23.6%)	10 (20.4%)	0.03	1	0.87
Meconium Staining	3 (5.5%)	3 (6.1%)	1.22	2	0.54
Vaginal Bleeding	18 (32.7%)	10 (20.4%)	1.42	1	0.23

*N=51.

inborn and outborn infants within the two groups did not indicate that the groups differed significantly according to this parameter (Table 3).

Despite efforts to encourage maternal transport prior to delivery, realistically, accomplishing in utero transfer may not always be possible. When patient transport occurs over a 400-mile radius of the regional perinatal center, as is the situation in the intermountain west in the region served by the University of Utah Medical Center, there may be a time delay of several hours between the receipt of a call requesting mobilization of the transport team and the arrival of the team at the referring hospital. If cervical dilatation is advanced upon the team's arrival, safe delivery may be accomplished at the referring hospital and the infant stabilized. Professionals at the referring hospital may have no alternative but the delivery of a preterm infant if the mother's labor is far advanced at the time of presentation for care.

A total of 28 infants (26.9%) was the product of multiple gestations, 16 in Group I and 12 in Group II. Because multiple gestation is a risk factor for preterm labor and delivery (Friedman & Sachtleben, 1964), a 27% incidence of multiple gestation among the subjects may be a factor which contributed to the high incidence of prematurity (96.2%). Of the 16 back transported infants who were the products of multiple gestations, six (37.5%) were triplets and 10 (62.5%) were twins. There were no triplets among the non-transported infants. A total of 12 infants in Group II was the product of twin gestations. Group II contained five complete pairs of twins in addition to the survivors of two pairs of twins.

The two groups did not differ significantly when compared according to the method of delivery (Table 3), although more than two-thirds of the nontransported infants were delivered by the vaginal route, a finding which may be attributed to their larger sizes and longer duration of gestation. The incidence of abnormal presentation was comparable for the two groups (Table 3). Of the seven infants in Group I in whom malpresentation was documented, four (57%) were breech presentations, two (29%) were footling breech presentations, and one infant (14%) was a transverse lie. Presentation was not indicated on the charts of four of the infants in Group I. These infants were the second and third of each of the two sets of triplets. Among the infants in Group II, six (12.2%) were observed to have presentations other than cephalic. Four (66.6%) were breech presentations, one infant (16.6%) was a footling breech presentation, and one infant (16.6%) was a face presentation.

The two groups did not differ significantly in the incidence of prolonged rupture of membranes, vaginal bleeding, or the presence of meconium in the amniotic fluid (Table 3). Only six infants (5.8%), three in each group, exhibited amniotic fluid that was stained with meconium. The limited number of infants with meconium staining may be secondary to the preponderance of preterm infants in the sample, as the ability to pass meconium in response to vagal stimulation may be dependent upon fetal maturity (Corbet, 1983). The gestational ages of the infants with meconium staining ranged from 30 to 40 weeks gestation (mean = 36 weeks gestation). The birth weights of these infants ranged from 1630 to 3720 grams (mean = 2381 grams). Four of the six infants (67%) had a 5 minute Apgar score $\leq$ 6.

One infant (16.6%) had thick meconium in the amniotic fluid and was a 38 weeks gestation infant, weighing 3720 grams at birth, with Apgar scores of 1 and 6 at one and 5 minutes respectively.

Ninety-three infants (89.4%) were admitted to the NICU with some type of respiratory disorder. Table 4 indicates the distribution of respiratory disease within the two groups.

The two groups did not differ in the overall distribution of respiratory disease (Table 4). Seventy-four infants (71.2%) presented with clinical and radiological evidence of hyaline membrane disease (HMD). Because hyaline membrane disease is a disorder that is associated with prematurity (Avery, Fletcher, & Williams, 1981; Auld, 1978), this incidence is not unexpected due to the preponderance of preterm infants in the sample.

Although a larger number of infants in Group II were observed to have pulmonary hypertension accompanying their respiratory disease, this difference did not achieve statistical significance (Table 4). Because the propensity for development of pulmonary hypertension is related to the maturity of the pulmonary vascular bed (Avery, Fletcher, & Williams, 1981; Hoffman, 1978), the significant difference in gestational age between the two groups may have influenced the numerical difference in the incidence of pulmonary hypertension.

The two groups did not differ in the incidence of bronchopulmonary dysplasia (Table 4). Although the infants in Group I were smaller at birth and less mature than the nontransported infants, the lack of statistically significant difference in the incidence of

Table 4

Neonatal Respiratory Disease

	Group I (N=55)	Group II (N=49)	χ^2 Value	DF	p Value
Respiratory Disorder	49 (89.1%)	44 (97.8%)			
Hyaline Membrane Disease	41 (74.5%)	33 (67.3%)			
Transient Tachypnea	7 (12.7%)	8 (16.3%)	4.69	4	0.32
Meconium Aspiration	1 (1.8%)	0			
Other Aspiration	0	3 (6.1%)			
Pulmonary Hypertension	4 (7.3%)	9 (18.4%)	1.99	1	0.16
Bronchopulmonary Dysplasia	10 (18.2%)	9 (18.4%)	0.00	1	1.00
Apnea	23 (41.8%)	19 (38.8%)	0.13	1	0.91
Extraventilatory Air	7 (12.7%)	6 (12.2%)	9.76	6	0.14

bronchopulmonary dysplasia (BPD) may be related to the comparable incidence of respiratory disease and duration of assisted ventilation (Table 4).

There was no statistically significant difference observed between the groups when the incidence of apnea requiring oxygen, ventilatory support, or pharmacological therapy was compared (Table 4). The incidence of extraventilatory air was also found to be comparable when the two groups were compared (Table 4). Of the seven infants in Group I who had radiological evidence of pulmonary air leak, four infants had pneumothoraces, one infant had pulmonary interstitial emphysema (PIE), one infant had both pulmonary interstitial emphysema (PIE) and a pneumothorax, and one infant had pulmonary interstitial emphysema in addition to a pneumopericardium. Six infants (12.2%) in Group II demonstrated evidence of extraventilatory air. One infant had a pneumomediastinum, four infants demonstrated radiological evidence of PIE, and one infant was noted to have subcutaneous emphysema.

Forty-five (82%) of the infants in Group required assisted ventilation. Thirty-nine (80%) of the infants in Group II were artificially ventilated. When the duration of assisted ventilation required by each group was compared, no statistically significant difference was observed (Table 6). The mean duration of assisted ventilation in Group II may have been skewed by the inclusion in the sample of an infant who was ventilated for 68 days. Ten (26%) of the infants in Group II who required ventilation were ventilated for 24 hours or less. Among the back-transported infants, seven (16%)

of the 45 infants who required assisted ventilation were ventilated for 24 hours or less.

Data related to neonatal morbidity are outlined in Table 5. Because infection may have devastating consequences for the neonate, sepsis neonatorum must be included among the differential diagnoses that may produce respiratory distress. One hundred of 104 (96.2%) subjects were treated with antibiotics initially after NICU admission until sepsis was ruled out. Although the use of prophylactic antibiotics for infants admitted to NICUs is contraindicated (McCracken, 1981), the consequences of not initiating antibiotic therapy when infection may be a possibility may be disastrous.

All 55 of the back-transported infants (100%) were initially treated with antibiotics for suspected sepsis. Forty-five of the nontransported infants (91.8%) were treated for the initial suspicion of sepsis. Comparison between the two groups indicated that there was no significant difference in the incidence of suspected sepsis (Table 5).

Although four of the nontransported infants did not initially receive antibiotics, there was no difference between the two groups when the mean duration of initial antibiotic therapy was compared (Table 4). One infant in Group I was initially treated with 21 consecutive days of antibiotics. That infant, weighing 930 grams at 26 weeks gestation had multiple sepsis workups during the first three weeks of life, although no organisms were identified from any culture sites. Of the four infants who were not initially treated with antibiotics, one was the 1440 gram donor twin of a twin-to-twin transfusion syndrome who had no respiratory distress. The recipient

Table 5

Neonatal Disease - Part One

	Group I (N=55)	Group II (N=49)	χ^2 Value	DF	p Value
Suspected Sepsis	55 (100%)	45 (91.8%)	2.72	1	0.099
Infectious Complications	8 (14.5%)	10 (20.4%)	0.28	1	0.60
Hyperbilirubinemia/Treatment	45 (82%)	39 (79.6%)			
Phototherapy	44	39	0.96	2	0.62
Exchange Transfusion	1	0			
Patent Ductus Arteriosus/Mgmt	14 (25.5%)	12 (24.5%)			
Indomethacin Given	2	2	0.25	3	0.97
Surgical Ligation	2	1			
Necrotizing Enterocolitis	9 (16.4%)	7 (14.3%)			
Suspicion of NEC	8	5	1.41	2	0.65
Pneumatosis Intestinalis	1	2			
IVH/ICH	11 (20%)	13 (26.5%)			
Grade I	6	8	4.42	5	0.49
Grade III	4	2			
Grade IV	1	2			
Subarachnoid	0	1			

twin, a 2390 gram infant, presented with hyperviscosity and mild transient tachypnea of the newborn which required supplemental oxygen for less than one hour's duration. A 2070 gram infant of 33 weeks gestation with transient tachypnea also did not receive antibiotics initially. The fourth infant was a 36 weeks gestation, 2260 gram baby, with hyperviscosity who was initially admitted to the well baby nursery. That infant was later transferred to the NICU for necrotizing enterocolitis.

A total of 18 infants (17.3%) was noted to have documented or suspected bacterial infectious complications for which antibiotic therapy was resumed. The two groups did not differ significantly in the incidence of infectious complications (Table 5).

Hyperbilirubinemia is an expected problem in preterm neonates. A total of 83 neonates (79.8%) required phototherapy alone for the treatment of hyperbilirubinemia. The two groups did not differ when compared regarding the required treatment for hyperbilirubinemia (Table 5). Four preterm infants who were back transported at less than 48 hours of age required phototherapy for hyperbilirubinemia during their hospital courses. The data presented in Table 5 consider only those problems that occurred during hospitalization in the regional center. Only one infant in the entire sample required an exchange transfusion. That infant was transported to the University of Utah Medical Center because of hyperbilirubinemia and received a total of three exchange transfusions. The finding that only one infant received an exchange transfusion may be an indication of the early identification and treatment of hyperbilirubinemia in susceptible infants.

There was no significant difference observed in the mean number of days that phototherapy was required when the two groups were compared according to this index (Table 6). One infant in Group II required 16 days of phototherapy. When that infant was excluded from the sample, the range of duration of phototherapy was identical for the two groups (0 to 11 days).

Although the mean maximum total bilirubin of the nontransported infants exceeded that of the back-transported infants, this difference did not achieve statistical significance (Table 6). The higher maximum total bilirubin levels in Group II may be a consequence of the higher birth weights and greater gestational ages of the nontransported infants. For the infants in Group II, phototherapy may have been started at higher levels than for the more immature back transported infants. If the infant whose maximum total bilirubin was 24.2 mg/dl is excluded, the upper limit of the range of maximum total bilirubin for the infants in Group I is 17.3 mg/dl.

The two groups did not differ in the incidence and/or management of patent ductus arteriosus (PDA) (Table 5). Of the three infants in whom surgical ligation of the ductus arteriosus was accomplished, indomethacin failed to close the ductus arteriosus in one infant. Indomethacin was not administered to the other two infants. The birth weights of the infants who underwent ductal ligation were 900, 910, and 1060 grams.

The incidence of necrotizing enterocolitis was comparable for the two groups (Table 5). All infants with suspicion of

Table 6

Neonatal Disease - Part Two

	Group I (N=55)			Group II (N=49)				
	Mean	S.D.	SEM	Mean	S.D.	SEM	t Value	p Value
Days of Assisted Ventilation	7.69	10.6	1.43	7.02	11.5	1.64	0.31	0.76
Days of Antibiotics	4.59	3.0	0.41	4.47	2.5	0.36	0.22	0.82
Days of Phototherapy	3.07	2.7	0.37	2.94	3.2	0.45	0.23	0.82
Maximum Total Serum Bilirubin (mg/dl)	10.93	3.4	0.46	12.03	2.8	0.41	-1.79	0.08

necrotizing enterocolitis, or with radiological evidence of NEC, responded to medical treatment.

A total of 24 infants (23%) was diagnosed as having intracranial or intraventricular hemorrhages. Hemorrhages were further classified according to the classification described by Papile and colleagues (Papile, Burstein, J., Burstein, R., & Koffler, 1978). The two groups did not differ significantly in the incidence of intracranial hemorrhage (Table 5). The majority of bleeds, 14 (58%), were classified as Grade I hemorrhages. Of those infants with Grade I hemorrhages, birth weights ranged from 860 grams to 1940 grams (x = 1437 grams). The mean birth weight of the six infants with Grade III hemorrhages was 1053 grams (range = 860 to 1250 grams). Three infants were noted to have Grade IV hemorrhages and weighed 930, 940, and 1780 grams respectively. With the exception of the 1780 gram infant with the Grade IV hemorrhage, the birth weights were inversely proportional to the severity of the hemorrhage. One infant weighing 2650 grams at birth after a gestation of 35 weeks was noted to have had a subarachnoid hemorrhage.

Of the 24 infants who developed intracranial hemorrhages, 19 (79%) occurred in inborn infants. Nineteen of the 79 inborn infants (24%) developed intracranial hemorrhages compared to 5 (20%) of the 25 outborn neonates. When inborn and outborn infants were compared, the incidence of intracranial hemorrhage did not differ (p = 0.88). Because of the limited number of outborn infants in the sample, evaluating the influence of the hospital of birth upon the incidence of intracranial hemorrhage is difficult.

Of the 55 back-transported infants, 16 (29%) did not meet the criteria established for back transport. All of these infants did not conform to the criterion of lack of evidence of feeding intolerance for 96 hours. Ten infants (62.5%) were back transported prior to their having completed 4 full days of feeding after feeding was first initiated. One infant was transported on the third day of feedings while accompanying a twin who met all the criteria for back transport. Three triplets were back transported on their second day of life due to the absence of respiratory disease. Two of the triplets were being fed for the first time on the day of transport. One infant who had had full feedings interrupted because of diarrhea secondary to rotavirus was back transported on the second day after feedings were resumed. The final infant was retransferred to the hospital of birth after spending only 10 hours in the NICU. That infant weighed 1900 grams at birth at 36 weeks gestation and had no respiratory disease at the time of back transport.

A possible explanation for transporting these infants prior to the assurance that feedings were well tolerated was the need to make NICU beds available for more seriously ill infants. Back transport also may have occurred in efforts to facilitate maternal-infant interaction, if the infant's mother remained hospitalized in the referring hospital. Back transport may also have alleviated patient load during times of nursing shortage. Had this been a prospective study, overall staffing patterns and patient acuity could have been evaluated as factors impacting upon the decision to back transport. No attempt was made to make associations between early back transport and unit census. An additional difficulty encountered

while evaluating the timing of back transport occurred because the criteria utilized were developed by the investigator independently of the caretakers who made the decisions regarding the timing of transport.

For the 39 infants who met the criteria for back transport, the mean age at which the criteria for back transport were met was 18.6 days. The ages at which criteria were met ranged from 4 to 62 days (range = 58). Among the nontransported infants, the mean age at which the criteria for back transport were met was 13.8 days, with a range of 4 to 79 days (range = 75). When the two groups were compared, this difference was not statistically significant (Table 7). For the entire sample, the mean age at which the criteria for back transport were met was 15.9 (± 13.1) days. Although not statistically significant, the difference between the two may have been a result of the smaller size and gestational ages of the back transported infants, resulting in a later readiness for transfer following the resolution of major clinical problems.

At the time of meeting the criteria for back transport, the mean weight of the 88 infants was 1747 (± 525) grams. Comparison between the two groups revealed that the back-transported infants weighed significantly less than the nontransported infants at the time of meeting the criteria for back transport (Table 7).

Although the infants in Group I were older at the time of meeting the criteria for back transport, their weights were significantly less. This may be attributed to their significantly lower birth weights, rather than to clinical problems, as the two groups did not differ in the incidence of problems. Because of their lower

Table 7

Additional Findings

	Group I (N=39)			Group II (N=49)				
	Mean	S.D.	SEM	Mean	S.D.	SEM	t Value	p Value
Age at Criteria for Back Transport (Days)	18.6	13.8	2.21	13.6	12.2	1.74	1.75	0.08
Weight at Criteria for Back Transport (Grams)	1539.6	426.7	68.3	1912.2	540.8	77.3	-3.52	0.001

birth weights, caloric requirements for growth may not have been met for an extended period of time. As a consequence, comparable growth may not have been observed despite a longer period of hospitalization.

The mean age of the 55 back-transported infants at the time of transfer was 18.5 (± 15.3) days. This age varies very little from the age (18.6 ± 13.8) at which the criteria were met by those 39 infants who met the criteria prior to transport. This lack of difference in ages occurred because 16 infants did not meet the criteria for back transport. When those 16 infants are excluded from the sample, the mean age of the infants at the time of transfer becomes 23.5 days (± 15.4). When compared with the age at which the criteria for back transport were met, this difference was statistically significant ($p < 0.001$).

It was anticipated that many infants would remain at the regional center despite their having met the criteria for back transport. This may have occurred for a variety of reasons. The referring hospital to which the infant was being transported may have been incapable of providing the level of care required by the infant. Unit census in the NICU may have been low; therefore, retention of these infants did not result in overcrowding, as bed space was readily available. Back-transported infants were usually accompanied by the neonatal transport team, whose priority is the transport of acutely ill neonates to tertiary centers; incoming transports take precedence over back transports. Delays in transfer may also have occurred as a result of bad weather. Throughout the

intermountain west, air travel may be hampered by winter storms and fog which make transport unsafe.

Thirty of the back-transported infants spent a mean of 3.49 (± 4.6) days at the University of Utah Medical Center prior to being transferred after having met the criteria for back transport. Excluded in this compilation are the 16 infants who did not meet the criteria for back transport and nine infants who were transferred on the day upon which the criteria for back transport were met.

Transfer of two infants was delayed when, after having met the criteria for back transport, signs of necrotizing enterocolitis appeared. These infants were treated medically with isolation, gastric decompression, antibiotics, and parenteral nutrition. The transport of two infants was delayed because of the appearance of diarrhea and identification of rotavirus in stool cultures. The presence of diarrhea delayed transport of another infant; however, no organism was cultured from the stool. The unavailability of the accepting pediatrician delayed the transport of one subject.

The weights of the infants at the time of back transport ranged from 990 to 3420 grams (range = 2430), with a mean weight of 1700 (± 455) grams. Six infants (11%) weighed less than 1200 grams at the time of transfer. Nineteen infants (35%) weighed less than 1500 grams at the time of transport. Twelve infants (22%) weighed more than 2000 grams at the time of transport. Only one infant weighed more than 2500 grams when back transported.

At the time of discharge from the hospital, the mean weight of the subjects was 2197 (± 367) grams. Although it was anticipated that the back-transported infants would weigh more than the

nontransported infants at the time of discharge home due to caretaker discomfort with sending small preterm infants home, the difference between the discharge weights was not statistically significant (Table 7).

The discharge weights for the infants in Group I may have been lower than those in Group II (Table 8) because four of the back-transported infants were discharged to tertiary units rather than to home. Those infants weighed 1474, 1890, 2045, and 2440 grams at the time of discharge. When these infants were eliminated from the sample, the mean weights at the time of discharge to home did not differ significantly (Table 8). The higher discharge weights in Group II may merely be a reflection of the higher birth weights of those infants.

The subjects spent an average of 32 (± 19.5) days in the hospital. The duration of hospitalization ranged from 7 to 94 days (range = 87). The back-transported infants were hospitalized for a significantly longer period of time than the nontransported infants (Table 8). This prolonged period of hospitalization occurred despite the observation that 4 (7.3%) of the infants in Group I were readmitted to tertiary level units following back transport. This additional duration of NICU hospitalization was not included in this analysis. Because of the lower birth weights and shorter gestations of the back-transported infants, this finding is not unexpected. Caretakers in referring hospitals may also have exercised caution while managing these infants, ensuring that adequate nutritional intake, temperature control, and parental confidence with care were established prior to discharge. Discharge home may also have been

Table 8

Discharge Data

	Group I (N=55)			Group II (N=49)				
	Mean	S.D.	SEM	Mean	S.D.	SEM	t Value	p Value
Discharge Age (Days)	36.0	20.1	2.74	27.6	17.7	2.53	2.25	0.026
Weight at Discharge From Hospital (Grams)	2180.5	344	46.4	2214.7	393	56.1	-.47	0.637
Weight at Discharge To Home (Grams)*	2197.6	338	47.4	2214.7	393	56.1	-.47	0.816

*For Group I, N = 51

delayed for infants in both groups if one infant who was a product of a multiple gestation was awaiting a sibling's readiness for discharge.

Because of limited exposure to preterm infants, it was anticipatd that infants at community hospitals would be transferred from Isolettes® to bassinets at higher weights. One of the 104 infants in the sample was not weaned to an open crib prior to retransfer to the NICU. The remaining 103 infants weighed an average of 2063 (± 403) grams at the time of transfer to a bassinet. Of the 55 back transported infants, 8 (14.5%) were weaned from the controlled environment of Isolettes® prior to discharge. For the infants weaned from Isolettes® during their stay at the regional center, transfer to an open crib occurred at a mean weight of 2147 (± 422) grams. At the community hospitals, the mean weight of the infants at the time of transfer to open cribs was 2003 (± 199) grams. This difference achieved statistical significance ($p = 0.026$). The greater birth weights of the infants in Group II may have been responsible for this difference.

Eleven of the infants in Group I received blood transfusions a total of 16 times during their stay in community hospitals. For the 10 infants whose pretransfusion hematocrit was recorded on the chart (a total of 15 transfusions), hematocrits at the time of transfusion ranged from 23 to 45. Seventeen of the nontransported infants received a total of 24 blood transfusions after having met the criteria for back transport. For the 16 infants in whom pretransfusion hematocrits were recorded (a total of 23 transfusions), the hematocrits at the time of transfusion ranged from 33 to 46.

Comparison between the two groups revealed a statistically significant difference (Table 9).

Infants in the regional center may have been transfused at higher levels in anticipation of the need to obtain laboratory work over several days' time. In the NICU, transfusion for many infants is a routine procedure, performed at a given hematocrit level for sick babies that may not have been individualized for convalescing infants. The lower mean hematocrit of the infants in Group I was influenced by the finding that three of the transfusions were administered for hematocrits less than 30%. The ages of the infants who were the recipients of these transfusions were 44, 53, and 74 days. Transfusion may have postponed in order to avoid interfering with the infants' own hematopoietic responses. In all three of these infants, both hematocrits and reticulocyte counts were monitored on a regular basis prior to the decision to transfuse. It is possible that these infants may have benefitted from earlier transfusion.

A total of 10 public health nursing referrals was made for the infants in Group I. The charts of the nontransported infants indicated that only one referral to public health nursing service was made and that the parents refused followup. Utilization of public health nurses in community hospitals may occur more frequently if access to care and availability of developmental followup of NICU graduates is limited. Because the nontransported infants were larger and more mature, it is possible that anticipated needs for home care were less than those of the back-transported infants.

Table 9

Comparison of Hematocrit at Which Blood

Transfusion Administered

	Group I (N=10)			Group II (N=16)				
	Mean	S.D.	SEM	Mean	S.D.	SEM	t Value	p Value
Hematocrit at Transfusion	34.4	6.31	2.0	39.6	3.48	0.87	-2.39	0.034

No attempt was made to assess the social situation of the subjects. It is entirely possible that assessment of family resources, which was beyond the scope of this investigation, may have indicated that the back-transported infants may have been more susceptible to medical and social problems than the nontransported infants.

1) Is the clinical improvement of infants who are back transported from neonatal intensive care units to newborn and intermediate care nurseries comparable to that of infants who receive convalescent care in the tertiary center?
   a) Do back-transported infants exhibit a change in oxygen requirements?

Meyer and associates (1982) reported that 2 of 37 infants who were transferred from NICUs to nurseries in community hospitals required an increased concentration of supplemental oxygen. In this investigation, 14 of the 55 infants in Group I (25%) were receiving supplemental oxygen at the time of back transport. One infant was receiving a fraction of inspired oxygen (FiO_2) of 1.00 per nasal cannula when transported. All other infants were receiving a fraction of inspired oxygen (FiO_2) $\leq$ 0.27 by cannula or headbox at the time of transfer.

The maximum concentration of oxygen administered at the community hospital was utilized to measure the change in oxygen needs. Seven of the 14 infants (50%) who were receiving oxygen at the time of discharge from the regional center did not require increased oxygen at the referring hospital. One infant's oxygen requirements decreased immediately after transport. Six infants (43%) required

increased amounts of supplemental oxygen after transport. The maximum FiO_2 delivered to the back-transported infants was 0.36. Three of the back-transported infants who were not receiving oxygen at the time of discharge subsequently received supplemental oxygen after back transport. One infant was placed in oxygen for approximately 10 hours overnight after an episode of cyanosis during feedings. A second infant who was transported to the community hospital by his parents was found to be cyanotic and in respiratory distress upon admission. That infant was maintained in oxygen throughout the duration of his hospital stay and was eventually discharged to home while receiving supplemental oxygen. The third infant, who developed numerous episodes of apnea and bradycardia and seizures, was placed in oxygen prior to transport back to the regional center.

Among the nontransported infants, 8 of 49 (14%) were receiving oxygen at the time of meeting the criteria for back transport. The maximum FiO_2 administered at this time was 0.37. Of those eight infants, oxygen requirements increased in four (50%). The maximum FiO_2 recorded for the duration of hospitalization was less than that when the criteria for back transport were met for three (38%) of the infants. No change in oxygen supplementation was recorded in one (12.5%) infant. The maximum FiO_2 delivered to infants after their meeting the criteria for back transport was 0.40. No infants required assisted ventilation or continuous positive airway pressure. Three infants who were not receiving supplemental oxygen at the time of their meeting the criteria for back transport subsequently

received oxygen. One infant whose oxygen had been discontinued for several days was repeatedly cyanotic during feeding. Oxygen supplementation was provided during feeding and as needed. Oxygen for home use during feeding was administered at the time of discharge. A second infant was placed in oxygen for frequent episodes of apnea and bradycardia. Oxygen therapy was maintained for several days as that baby was subsequently treated for necrotizing enterocolitis. For the third infant, oxygen therapy was initiated for possible pneumonia. Oxygen therapy was continued for nearly a month after the resumption of supplemental oxygen.

Statistical analysis of the mean change in oxygen concentration required by the infants in each group revealed that the two groups did not differ significantly in this respect (Table 10).

Comparing these data to that presented by Meyer and colleagues (1982) is difficult, as those investigators did not indicate how many infants were receiving supplemental oxygen at the time of transport. Information regarding the clinical problems of the subjects was not included in the report. The reasons for increased oxygen needs also were not elaborated upon.

The finding that 22 (21%) of the subjects were receiving supplemental oxygen at the time the criteria for back transport were met or at the time of transfer indicates that many of these infants continued to have some residual respiratory disease. This finding is not surprising because of the high incidence of respiratory disease among the subjects (Table 4).

Back transport was not found to increase the need for oxygen supplementation of infants. One may question whether transport by

Table 10

Change in Oxygen Requirements After

Back Transport/Criteria

	Group I (N=55)			Group II (N=49)				
	Mean	S.D.	SEM	Mean	S.D.	SEM	t Value	p Value
Change in FiO_2 (%)	0.91	0.028	0.004	0.90	0.03	0.004	0.02	0.984

parents is a desirable alternative to transfer accompanied by skilled personnel, as the infant who was transported by the parents was found to be in respiratory distress upon arrival at the community hospital. Although the infant's temperature was normal upon admission, cold stress during transfer may have occurred. Change in altitude between Salt Lake City and the location of the referral hospital may have been a factor which influenced this subject's oxygen requirements. However, since that baby continued to receive supplemental oxygen at the time of discharge to home, it is unlikely that back transport itself was responsible for increased oxygen needs. For five of the six infants who required increased oxygen, the duration of therapy exceeded several days. Concurrent illness influenced the need for oxygen supplementation in three infants (possible sepsis with seizures, necrotizing enterocolitis, and pneumonia). In one of the back-transported infants, the use of supplemental oxygen was a nursing judgment which may have been inappropriate.

In only one infant, oxygen needs were found to decrease immediately following back transport. That baby was receiving minimal oxygen supplementation at the time of transfer $FiO_2 = 0.23$ and was rapidly weaned from oxygen. Overall, oxygen requirements of the back-transported infants did not change when they were compared to the nontransported infants.

b) Do back-transported infants exhibit a change in the pattern of weight gain?

For all the infants in the sample, overall weight gain was calculated as weight increase in grams per day of hospitalization. For those infants in Group I who remained in the NICU at the University of Utah Medical Center after having met the criteria for back transport and prior to transfer, weight gain pre- and posttransport was compared utilizing a paired *t*-test. For those infants in the sample who failed to demonstrate a weight gain after back transport, or in the case of the infants in Group II, after meeting the criteria for back transport, weight gain was recorded as zero grams rather than as negative values.

Weight gain (expressed in grams per day) in the infants in Group I was significantly greater than that of the nontransported infants (Table 11). The mean daily weight gain for the back transported infants ranged from 0 to 55 grams per day. Sixteen infants had an average daily weight gain greater than 30 grams per day, which is considered to be the upper limit of normal.

One of the infants in Group I lost weight following back transport. That infant had been started on feedings on the day of transfer and was receiving peripheral hyperalimentation. The infant's intravenous line infiltrated approximately 6 hours after arrival at the community hospital and was not restarted. For the initial 24 hours after transport, both fluid and caloric intake were less than that recommended. This infant did not regain his birth weight prior to discharge to home. A total of six infants in Group I (11%) did not regain their birth weights prior to discharge; however, five of these infants demonstrated evidence of weight gain following back transport.

Table 11

Pattern of Weight Gain

	Group I (N=55)			Group II (N=49)				
	Mean	S.D.	SEM	Mean	S.D.	SEM	t Value	p Value
Weight Change at Regional Center (Grams Per Day)*	16.12	16.94	3.09	16.58	12.0	1.71	0.141	0.444
Weight Change After Back Transport/Criteria (Grams Per Day)*	26.00	11.1	1.49	16.58	12.0	1.71	4.17	0.000

*Group I - N=30.

The mean daily weight gain among the nontransported infants ranged from 0 to 36 grams. For four infants (8.2%), the mean daily weight gain was greater than 30 grams per day. Thirteen infants (27%) failed to gain weight after meeting the criteria for back transport. All but two of these infants weighed greater than 2000 grams at birth. Three of these babies (23%) were discharged to home on the day on which they met the criteria for back transport. Two infants (15%) maintained stable weights for several days after meeting the criteria for back transport. Eight infants (62%) lost weight during the interval between their meeting the criteria for back transport and discharge to home.

Seven of these 13 infants (54%) failed to regain their birth weights prior to discharge to home. An additional six of the nontransported infants were discharged to home at weights less than their birth weights.

For the 30 infants in Group I who remained at University Hospital after having met the criteria for back transport, average daily weight gain before and after leaving the regional center were compared. Weight gain following back transport was significantly greater than that at the regional center (Table 12).

Although daily weight gain may not be the best parameter according to which adequacy of nutritional intake may be assessed, it is one that is nearly universally measured in all nurseries. The investigator assumed that, in many hospitals, nutritional intake would not be adjusted according to calculations of daily fluid and caloric intake. Variable consistency of charting of intake

Table 12

Weight Gain Before and After Back

Transport - Group I (N = 30)

	Before			After				
	Mean	S.D.	SEM	Mean	S.D.	SEM	t Value	p Value
Weight Change (Grams Per Day)	16.12	16.9	3.09	29.42	10.3	1.88	3.43	0.002

precluded the investigator's utilizing this measure as an additional evaluative tool.

The significantly higher mean daily weight gain in Group I may have been a consequence of the finding that 16 (29%) of the back transported demonstrated above average daily weight gains. It is possible that commercial formulas providing 24 calories per ounce may have been overused by caretakers in community hospitals while efforts were made to ensure adequate weight gain. Earlier discharge of these babies may have been a motive behind this intervention. Differences in scales utilized by the regional center and community hospitals were not influential in affecting weight change. No infant demonstrated an unusually large weight gain or loss when initial weights were performed at the community hospitals.

During hospitalization at the regional center, while feedings were being advanced slowly, caloric intake may have been suboptimal. However, 16 infants were transported prior to their receiving 96 hours of full feedings. These infants were not receiving adequate calories for growth at the time of transfer and would potentially lower the mean daily weight gain. However, the finding that the mean daily weight gain for these 30 infants in Group I was comparable to the mean daily weight gain of the nontransported infants (Table 11) suggests that the nontransported infants may have been discharged to home shortly after achieving adequate nutritional intake.

Because the nontransported infants were significantly larger than the back transported infants, feedings may have been advanced rapidly after their clinical problems were resolved. During the acute phase of illness, the provision of adequate calories for

growth is difficult. Once an adequate caloric intake was established and, in the absence of feeding intolerance, these infants may have been readily discharged to the parents when parental confidence with caretaking was demonstrated. The finding that the infants in Group II were significantly younger at discharge than those in Group I suggests that caretakers at the regional center may have been more comfortable with sending these babies home earlier.

Many of the larger infants in the sample either did not regain to their birth weight or lost weight prior to discharge to their parents. This was especially true among the nontransported infants. For larger infants, weight loss may have been viewed as being acceptable. For term, healthy infants, failure to gain weight prior to their discharge from the hospital is not viewed as a problem, as weight loss is anticipated. Adapting that approach for infants who have been sick and undernourished during the course of their hospitalization may be unfounded. However, assessment of individual circumstances at home may have prompted the decision to discharge infants despite their failure to demonstrate an upward trend in weight gain.

c) Do back-transported infants exhibit evidence of feeding intolerance?

In efforts to answer this question, the investigator examined the incidence of emesis, abdominal distention, and gastric residuals in the amount greater than 3 milliliters per kilogram of body weight. The incidence of each of these signs was recorded in each group before and after back transport in Group I and before and

after meeting the criteria for back transport for the infants in Group II. The Mantel-Haenzsel Chi-Square was utilized to analyze changes in each group over time, independently of back transport. Signs of emesis, distention, or residuals independently were to be present for a minimum of two times during a 24 hour period of time before being considered indicative of feeding intolerance. If the constellation of all three signs appeared simultaneously, this was considered to be sufficient evidence of feeding intolerance. Although the investigator's criteria for defining feeding intolerance may be somewhat stringent, the investigator preferred to exercise caution in assessing feeding intolerance as the data were obtained from retrospective chart review. Statistical comparison of the two groups regarding the incidence of signs of feeding intolerance appears in Table 13.

Fourteen of the infants in Group I (25%) had evidence of emesis prior to back transport. Of those 14 infants, 10 (71%) continued to experience emesis following transport. Four infants (29%) who vomited feedings prior to back transport did not have vomiting identified as a problem subsequent to transfer. Following back transport, 13 of the remaining 31 infants (32%) demonstrated evidence of vomiting. Although the incidence of vomiting increased following back transport, this increase did not result in a statistically significant difference (Table 14).

Twelve of the infants in Group II (24%) experienced vomiting prior to their meeting the criteria for back transport. All 12 of these infants (100%) continued to vomit after meeting the criteria for back transport. An additional eight of the remaining 37 infants

Table 13

Comparison of Groups Regarding Feeding Intolerance Before and After Back Transport/Criteria

	Group I (N=55)	Group II (N=49)	χ^2 Value	DF	p Value
Residuals Before	7*	6*	0.00	1	1.00
Residuals After	6*	10*	1.14	1	0.29
Distention Before	1*	0*	0.00	1	1.00
Distention After	6*	1*	1.99	1	0.16
Emesis Before	14*	12*	0.00	1	1.00
Emesis After	23*	20*	0.00	1	1.00

*Number of subjects.

Table 14

Feeding Intolerance - Group I (N=55)

	Before (#)	After (#)	$MH\chi^2$	DF	Odds Ratio	p Value
Emesis	14 (25.5%)	23 (41.8%)	2.58	1	0.48	0.11
Distention	1 (1.8%)	6 (10.9%)	2.42	1	0.15	0.12
Residuals	7 (12.7%)	6 (10.9%)	0.086	1	1.19	0.77

(22%) had recorded evidence of emesis following their meeting the criteria for back transport. The increase in the incidence of vomiting following meeting the criteria for back transport did not achieve statistical significance (Table 15).

One of the back transported infants (1.8%) experienced abdominal distention prior to leaving the regional center. Abdominal distention was not noted for that infant following back transport. However, six (11%) of the back-transported infants were noted to be distended at some time following transport. This difference approached statistical significance (Table 14).

None of the nontransported infants experienced abdominal distention in the days immediately prior to meeting the criteria for back transport. Only one infant's chart indicated that abdominal distention was observed following meeting criteria for back transport. This difference in the incidence of abdominal distention before and after meeting the criteria for back transport was not statistically significant (Table 15).

Seven of the infants in Group I (13%) were observed to have gastric residuals in excess of 3 milliliters per kilogram of body weight prior to back transport. Only two of these infants (29%) continued to have residuals following transfer and for five (71%) infants, gastric residuals were no longer a problem. An additional four infants were identified as having gastric residuals following back transport. The difference in the incidence of gastric residuals among the infants in Group I before and after back transport did not achieve statistical significance (Table 14).

Table 15

Feeding Intolerance - Group II (N=49)

	Before (#)	After (#)	$MH\chi^2$	DF	Odds Ratio	p Value
Emesis	12 (24.5%)	20 (40.8%)	2.25	1	0.47	0.13
Distention	0	1 (2.0%)	1.00	1	0.00	0.32
Residuals	6 (12.2%)	10 (20.4%)	0.67	1	0.54	0.41

Six of the nontransported infants (12%) manifested gastric residuals in excess of 3 milliliters per kilogram of body weight prior to their meeting the criteria for back transport. All of these infants (100%) continued to have residuals after meeting the criteria for back transport. Four additional infants were noted to have gastric residuals after the criteria for back transport were met. Despite this increase in the incidence of gastric residuals after the infants in Group II had met the criteria for back transport, this change did not produce a statistically significant difference (Table 15).

Necrotizing enterocolitis has been identified as a problem occurring among back-transported infants (Clarke et al. 1983). The incidence of individual signs of feeding intolerance has not been reported in the literature. Extracting information about feeding intolerance from the charts was difficult because the assessment skills of caretakers varies, as well as their ability to accurately record data. If actual volume of emesis was not estimated, evaluating whether vomiting was actually a problem became more difficult. The researcher was obligated to assume that nurses defined emesis in a consistent way while documenting patient problems.

In many of the back transport hospitals, abdominal girths were not measured by the nursing staff on a regular basis. Therefore, evaluating the presence of abdominal distention on the basis of change in abdominal girth frequently was impossible. The researcher considered abdominal distention to be a problem when nursing or medical staff described the appearance of the abdomen as such. The

necessity of depending upon descriptive evidence of distention may explain the change that occurred before and after back transport.

For the infants in Group I, the numerical incidence of emesis and abdominal distention increased following back transport; however, a statistical difference was not observed. Among the infants in Group II, the incidence of vomiting, residuals, and distention increased after infants had met the criteria for back transport, however, statistical significance was not achieved for any of these parameters. Although infants in both groups demonstrated evidence of feeding intolerance, changes which occurred in each group over time did not achieve statistical significance.

d) Do back-transported infants exhibit a change in the frequency and/or nature of episodes of apnea and bradycardia?

A total of 42 infants in the sample (40%) had a history of apnea and bradycardia requiring ventilation, oxygen, and/or pharmacological therapy. The incidence of apnea and bradycardia was comparable when the two groups were compared (Table 4). Assessing the true incidence of apnea and bradycardia for each infant was difficult, due to the nature of charting. When babies had multiple episodes of apnea and bradycardia, the precise number of episodes frequently was not charted. Charting often consisted of a notation of "multiple," "frequent," or "numerous" episodes of apnea. As a consequence, calculating the mean number of episodes per patient per day was not possible. Episodes of apnea and bradycardia were coded

utilizing a 5-point Likert scale, with possible scores ranging from "never" to "frequent."

Among the 55 infants in Group I, 20 (36.5%) were noted to have episodes of apnea and bradycardia prior to back transport. The frequency of episodes of apnea and bradycardia of the subjects is delineated in Table 16. Twenty-three (42%) of the infants who were back transported had evidence of episodes of apnea and bradycardia recorded in their charts after back transport. There was no significant change in the frequency of episodes of apnea and bradycardia before and after back transport (Table 16).

Eleven (22%) of the nontransported infants had episodes of apnea and bradycardia recorded in the days immediately preceding their meeting the criteria for back transport. Table 17 indicates the frequency of apnea and bradycardia episodes among the subjects in Group II. After having met the criteria for back transport, 19 (39%) of the infants were observed to have episodes of apnea and bradycardia. When the frequency of episodes of apnea and bradycardia before and after meeting the criteria for back transport was compared, no statistically significant difference was observed (Table 17).

The greatest amount of intervention required for episodes of apnea and bradycardia, or nature of episodes of apnea and bradycardia, was evaluated while utilizing a 4-point Likert scale ranging from spontaneous resolution to the need for bag and mask ventilation. Information regarding the intervention required by the 20 infants in Group I with recorded episodes of apnea and bradycardia before back transport is presented in Table 18. Twenty-three

Table 16

Frequency of Episodes of Apnea

and Bradycardia--Group I (N=55)

	Before	After
Never	35 (63.6%)	32 (58.2%)
Seldom	7 (12.8%)	7 (12.8%)
Occasional	8 (14.5%)	11 (20.0%)
Several	4 (7.3%)	4 (7.3%)
Frequent	1 (1.8%)	1 (1.8%)

Mantel-Haenzsel Chi-Square = 0.18; DF = 1; p = 0.67

Code:

Never: 0 episodes
Seldom: 1-2 episodes, not occurring every day
Occasional: 1-3 episodes per day
Several: 4-8 episodes per day
Frequent: More than 8 episodes per day

Table 17

Frequency of Episodes of Apnea

and Bradycardia-Group II (N=49)

	Before	After
Never	38 (77.6%)	30 (61.2%)
Seldom	4 (8.2%)	8 (16.3%)
Occasional	2 (4.1%)	6 (12.2%)
Several	2 (4.1%)	3 (6.1%)
Frequent	3 (6.1%)	2 (4.1%)

Mantel-Haenzsel Chi-Square = 0.61; DF = 1; p = 0.43

Table 18

Nature of Episodes of Apnea

and Bradycardia - Group I

	Before (N=20)	After (N=23)
Spontaneous Resolution	1 (5%)	2 (8.7%)
Tactile Stimulation	19 (95%)	20 (87.0%)
Oxygen/Suction	0	1 (4.4%)
Bag and Mask Ventilation	0	0

Mantel-Haenzsel Chi-Square = 0.59; DF = 1; p = 0.44

infants were observed to have episodes of apnea and bradycardia following back transport (Table 18).

There are some discrepancies recorded in the numbers of infants for whom apnea and bradycardia was a problem during specific time periods. Data indicating the frequency and nature of episodes of apnea and bradycardia before back transport or before meeting the criteria for back transport were collected for a 96 hour period of time. Therefore, an infant whose apnea and bradycardia was well controlled with medication may have had no episodes during this time interval, yet may have had a reoccurrence of spells following transport or after criteria were met. This may have occurred if dose changes did not correspond to increasing weights, with resultant changes in drug levels in the blood. Twenty infants had evidence of apnea and bradycardia prior to back transport. Of those infants, 8 (40%) did not have any record of apnea and bradycardia following transfer. Conversely, five infants without apnea before back transport were observed to have episodes following transport.

Among the nontransported infants, 11 (22%) had recorded episodes of apnea and bradycardia prior to their meeting the criteria for back transport. Seven infants with no evidence of apnea during the 96 hours prior to meeting the criteria for back transport, were observed to have apnea during the remainder of their hospitalization. Data regarding the nature of episodes of apnea and bradycardia before and after meeting the criteria for back transport are presented in Table 19. When the nature of apnea and bradycardia spells of the infants in Group II were compared before and after

Table 19

Nature of Episodes of Apnea

and Bradycardia - Group II

	Before (N=11)	After (N=19)
Spontaneous Resolution	0	2 (10.5%)
Tactile Stimulation	11 (100%)	17 (89.5%)
Oxygen/Suction	0	0
Bag and Mask Ventilation	0	0

Mantel-Haenzsel Chi-Square = 1.02; DF = 1; p = 0.31

their meeting the criteria for back transport, no difference was observed (Table 19).

Apnea and bradycardia have been reported to be an indication for readmission of back transported infants to NICU's (Jung & Bose, 1983). In this study, of the four infants who were readmitted to a tertiary level unit, one infant had multiple episodes of apnea and bradycardia, suspected sepsis, and seizures. The overall frequency of episodes of apnea and bradycardia among back-transported infants has yet to be reported. No change in the frequency or the nature of episodes of apnea and bradycardia over time was found in either group.

e) Do back-transported infants exhibit a change in the ability to maintain body temperature?

Only one reference to neonatal temperature regulation has been recorded in the back transport literature. While studying back transport from an infectious standpoint, Leake and colleagues (1976) observed that four of 43 back-transported infants developed temperature instability. In three instances, temperature instability occurred during the weaning of infants to bassinettes. Rather than investigating solely the incidence of temperature instability, the investigator viewed the maintenance of thermal neutrality as an integral part of neonatal care. Temperature instability as an identifiable problem will be addressed later in this investigation.

Because of the variable frequencies with which vital signs were monitored in the participating hospitals (frequency varying from every 2 to every 8 hours), data were analyzed collectively by

determining the mean number of patient days with low and high temperatures rather than calculating the mean number of episodes of hypothermia or hyperthermia per patient.

Temperature data were recorded for 49 back-transported infants during their hospitalization at the University of Utah Medical Center. For six infants who were back transported prior to meeting the criteria for back transport, data were not obtained because the duration of hospitalization prior to back transport was limited. Data were available for a total of 242 (range: 1 to 24) hospital days. Twelve infants (24.5%) had no days on which hypothermia was recorded. Seventeen infants (37.4%) were observed to be hypothermic on one day of hospitalization. The number of days on which hypothermia was recorded ranged from 0 to 7 days with two infants (4.1%) having low temperatures recorded on seven days. Birth weights of these two infants were 1240 and 1100 grams. Hypothermia was observed on a total of 91 patient days (Table 20).

Forty-seven (85.5%) of the infants in Group I were in Isolettes® at the time of back transport. Any type of patient care which necessitates entry into the Isolette® results in loss of heat through the portholes. Weaning to bassinettes, which has been identified as a factor contributing to temperature instability (Leake, et al. 1976) was not a contributing factor to the incidence of hypothermia among the infants in Group I prior to back transport as the vast majority of infants remained in the controlled environment of Isolettes® at the time of transport.

Hyperthermia (axillary temperature greater than 37.3°C) occurred in a total of 16 (32.7%) of the 49 back-transported infants

Table 20

Temperature Regulation Before and After

Back Transport - Group I (N = 49)

	Before			After				
	Mean	S.D.	SEM	Mean	S.D.	SEM	t Value	p Value
Hypothermia (# Days)	0.432	0.400	0.057	0.161	0.183	0.026	4.25	0.000
Hyperthermia (# Days)	0.092	0.189	0.027	0.118	0.130	0.019	-.74	0.465

for whom data were available. The number of days with recorded hyperthermia ranged from 0 to 3 days, for a total of 30 days (Table 20).

A paired t-test was utilized to compare the incidence of hypothermia and hyperthermia before and after back transport. The infants in Group I spent a total of 976 days at Level I and Level II hospitals. The number of days that individual infants spent at referring hospitals ranged from 2 to 44 days (range = 42 days). Thirteen infants (23.6%) were not hypothermic after back transport. Of the 42 infants who experienced hypothermia, the number of days on which low temperatures occurred ranged from 1 to 10 (range = 9) for a total of 135 days with recorded hypothermia. Three of the 42 infants (9.5%) were hypothermic on more than seven days. Weights of these subjects at the time of back transport were 1190, 1880, and 1900 grams.

The mean number of days on which hypothermia occurred among the 49 infants for whom data were available prior to transport is presented in Table 20. This value was significantly different from the mean number of days of hypothermia occurring after back transport (Table 20). This difference may possibly be attributed to growth of these infants with subsequent maturation of thermoregulatory mechanisms. As the incidence of hypothermia was significantly reduced following back transport, it appears that weaning from Isolettes® did not adversely alter temperature regulation. The finding that the mean weight of the back-transported infants at the time of weaning to bassinettes was 2003 (± 199) grams suggests that these infants were sufficiently mature to maintain their temperature and

that weaning occurred at an appropriate time. It is also possible that handling of these infants, particularly for the purposes of repeated physical examinations or procedures, may have occurred less frequently, thereby reducing the potential for heat loss.

Thirty-six of the back-transported infants (65%) were hyperthermic at some time following back transport. The number of days on which hyperthermia was recorded ranged from 1 to 8 days, for a total of 134 days. When compared with the incidence of hyperthermia prior to transport, the difference was not statistically significant (Table 20).

Hyperthermia may occur as a result of inadequate regulation of the thermal environment. With larger infants in Isolettes®, it may be difficult to maintain thermal neutrality, particularly if manual control rather than servo control is utilized when infants are housed in Isolettes®. The overall incidence of hyperthermia was less than the incidence of hypothermia; however, hyperthermia may also have deleterious results for the neonate (Perlstein, Edwards, & Sutherland, 1970; Swyer, 1978). No efforts were made to determine whether the infants with abnormal temperatures were those with intracranial hemorrhage or neurological impairment secondary to asphyxia, disorders which may interfere with the capacity to regulate temperature, as the incidence of these disorders was not different when the two groups were compared.

2) Are the clinical problems identified in back-transported infants different from those identified in babies recovering in the regional center?

Clinical problems identified in the subjects following back transport or after meeting the criteria for back transport were classified accordingly: respiratory, cardiovascular, gastrointestinal, neurological, metabolic, infectious, integumentary, and miscellaneous.

A total of 65 infants (63%) manifested indications of one or more problems following their meeting the criteria for back transport or after transfer to community hospitals, 38 (69%) in Group I and 27 (55%) in Group II.

A total of 78 clinical problems was identified among 38 back-transported infants. Fifty-one problems were identified among the 27 nontransported infants who developed problems.

The subjects in Group I experienced a mean of 0.08 problems per day of hospitalization as compared to 0.07 problems per hospital day for the nontransported infants. Table 21 illustrates the statistical analysis of the incidence of new problems (classified according to system) which were identified among the subjects in each group.

Sixteen of the 55 back-transported infants (29.1%) demonstrated a total of 16 respiratory problems, delineated in Table 22, the most common being increased episodes of apnea and bradycardia which necessitated oxygen, changes in pharmacological therapy, or a workup for sepsis. Although changes in the nature and frequency of episodes of apnea and bradycardia following transport were not found to be significant, apnea was considered separately as a problem because it is frequently a manifestation of other disorders such as metabolic deviations, sepsis, necrotizing enterocolitis, and anemia.

Table 21

Incidence of New Problems After

Back Transport/Criteria

	Group I (N=55)	Group II (N=49)	χ^2 Value	DF	p Value
1. Respiratory	16	10	1.04	1	0.43
2. Cardiovascular	14	4	4.27	1	0.04
3. Gastrointestinal	18 (21)	14 (14)	1.87	1	0.39
4. Neurological	3	2	0.00	1	1.00
5. Metabolic	7	7	0.00	1	1.00
6. Infectious	10	5 (8)	0.77	1	0.38
7. Integumentary	4	3	0.00	1	1.00
8. Miscellaneous	3	3	0.29	1	0.59

Table 22

New Respiratory Problems

	Group I (N=55)	Group II (N=49)
Increased Apnea and Bradycardia	11	3
Suspected Aspiration (Clinical and Radiological Evidence)	2	2
Cyanosis with Feeding Requiring Oxygen	1	4
Nasal Congestion	1	0
Respiratory Distress with Cyanosis	1	0
Respiratory Arrest	0	1

Pearson Chi-Square = 7.81; DF = 6; p = 0.25

Eleven of the 16 infants (69%) with respiratory problems were observed to have an increased frequency of episodes of apnea and bradycardia. This increase was considered to be a problem when eight or more episodes occurred within a 24 hour time period in an infant whose previous pattern of apnea and bradycardia spells was much different. There is a discrepancy in the numbers of infants with recorded apnea and bradycardia following back transport and those with apnea as an identified problem. In the latter circumstance, increased frequency of apnea was generally of short duration. Ten of the 49 nontransported infants (20%) demonstrated a total of 10 respiratory problems (Table 22).

The incidence of the occurrence of new respiratory problems did not differ significantly when the two groups were compared (Table 21). Thirteen of the 26 infants presented with an increased frequency of episodes of apnea and bradycardia. When the two groups were compared according to the incidence of apnea and bradycardia based upon birth weight, no statistically significant difference was observed (Table 23). When compared according to the infant's weight at the time at which the problem occurred, the two groups did not differ (Table 23).

Meyer and colleagues (1982) reported that respiratory complications occurred in three of 37 back transported infants. Two of these infants required an increased concentration of supplemental oxygen and one infant developed pneumonia. No information about respiratory problems which occurred during the subjects' NICU stay was reported. Bose, LaPine, and Jung (unpublished) reported that, of three of 172 back-transported infants who required readmission to

TABLE 23

New Problems Related to Birth Weight and

Weight at Problem Identification

	Group I (N=55)		Group II (N=49)					
	<1.5 Kg	>1.5 Kg	<1.5 Kg	>1.5 Kg	$MH\chi^2$	DF	Odds Ratio	p Value
Respiratory								
Birth Weight	11	5	3	7	2.23	1	5.13	0.14
Weight at Problem	7	9	3	7	0.47	1	1.81	0.78
Apnea and Bradycardia								
Birth Weight	7	4	1	2	0.07	1	3.50	0.79
Weight at Problem	6	5	1	2	0.39	1	2.40	0.53
New Cardiovascular								
Birth Weight	10	4	2	2	0.04	1	2.50	0.85
Weight at Problem	3	11	0	4	0.06	1	0.00	0.81
Murmurs								
Birth Weight	8	3	1	1	0.38	1	2.67	0.54
Weight at Problem	2	9	0	2	0.40	1	0.00	0.53
New Neurological								
Birth Weight	2	1	1	1	0.11	1	2.00	0.74
Weight at Problem	2	1	1	1	0.11	1	2.00	0.74

TABLE 23 (Continued)

	Group I (N=55)		Group II (N=49)					
	<1.5 Kg	>1.5 Kg	<1.5 Kg	>1.5 Kg	$MH\chi^2$	DF	Odds Ratio	p Value
Bloody Stools								
Birth Weight	6	1	0	4	4.07	1	0.00	0.04
Weight at Problem	3	4	0	4	0.63	1	0.00	0.43
Rule Out Reflux								
Birth Weight	1	1	0	3	0.04	1	0.00	0.84
Weight at Problem	1	1	0	3	0.04	1	0.00	0.84
Constipation								
Birth Weight	2	2	1	1	0.00	1	1.00	1.00
Weight at Problem	0	4	0	2	0.00	1	0.00	1.00
Rule Out NEC								
Birth Weight	0	2	0	2	0.00	1	0.00	1.00
Weight at Problem	0	2	0	2	0.00	1	0.00	1.00
New Neurological								
Birth Weight	2	1	1	1	0.11	1	2.00	0.74
Weight at Problem	2	1	1	1	0.11	1	2.00	0.74
New Metabolic								
Birth Weight	4	3	2	5	0.27	1	3.33	0.60
Weight at Problem	3	4	3	4	0.00	1	1.00	1.00

TABLE 23 (Continued)

	Group I (N=55)		Group II (N=49)					
	<1.5 Kg	>1.5 Kg	<1.5 Kg	>1.5 Kg	$MH\chi^2$	DF	Odds Ratio	p Value
New Infectious								
Birth Weight	7	3	2	6	1.91	1	7.00	0.17
Weight at Problem	1	9	1	7	0.03	1	0.78	0.87
Thrush/Monilia								
Birth Weight	2	2	0	4	0.58	1	0.00	0.45
Weight at Problem	0	4	0	4	0.00	1	0.00	1.00
New Integumentary								
Birth Weight	2	2	1	2	0.17	1	2.00	0.68
Weight at Problem	1	3	0	3	0.75	1	0.00	0.39

an NICU, one was readmitted because of apnea and bradycardia, and one was readmitted for apnea and bradycardia accompanying gastro-esophageal reflux.

Twenty-six of the 104 subjects in this investigation (25%) developed some type of respiratory problem either after having met the criteria for back transport or after transport itself. The incidence of respiratory problems among the subjects in this study is much higher than that reported elsewhere. That difference may be a function of the methodology utilized in this investigation, which allowed problems that occurred on a daily basis to be identified. The magnitude of the problems identified in this investigation was such that readmission to an NICU would not have been warranted for the majority of the problems. If problems for which NICU admission was required were the only disorders identified in this study, the number of infants with problems would have been much less.

The incidence of neonatal respiratory disease in this sample was high, (89% of subjects, Table 4). Forty percent of the subjects were treated with oxygen, assisted ventilation, or medication for apnea. Eighteen percent of the infants developed bronchopulmonary dysplasia as a complication of their respiratory disease. It is not unexpected that residual respiratory problems would complicate the clinical course of back-transported infants. Residual respiratory disease is prevalent among NICU graduates and hospital readmission during the first year of life may be necessary if respiratory infections should occur (McCormick, Shapiro, & Starfield, 1980; Hack, DeMonterice, Merkatz, Jones, & Fanaroff, 1981). The finding that 22 of the 104 subjects (21%) were receiving supplemental oxygen at the

time of transport or at the time when the criteria for back transport were met indicates that the respiratory problems of these infants were not yet resolved.

A total of 18 infants (17%) developed cardiovascular problems after back transport or after having met the criteria for back transport. Fourteen of the back-transported infants (25%) presented with cardiovascular problems after back transport. When this incidence was compared with the appearance of new cardiovascular problems among the nontransported infants (four problems for an 8.2% incidence), a statistically significant difference was noted (Table 21). New cardiovascular problems are listed in Table 24.

When the appearance of new cardiovascular problems was related to birth weight, the two groups did not differ significantly (Table 30). The back-transported and nontransported infants also did not differ when comparisons were made according to the age when cardiovascular problems appeared (Table 23).

The presence of a heart murmur was the most commonly noted cardiovascular problem, occurring in 72% of the subjects with cardiovascular problems. When the incidence of murmurs was evaluated in relation to the infants' birth weights and the weights at which the problems were apparent, no statistically significant differences were noted (Table 23).

The appearance of cardiovascular problems in back-transported infants has not been addressed in the literature. The reason for the increased incidence of cardiovascular problems in the back-transported infants, primarily murmurs, is not entirely clear. It is possible that, because of the longer duration of hospitalization of

Table 24

New Cardiovascular Problems

	Group I (N=55)	Group II (N=49)
Audible Murmur	11	2
Hypertension	2	1
Generalized Edema, Pallor, Tachycardia	1	1

Pearson Chi-Square = 6.43; DF = 3; p = 0.092

the infants in Group I, hemodynamic alterations which may not be completed for several weeks after birth and which may influence blood flow, were completed with subsequent production of murmurs.

The most frequently observed problems in both groups were gastrointestinal problems. A total of 35 problems was noted in 32 infants (31% of the sample). Three of the back-transported infants each manifested two gastrointestinal (GI) problems.

Twenty-one gastrointestinal problems were identified in 18 of the infants in Group I (33%). The most commonly observed problem was the presence of blood in the stools which occurred seven (33%) times. Guaiac-positive or occult blood in stools may be benign, if associated with an anal fissure, or if occurring as a consequence of irritation from repeated insertions of oral or nasogastric tubes for feedings. However, the presence of blood in the stools may also be indicative of necrotizing enterocolitis (NEC). Additional problems which were observed are listed in Table 25.

NEC has been identified as a problem which has occurred among back-transported neonates (Clarke et al. 1983). Although many of the identified problems may not be viewed by some as unusual occurrences among NICU graduates, the association of bloody stools, emesis, and distention, with NEC dictates that caretakers be suspicious when these signs appear. The two infants in Group I who were suspected of having NEC were retransferred to a tertiary level unit for evaluation.

Fourteen GI problems were identified in 14 of the non-transported infants (Table 25). Comparison of the incidence of new GI problems between the two groups revealed that the

Table 25

New Gastrointestinal Problems

	Group I (N=55)	Group II (N=49)
Bloody Stool	7	4
Constipation	4	2
Distention with Vomiting/ Residuals	3	1
Question of Reflux	2	3
NEC or Suspicion of NEC	2	2
Diarrhea	1	2
Vomiting	1	0
Anal Stricture	1	0

Pearson Chi-Square = 4.35; DF = 8; p = 0.82

back-transported and the nontransported infants did not differ in this respect (Table 21). When the two groups were compared for the incidence of problems according to birth weight, the difference between the two groups approached statistical significance (Table 23). Twelve of the 14 infants (86%) in Group II who developed GI problems weighed 1500 grams or more at birth. Ten of the 21 GI problems (48%) which appeared in the back-transported infants occurred in babies who weighed more than 1500 grams at birth. When comparisons were made between the groups according to the weights at which GI problems appeared, no significant difference was noted (Table 23).

Analysis of the incidence of specific GI problems revealed that:

1) Birth weights of the infants who presented with bloody stools were significantly lower among the back-transported infants (Table 23). Six of the seven infants (86%) with bloody stools weighed $\leq$ 1499 grams at birth. All of the infants in Group II with bloody stools weighed 1500 grams or more at birth.
2) Infants in Group I and Group II did not differ when the weights at which bloody stools were observed were compared (Table 23).
3) The incidence of constipation among the back-transported and nontransported infants was comparable, regardless of birth weight or the weight at which the problem was noted (Table 23). All infants who developed constipation weighed more than 1500 grams at the time constipation was identified as a problem.
4) All four infants who developed NEC or in whom NEC was strongly suspected, weighed more than 1500 grams at birth. Feedings may

have been advanced with less caution than in smaller infants. These larger infants may also have had fewer risk factors which predisposed them to the development of NEC. The two groups did not differ when birth weights and suspicious or confirmed NEC were observed (Table 23). All four infants weighed more than 1500 grams when signs of NEC appeared. The two groups did not differ statistically in this respect (Table 23).

New neurological problems appeared in five (4.8%) of the subjects. Three of the back-transported infants (5.5%) and two (4.1%) of the nontransported infants presented with signs indicative of neurological problems. These problems are delineated in Table 26.

The two groups did not differ statistically when the incidence of new neurological problems was compared (Table 21). Birth weight of the infants did not influence the appearance of neurological problems (Table 23). However, the small number of infants with neurological problems renders statistical interpretation difficult. When the weights of the infants at the time the neurological problems presented were compared, no statistically significant difference was observed (Table 23).

New metabolic problems appeared in 14 subjects (13.5% of the sample); seven were observed in Group I (12.7%) and seven in Group II (14.3%). The two groups did not differ significantly when the incidence of new metabolic problems was compared (Table 21). A description of new metabolic problems is presented in Table 27.

Four infants in Group I (57%) required phototherapy for hyperbilirubinemia. All of these preterm infants were back transported at less than 48 hours of age. The appearance of hyperbilirubinemia

Table 26

New Neurological Problems

	Group I (N=55)	Group II (N=49)
Suspicion of Seizures	1	2
Intraventricular Hemorrhage	1	0
Full Anterior Fontanel Without Excessive Head Growth	1	0

Pearson Chi-Square = 2.25; DF = 3; p = 0.52

Table 27

New Metabolic Problems

	Group I (N=55)	Group II (N=49)
Hyperbilirubinemia	4	0
Hyperglycemia	1	0
Hypoglycemia	0	3
Poor Weight Gain After Transfer to Bassinette	1	0
Hyponatremia	0	1
Elevated Phosphorus	0	1
Late-Onset Metabolic Acidosis	0	1
Temperature Instability	0	1
Mismanagement of Suspected Hyperbilirubinemia	1	0

Pearson Chi-Square = 14; DF = 8; p = 0.082

requiring phototherapy was not unexpected. Phototherapy was initiated on day 2 of life for one baby and on day 3 of life for the other three, who were triplets back transported together. One infant developed hyperglycemia following transport. One infant demonstrated poor weight gain but no temperature instability following transfer from Isolette® to bassinettes and was subsequently returned to the Isolette®. The seventh infant appeared jaundiced at 19 days of age and was placed under phototherapy without evaluation of the bilirubin level.

Temperature instability occurring secondarily to weaning of back-transported infants to open cribs was identified as a problem by Leake and colleagues (1976). In this investigation, temperature instability occurred during the convalescence of only one infant who was not back transported. The difficulty with temperature regulation occurred independently of weaning to a bassinette. The back-transport literature has not addressed the occurrence of metabolic problems in back-transported infants. The majority of metabolic problems of the nontransported infants were identified through the use of laboratory tests. It is possible that the wider variety of metabolic problems identified among nontransported infants occurred because of a tendency to monitor a greater number of parameters in the regional center as opposed to community hospitals.

Infectious complications appeared in a total of 15 infants (14.4%). Ten infectious problems occurred in 10 of the infants in Group I (18%). Five of the infants in Group II (10%) experienced a total of eight infectious problems. Comparison of the two groups revealed no statistically significant difference in the incidence of

new infectious problems (Table 21). Table 28 lists the new infectious problems which were identified among the subjects. Thrush and monilial diaper rashes occurred simultaneously in two of the subjects in Group II.

Seven of the back-transported infants (70%) who developed infectious complications weighed $\leq$ 1499 grams at birth, as compared to two of the nontransported infants (40%). This difference was not statistically significant (Table 23). However, only two of the infants, one in each group, weighed less than 1500 grams at the time that the problem appeared. The infectious complications may have been related to the duration of hospitalization, with the incidence of infection being directly proportional to the length of hospital stay.

Oral or perianal monilial infections were the most commonly recorded infectious complications and occurred in eight of the 18 (44%) of the infants. All infants weighed more than 1500 grams at the time of infection. The age of the infants when signs of monilial infection appeared ranged from 18 days to 45 days (range = 27 days, mean = 34.4 days). In six of the eight cases of monilial infection (75%), signs of infection appeared at 36 or more days of age, reinforcing the suggestion of a direct relationship between incidence of infection and duration of hospitalization.

Leake and colleagues (1976) investigated the safety of back transport from an infectious standpoint. Two of 43 back-transported infants (4.7%) developed monilial diaper rashes as compared to a 3.8% incidence of monilial diaper rashes in this investigation. However, the duration of hospitalization of the subjects was not

Table 28

New Infectious Problems

	Group I (N=55)	Group II (N=49)
Eye Drainage	4	1
Thrush	2	2
Monilia Diaper Rash	2	2
Umbilical Exudate	1	1
Foul-Smelling Umbilicus	1	0
Symptoms of Generalized Septicemia	0	2

Pearson Chi-Square = 4.73; DF = 6; p = 0.58

specified in that investigation. The incidence of temperature instability was greater in Leake's study (4/43 = 9.3% versus 1/104 = 0.96%). No positive stool cultures were reported among the 104 subjects in this investigation following transport or after their having met the criteria for back transport.

New skin problems (primarily diaper rashes, excluding monilial rashes) appeared in four of the infants in Group I (7.3%) and in three of the nontransported infants. This difference was not statistically significant (Table 21). All three of the infants in Group II (100%) presented with diaper rashes. Three of the four back-transported infants (75%) developed diaper rashes and one infant (25%) developed an area of skin breakdown on the scalp (Table 29).

Miscellaneous problems appeared in a total of six infants (5.8%), three in each group (Table 30). The incidence of miscellaneous problems did not achieve statistical significance (Table 21) when the two groups were compared. Among the back-transported infants, one baby was noted to have left-sided tear duct obstruction, one infant presented with an inguinal hernia and was discharged from the community hospital to the parents for admission to a tertiary level unit for an inguinal herniorrhaphy, and one infant who developed an inguinal hernia was transferred to the tertiary unit for evaluation of suspected incarceration.

Among the infants in Group II, one infant was observed to have a hydrocele, one infant developed an inguinal hernia with hydrocele, and one infant was noted to have a calcified scalp hematoma secondary to the use of a fetal scalp electrode.

Table 29

New Integumentary Problems

	Group I (N=55)	Group II (N=49)
Diaper Rash	3	3
Scalp Breakdown	1	0

Pearson Chi-Square = 0.91; DF = 2; p = 0.63

Table 30

New Miscellaneous Problems

	Group I (N=55)	Group II (N=49)
Obstructed Tear Duct	1	0
Inguinal Hernia	2	1
Hydrocele	0	1
Calcified Scalp Hematoma	0	1

Pearson Chi-Square = 3.43; DF = 4; p = 0.49

A total of four of the 55 back-transported infants (7.2%) was transported to tertiary level centers prior to their discharge home. Only one of these infants was transported to the regional center in which it was previously hospitalized. The other three infants were transported because of the appearance of problems for which surgery may have been required, and, consequently, were transported to another NICU. Other investigators (Clarke et al. 1983);Jung & Bose, 1983; Leake et al. 1976) have reported that patient readmission to the regional center following back transport has been necessary under some circumstances. If these investigators only considered admissions to their own institutions, without considering the possibility of readmission to other units, their findings may have underestimated the true incidence of NICU readmissions. During the course of their hospitalization following discharge from the NICU, two of the infants in Group I were also transferred to the University of Utah Medical Center for sleep studies for the evaluation of apnea and bradycardia. Following evaluation, they were both re-transferred to the community hospitals.

3) Upon identification of clinical problems, is treatment provided in the regional center and the referring hospitals appropriate?

The investigator attempted to determine whether the approach taken by caretakers while managing problems that surfaced among the subjects was suitable to the specific problems identified. Extrapolating this information from charts was difficult because the thought processes and logical progression of thought of the

caretakers who evaluated the infants, in many instances, could not be determined from the progress notes.

The investigator acknowledges that a number of approaches to a single problem may be acceptable. These approaches may be a consequence of the educational backgrounds of individual physicians or may be attributed to personal preference for and/or comfort with a particular method of management. Attempting to make judgment calls on the basis of extrapolation and interpretation of information from charts made answering this question difficult. Lack of documentation, or inaccurate or insufficient documentation, rather than failure to intervene, may have been the problem in some situations.

The investigator attempted to determine whether problems identified retrospectively at the time of chart review were also identified by the caretakers. Efforts were made to avoid making judgment calls whenever possible, and to objectively determine whether the general approaches were reasonable. For example, when guaiac-positive stools were observed, was the possibility of NEC considered and intervention directed toward observation for additional signs? Were sepsis and metabolic abnormalities considered in the differential diagnosis when increased frequency of apnea and bradycardia was recognized as a problem?

In the vast majority of circumstances, the treatment that was provided at both the regional center as well as at the community hospitals was considered to be reasonable. For the 51 problems which occurred among the infants of Group II, in only one instance (2.0%) was the approach that was taken by the caretakers questioned. In that instance when hypoglycemia was documented by a low blood

sugar, no notation in the nurses' notes indicated that a physician was notified or treatment provided. The physician's progress notes did not indicate that hypoglycemia was a problem. Because the care provided at the regional center should be the standard of neonatal care within a region against which other care is measured, the occurrence of several instances of questionable management would have been worrisome.

For the 78 problems occurring among the back-transported infants, in eight instances (10.2%) the treatment provided was questionable. One infant was placed in a headbox for supplemental oxygen delivery by a nurse who observed that the baby became cyanotic during feeding. The charting did not indicate that a physician was notified regarding the appearance of cyanosis or the intervention. No blood gas values were recorded on the chart to document whether hypoxemia was present. The baby's oxygen therapy was discontinued on the following morning.

A second infant was observed to be jaundiced on day 19 of life. That baby was placed under phototherapy by a nurse because of the appearance of jaundice. No record of physician notification was in the chart. Although a night of phototherapy may not have harmed the infant, if hyperbilirubinemia had persisted for more than two weeks of life, further investigation would have been warranted. No record of serum bilirubin levels appeared on the infant's chart.

A third infant was observed by nursing staff to be "tachycardic, gray, and edematous." No blood pressures were obtained or laboratory work done. After this notation in the chart, no further similar observations were recorded. This baby was transferred to an

NICU approximately 5 days later for the evaluation of a suspected incarcerated inguinal hernia. For a fourth infant, a problem was identified by the physician and treatment was prescribed. The nursing staff failed to document that the treatment was actually instituted.

In four of the eight circumstances of questionable therapy (50%), infectious problems were involved. In three infants, pharmacological therapy was instituted because of suspected conjunctivitis without the recording that a culture of eye drainage was obtained. A fourth infant was described as having a "foul-smelling exudate" from the umbilicus. No culture of the drainage was obtained; no treatment other than expectant management was initiated. It is possible that, for all of the above situations, physicians may have considered that culture results may not have directed or altered their course of treatment and that the expense of obtaining a culture was not warranted.

In four of the above circumstances, nursing management, either lack of documentation, failure to notify a physician, or independent intervention was involved. Nursing intervention without physician consultation was a cause of concern in two instances. Nursing policies and protocols sometimes govern the care that is provided in well baby nurseries. For example, placing a healthy, term, jaundiced infant under phototherapy without physician consultation may be covered by protocols in some nurseries. However, the application of these protocols to the care of convalescing infants who have been hospitalized in an NICU may not be appropriate.

There were indications on the charts of some of the back-transported infants that consultation with caretakers at the regional center occurred (for example, consultation with neurosurgery after the appearance of an intraventricular hemorrhage (IVH) in one baby, consultation with a pediatric pulmonary specialist when persistent apnea and bradycardia were noted, and consultation with pediatric surgery regarding management of inguinal hernias). This was viewed by the investigator as a positive approach to management of back-transported infants, and may be indicative of established and open lines of communication between hospitals. The continued communication between professionals in the regional center and those in community hospitals is a desired outcome of regionalized perinatal care.

4) Is the therapy that was provided for infants at the regional center altered after the infant's arrival at the community hospital?

The investigator attempted to determine whether the medical and nursing management of the subjects was changed after their arrival at the community hospitals to which they were back transported. The 24 hour period of time immediately after the infant's arrival at the community hospital was utilized as the time frame during which changes in therapy were monitored.

At the time of back transport, the subjects were receiving a variety of nutritional products by which calories were provided by the enteral route. If a formula of equal caloric density was substituted for the product that the infant was receiving at the time

of transfer, this was not considered an alteration in therapy, unless the infant was receiving a special formula. This type of change may have been dictated by contractual agreements between hospitals and formula companies or by physician preference for a particular brand of formula. For one infant, formula was changed from an investigational formula being received in the NICU while under a study protocol to a 24 calorie per ounce formula which was appropriate for a preterm infant. Because the investigational formula was not available after back transport, this was not considered to be a change in management.

A total of nine infants (16%) experienced formula changes during the first 24 hours following back transport. Of those nine infants, five (55%) received new formulas of a lesser caloric density than that which they had received prior to transport. One infant's formula was changed from a 24 calorie per ounce formula to a 20 calorie per ounce formula. For this infant who weighed 1240 grams at the time of transport, a formula of greater caloric density may have been advantageous. Prior to transport, this baby was receiving a mixed formula that was a 1:1 dilution of a standard preterm formula and a formula that contained partially-hydrolyzed protein. Following transport, this infant received only the formula containing the partially-hydrolyzed protein; however, this was reconstituted to provide 20 calories per ounce. It is possible that nursing staff were unaware of the method of preparing the formula in order to achieve a product containing 24 calories per ounce of formula.

In two infants, caloric density of formula administered was decreased to 13 calories per ounce (in one instance from a 20 calorie per ounce formula and in the other, from a 24 calorie per ounce formula). The rationale for this change could not be determined from the patient charts. One infant was initiating feedings and volume and progression of feeding remained in a transitional stage. The other infant was maintained on the 13 calorie per ounce formula for less than 24 hours. Possibly unit protocol dictated the use of lower caloric density formulas in order that tolerance of feedings could be assessed by the new caretakers.

In two infants, the caloric density of the formula was reduced from 24 calories per ounce to 20 calories per ounce. One of these babies weighed 2340 grams at the time of transport. In this instance, a change in the caloric density of the formula provided may have been warranted. The other infant weighed 1740 grams at the time of transport and this reduction in the caloric density of the formula administered may have been somewhat premature.

Four infants (45%) received formula of a greater caloric density than that administered prior to transport. One infant, weighing 2180 grams at the time of back transport, was advanced to a 24 calorie per ounce formula. This infant most likely would have been able to assimilate sufficient calories for growth on a 20 calorie per ounce formula, as all feedings were being taken by the oral route rather than by gavage.

For two infants, this change in formula to one of greater caloric density occurred as a result of recommendations generated from caretakers at the regional center. In those two babies, a 20 calorie

per ounce formula was to be administered until a volume which resulted in the provision of adequate fluids and calories was achieved. At that time, formula was to be changed to one which provided 24 calories per ounce.

The final infant, who was receiving feedings for only the second day at the time of back transport, was receiving a standard preterm formula diluted 1:1 with sterile water to achieve a strength of 12 calories per ounce. Feedings were rapidly advanced to a full-strength, 24 calorie per ounce formula following transport.

For six of the 55 back-transported infants (11%), the route by which feedings were administered was changed after the infant's arrival at the community hospital. Four of the six infants (67%) who were receiving feedings by both nipple and gavage were allowed to nipple all feedings. Two of these babies weighed more than 2250 grams at the time of transport and were able to nipple adequate volumes of formula. Two infants, weighing 2370 and 1340 grams respectively, were unable to maintain adequate fluid and caloric intake by the oral route alone. It is possible that the nursing staff at the community hospitals were not completely comfortable with gavage feedings and believed that the infants were of adequate size and maturity (the 1340 gram infant was extremely small for gestational age at birth) to nipple all feedings. However, in the latter two infants, growth was compromised because of inadequate caloric intake.

One infant, who was taking feedings entirely by nipple at the time of discharge, was allowed to nipple only every other feeding following back transport. The remaining feedings were administered

by gavage. The sixth infant was receiving continuous feedings by the nasojejunal (NJ) route at the time of transfer. The recommendations provided by the regional center suggested that feedings be administered by the transpyloric route for 2-3 days following transport to assure that renewed respiratory distress requiring the use of continuous positive airway pressure by the nasal route would not occur. Because nasojejunal (NJ) feedings are now administered less frequently in NICU's as a result of the potential risks involved, it is entirely possible that nursing staff at the community hospital were unfamiliar with administration of feedings by the nasojejunal (NJ) route. If caretakers' experience and knowledge about NJ feedings were limited, removing the NJ tube and conversion to intermittent gavage feedings may have been in the infant's best interests.

As a result of changing the route of administration of feedings, feeding volume was altered in three of the six infants in whom the feeding route was changed. Two of the infants who were allowed to nipple all feedings consumed insufficient calories and fluids during the initial 24 hours following back transport. One infant's optimal feeding volume was 40 milliliters (ml) at every three hour intervals. That baby nippled volumes ranging from 5 ml to 70 ml; however, overall fluid and caloric intake was insufficient to meet growth requirements. The second infant also was to receive 40 ml of formula every 3 hours. When allowed to nipple all feedings, intake ranged from 20 to 50 ml; however, total daily nutritional intake was inadequate. Nutritional intake was also insufficient in the infant who made the transition from NJ feedings to intermittent

gavage feedings, as initial feeding volumes administered by the nasogastric route were reduced in order to advance feedings slowly.

An additional seven infants were subjected to changes in the volume of feeding administered without alteration in route. A total of 10 of the back-transported infants (18%) received feeding volumes different from that which were recommended at the infant's discharge. In all cases, feeding volume administered following back transport was less than that provided at the regional center, resulting in insufficient nutritional intake. Because, in many hospitals fluid and caloric intake of the infants were not calculated, caretakers may have been unaware that the nutritional requirements of these babies were not being met. Perhaps recommendations from the caretakers at the regional center should be more specific about the recommended volume and the route of administration of feedings when discharge summaries are prepared.

It was unclear from the patient charts why those infants who were receiving gavage feedings did not receive the recommended volumes when feedings were given. Discrepancies noted are outlined below:

	Recommended	Volume Administered
1)	33 ml every 3 hours	20 to 33 ml every 3 hours, all gavage
2)	32 ml every 3 hours, then increase 3 ml every other feeding to 35 ml maximum every 3 hours	18 to 30 ml every 3 hours
3)	30 ml every 3 hours, increase 3 ml every other feeding to a maximum of 36 ml every 3 hours	22 to 30 ml every 3 hours

4)	36 ml every 3 hours	20 to 35 ml every 3 hours
5)	55 ml every 3 hours	20 to 65 ml every 3 hours (overall 24 hour intake decreased)

The volume of feeding of one infant was reduced from 21 ml every 3 hours to 19 ml every 3 hours. No weight loss which may have influenced this change was recorded. No indications for fluid restriction, for example, appearance of a heart murmur suggestive of a patent ductus arteriosus, were reported.

Prior to the transport of one infant, only one feeding has been administered. When the infant's IV infiltrated shorted after admission to the community hospital, the infant's feeding volume was rapidly increased. The chart did not indicate if efforts were made to restart the IV and were unsuccessful. Assuming that an infant may readily tolerate an increased volume of feeding may be dangerous, particularly for the preterm infant who may be at risk for the development of necrotizing enterocolitis. This particular baby was the only infant in the back-transport group who failed to gain weight during his hospital stay following back transport.

Because four of these 10 infants were transported to the same institution, the need for education in this area was identified. Providers need to be aware of the nutritional needs of convalescing infants and must be cognizant of the importance of evaluating parameters other than weight change. More explicit recommendations at time of infant discharge with emphasis upon the importance of providing adequate nutrition by ensuring that recommended feeding

volumes are administered may contribute to compliance with those recommendations.

One infant's environment was changed following back transport. That infant had remained in an Isolette® up until the time of transfer. Upon arrival at the community hospital, he was placed in a bassinette. It is entirely possible that that recommendation was made by the transport team. This infant weighed 2270 grams at the time of transport; such an intervention may have been appropriate. However, transfer from an environment such as an Isolette® to a bassinette is generally completed as a gradual procedure over several hours' time. This infant did not experience any difficulty with temperature instability following the move to an open crib.

Three of the back-transported infants were subjected to changes in oxygen supplementation following transfer. One infant who was transported by the parents to a hospital which is approximately a 5 hour drive from the regional center was found to be cyanotic, with accompanying respiratory difficulty upon arrival at the referring hospital. The infant was placed in oxygen, remained in oxygen throughout the duration of hospitalization, and was receiving supplemental oxygen at the time of discharge to home.

One infant who experienced cyanosis with feeding during the first evening after arrival at the community hospital was placed in oxygen by headbox throughout the night. The oxygen was discontinued in the morning and no further supplementation was provided. The third infant was receiving FiO_2, 0.27, by nasal cannula at 0.5 liters/minute upon discharge to the referring hospital. Approximately one hour after the infant's arrival, FiO_2 was increased to

0.30 and liter flow was increased to 3 liters per minute. Liter flow was decreased to one liter per minute by the next day as a result of frequent blood gas monitoring. This infant was discharged to home 6 days after admission to the referring hospital receiving FiO_2, 0.30, and a liter flow of 0.5 liters per minute, comparable to that administered at the time of admission.

Eight infants were subjected to alterations in pharmacological therapy (a total of nine medication changes) after their arrival at the referring hospital. For three of these infants, the change involved substitution of theophylline for caffeine as therapy for apnea. The use of theophylline rather than caffeine is not unexpected. It would be anticipated that the majority of family practice physicians and pediatricians are more familiar with the use of theophylline as opposed to caffeine. Pharmacies in small hospitals may not have caffeine available; therefore, physicians' options for therapy may have been limited. The use of theophylline may be preferable if an institution had the capability of monitoring blood levels of theophylline and not of caffeine, if the ability to monitor therapy was taken into account when the selection of the medication was made.

The other six medication changes involved the use of vitamin preparations. Two infants who were receiving a multiple-vitamin preparation at the regional center received no vitamins following transport. One of these infants had feedings changed from breast milk to a preterm formula as breast milk was no longer available. The pediatrician may have considered that the formula may have

supplied sufficient quantities of vitamins that were not available in breast milk.

Two infants who were not receiving vitamins at the time of transport had a multivitamin preparation added to their feeding regimen. In one of these infants who weighed 1100 grams at the time of transport, the route of feeding was altered from NJ to intermittent gavage. Concern has been expressed that the administration of hyperosmolar solutions such as medications through NJ tubes may increase an infant's risk for NEC (White & Harkavy, 1982). Therefore, the addition of a vitamin supplement following the change in the route by which the feedings were provided was an appropriate intervention.

Vitamin E and folate were added to the feeding regimen of one 1050 gram infant who was back transported. Because preterm infants are susceptible to deficiencies in these two vitamins (Dauman, 1973), their administration is not a cause of concern. In one infant, therapy with folate was discontinued following back transport. Physicians have varying philosophies regarding the use and timing of institution of vitamin supplementation. Changes in therapy may have been a consequence of individual variations in physician education and health care beliefs and practices.

Five infants whose cardiorespiratory status was monitored continuously while at the regional center were not placed on monitors following admission to the community hospital. The weights at back transport of these infants ranged from 1740 to 2380 grams (range = 640; mean = 2170). None of these infants had a history of apnea and bradycardia during their hospital course in the NICU.

In four infants, a change in the management of hyperbilirubinemia occurred following back transport. Phototherapy was discontinued for two infants after their arrival at the community hospital. For one infant whose total bilirubin was 8.7 mg/dl prior to transport, no further bilirubin levels were obtained during the remainder of hospitalization. A second infant who was discharged from the NICU with a total bilirubin level of 10.5 mg/dl had a total bilirubin level of 10.6 mg/dl at the referring hospital the next day, despite the decision of remove phototherapy at the time of admission.

Two infants whose phototherapy was discontinued at the regional center on the day prior to back transport were placed under phototherapy upon arrival at community hospitals. Bilirubin levels were measured at least daily for several days for both of these infants.

Intravenous fluid therapy was altered for four infants during the first 24 hours following their admission to the community hospitals. One infant was receiving a 12% dextrose solution of peripheral hyperalimentation (without a source of intravenous lipids) at the time of transport. When that IV infiltrated shortly after the infant's arrival, no IV was restarted. Both fluid and caloric intake for the first 24 hours following back transport were inadequate.

Three triplets who were transported to the same institution had the dextrose concentration of their IV solution reduced from 10% to 5%. These infants were not fed by the enteral route during the night following admission. The rationale for this change was not indicated on the patients' records, although the changes may have

been a consequence of unit policy and/or physician preference. These infants did not experience hypoglycemia following this change in IV therapy.

Because the methodology utilized in this investigation was a retrospective chart review, attempting to interpret the reasons for many of the changes in management that occurred was impossible. However, it was apparent that all recommendations made by caretakers at the regional center were not followed by the caretakers at the institutions to which infants were back transported. A total of 33 infants (60%) were subjected to a change in some aspect of the management that was provided at the regional center.

Many changes may have occurred as a result of a physician's educational background or personal preference with a particular form of therapy. For many of the changes, no rationale could be determined.

Of major concern was the alteration in the provision of nutrients to back-transported infants. Changes in the route and volume of feedings administered had individual impact upon the nutritional intakes of the babies subjected to these changes. However, these changes did not appear to have had a deleterious effect upon the weight gain of the back transported infants as a group.

Changes that were accomplished, in the majority of instances, were probably not detrimental to the recovery of the subjects.

CHAPTER IV

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

The purpose of this investigation was to determine whether back transport of convalescing infants from neonatal intensive care units to community hospitals was justifiable fropm the perspective of safety. Safety was defined as the lack of statistically significant difference between back-transported and nontransported infants when the incidence of clinical problems which occurred during convalescence were compared.

Although four of the back-transported infants were subsequently retransferred to NICU's for care, the back-transported and nontransported infants did not differ when the incidence of new respiratory, gastrointestinal, infectious, metabolic, neurological, integumentary, and miscellaneous problems were compared. New cardiovascular problems occurred significantly more frequently among the back-transported infants. These problems, primarily the appearance of new heart murmurs, were managed expectantly.

Back-transported infants did not experience increased evidence of feeding intolerance, changes in oxygen requirements, or changes in the frequency or nature of episodes of apnea and bradycardia. Weight gain and temperature control improved following back transport.

When clinical problems were identified in back-transported infants, nursing and medical management were considered to be appropriate ninety percent of the time. In over one-half of the infants, at least one aspect of clinical management that had been provided at the regional center was altered by caretakers in nurseries in community hospitals. These changes, in most circumstances, did not appear to be detrimental to the convalescence of the back-transported infants.

Conclusions

At the completion of this investigation, the researcher concluded that, for this population of infants, back transport was safe when practiced within the framework of a regional perinatal program. Back transport was found to be particularly advantageous when weight gain of the subjects was evaluated.

The ability to generalize the results of this study to other populations is limited by the design of this investigation. The findings of this study may not be applicable to a less homogeneous group of NICU graduates, for example, those with congenital anomalies or those who have undergone surgery.

The criteria for back transport which were developed by the researcher also limit the generalizability of the results of this investigation. Those criteria may not be considered acceptable by staff at other regional centers. Back transport or discharge criteria may have to be individualized for each perinatal center, with the criteria being dependent upon unit and personnel capability of hospitals served by the regional center. The development of

back-transport criteria which are based upon assessment of the needs of the region served by a regional center is preferable to the acceptance of "standardized" criteria. Without open lines of communication and continued consultation among caretakers with a regional program, the success of back transport may be limited.

Recommendations for Future Research

Additional systematic studies which investigate the clinical courses of back-transported infants are needed. Safety of back transport for infants with a wider variety of clinical problems is an area which remains to be investigated.

Had this been a prospective study, factors which influenced the decision to back transport could have been evaluated and taken into account. Completing a similar investigation prospectively would also allow the testing of the criteria for back transport in order to determine their usefulness and validity.

Examination of factors within the environments of the nurseries of the community hospitals which may have influenced the improved weight gains of the back-transported infants would provide useful information. Care practices, such as a reduced number of invasive procedures, diminished handling for physical examinations, limited sensory overload, and parental involvement could be examined to determine their impact upon convalescence.

An additional area to be investigated is the effect of changes in management upon the overall outcome of infants. Factors which determined why those changes occurred might also be evaluated. The impact of back transport upon the success of regionalization might

also be evaluated. If a theoretical advantage of back transport is improved communication between the regional center and community hospitals, the assurance that infants will be returned to referring hospitals following resolution of major clinical problems may influence earlier referrals of sick neonates. That hypothesis also remains to be tested. Educational programs which address the needs of convalescing infants may be included as a part of the repertoire of outreach education programs presented by professionals at the regional center. The effect of these programs on the care provided to back-transported infants may later be evaluated.

Current governmental regulations which may dictate the amount of federal funding available to neonates hospitalized in NICUs may necessitate earlier discharge of convalescing infants from hospitals. Back transport of infants may occur more frequently as a result of limited funding that is available to the regional center. Investigating the impact of back transport upon care practices in community hospitals will be necessary, as these institutions will be expected to provide convalescent care. In order to assure that the interests of infants who require care are considered, further research into the area of back transport is imperative.

APPENDIX A

BASELINE DATA

Hospital #:_____ Code #:_____

Sex: Male_____Female_____ Date of Birth:_____

Gestational Age: By dates_____By examination_____
AGA_____SGA_____LGA_____

Apgars: 1 minute_____5 minutes_____

Singleton Birth: Yes_____No_____ Birth weight_____
Twin: First_____Second_____
Triplet: First_____Second_____

Hospital of Birth: UUMC_____ Other (Specify)_____

CLINICAL PROBLEMS

Birth Associated:
____C-section
____Birth Asphyxia (Apgar <6)
____Malpresentation
____Prolonged ROM (>24°)
____Meconium Staining
____Other

Infectious:
____Sepsis and/or meningitis
(Positive culture)
____Presumed sepsis
____Other

Respiratory:
____HMD
____Aspiration
____Meconium
____Other
____TTN
____Extraventilatory Air
(Specify Site)_____
_____
____Other

Metabolic:
____Hyperbilirubinemia
____Phototherapy: # Days____
____Exchange
____IDM
____Other

Miscellaneous:

____PDA
____IVH/ICH
____Suspicion of NEC
____Pneumatosis

Other:_____
_____

# of days requiring ventilatory support:_____

APPENDIX B

DATA AT MEETING CRITERIA FOR BACK TRANSPORT

Code #:_____ Hospital #:_____

Date meets criteria for back transport:_____

Age:_____ Weight:_____

FiO_2:_____pO_2:_____pCO_2:_____pH_____

IV sol'n_____

Feedings: Type_____
Route: Nipple_____Alternate po/gav_____Complete gav_____
Other:_____
Pattern of Progression:_____

Feeding Problems: Residuals (3 cc/kg) Yes_____No_____
Emesis: Yes_____No_____
Distention: Yes_____No_____
cc/kg/24°_____KCal/kg/24°_____

Apnea spells per last 96°:_____No./day_____
Associated with cyanosis: Yes_____No_____ # of times_____
Associated with bradycardia: Yes_____No_____ # of times_____

Response: Spontaneous_____Oxygen_____
Tactile stim_____Suction_____Bag and Mask_____

Type of Bed:_____ Temp: Skin_____Axillary_____

Phototherapy: Yes_____No_____ Bili: Total_____Direct_____

Medications:

Additional Problems or Unusual Symptoms:

Date Back Transported:_____

Institution to Which Transported:_____

APPENDIX C

DAILY DATA COLLECTION INSTRUMENT

Date:_____ Code#_____

Age
Weight
Δ 24°
Δ Adm.

FiO2
pO2
PCO2
pH

Feedings:
Type
Volume
Progression
Route
Resid (>3/kg)
Emesis
Distention
Δ Girth

IV's:
Solution
Rate
Δ in 24°
cc/kg/24°
cal/kg/24°

Miscellaneous:
Monitor
Type/Bed
Hypothermia
Hyperthermia

Apnea (#)
Bradycardia
Cyanosis (#)
-Spont
Tactile Stim
Suction
Oxygen
Bag and Mask
Gav Tube
After Feeding

Sleeping
Ø Noted

Medications:

Additional Problems or Unusual Symptoms:

OFC
Length
Hematocrit
Other Labs

APPENDIX D

REQUEST TO REVIEW MEDICAL RECORDS

Director, Medical Records
Hospital
Address
City, State Zip

Date

Dear Director:

Babies born in your hospital who require admission to the Newborn Intensive Care Unit (NICU) at the University of Utah Medical Center (UUMC) are sometimes transported back to your hospital for care prior to discharge home. Back transport of newborns may offer several advantages to our babies, among them the opportunity for parents to visit their babies more often, the opportunity for the family physician to assume care-taking activities, and decreased cost of hospitalization.

Aspects of back transport which have previously been studied by the Division of Neonatology at the UUMC include cost effectiveness of back transport and improved bed utilization in the NBICU. Your hospital may have provided data which was incorporated into a report investigating the cost effectiveness of back transport. As a continuation of these studies, we are now investigating the effects of care provided in newborn and intermediate care nurseries upon the continued recovery of babies who have been hospitalized in the NICU at the UUMC. In this research study, the clinical course of back transported infants will be compared to that of infants who remain at UUMC for convalescent care.

Data will be collected by retrospective chart review for infants admitted to the NICU of the UUMC. Information collected will consist of: pattern of weight gain, nature, route, and tolerance of feedings, adequacy of nutritional intake, oxygen requirements, blood gas analysis, frequency and severity of apnea and bradycardia, monitoring, temperature regulation, pharmacological therapy, and laboratory testing. You are probably familiar with the procedure of chart review, as it is an evaluative tool that has been utilized by the neonatal outreach staff in the past.

Director, Medical Records Department
Date

Page 2

The Medical Records Department of your hospital will be given advance notice of my visit in order that charts of infants who have been back transported from UUMC may be pulled. The time required for data collection will be dependent upon the number of babies that have been back transported to your hospital. A period of 1 to 5 days should be sufficient for data collection.

Participation in this study is strictly voluntary and you may withdraw at any time without fear of reprisal. This decision will not alter services provided to your babies or staff by UUMC, such as patient care, transport, consultation, or outreach education. Charts of babies hospitalized at UUMC will receive the same evaluation as those of back transported infants.

In efforts to maintain confidentiality of subjects, the names of infants will be used solely for the purpose of identifying charts that must be pulled by the Medical Records Departments of participating hospitals. After charts are pulled, study subjects will be identified by hospital number and code number only. Only the investigators will have access to charts. All data will be analyzed collectively. No individual institutions, with the exception of UUMC will be named in the report of this study, which is a master's thesis. A report of this investigation will be submitted for publication.

Your hospital will be provided with feedback regarding the management of back transported infants. Strengths identified in the provision of care will be emphasized. In the event that deficiencies in the delivery of care are identified, outreach education programs will be made available to you in efforts to correct these deficiencies. Please understand that data collection and analysis are time-consuming processes and that immediate feedback of study results will not be possible.

In order to indicate your consent to participate in this study, please send a letter to Terese M. Lynch, R.N., Neonatal Outreach Coordinator, granting permission for review of charts of back transported infants. This permission is required by the University of Utah Review Committee for Research with Human Subjects.

We sincerely hope that you will continue to support the research efforts of the Division of Neonatology of UUMC. Participation in this study may result in improved communication between hospitals within the intermountain region, improved implementation of plans for regionalization of care, and improved utilization of neonatal beds.

Director, Medical Records Department
Date

Page 3

If you have any questions or reservations about participating in this study, please feel free to call me at (801) 581-7113 or 581-7052. Thank you for your cooperation.

Sincerely,

Terese M. Lynch, R.N.
Neonatal Outreach Coordinator

August L. Jung, M.D.
Director, Division of Neonatology

ALJ:lkh

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