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Comparing Nursing Costs for Preterm Infants Receiving Conventional vs. Developmental Care

Executive Summary

- The incremental costs incurred by VLBW (less than 1,500 grams) infants during the first year of life accounted for one-third of the $11.4 billion spent in the U.S. on health care.
- Developmental care for VLBW infants focuses on light and noise management, coordination of interventions to minimize sleep interruptions, and positioning/bundling the infant to prevent disorganizaiton and promote self-regulation.
- When compared to 60 VLBW infants receiving conventional NICU care, improved physiologic stability measures and fewer days in the NICU were recorded for the 60 VLBW infants cared for by nurses and trained developmental care specialists.
- Because the move from the NICU to the transitional unit occurred earlier for the developmental group of VLBW infants, and their nursing intensity needs were lower, the average cost savings achieved for this group was $4,340 per infant during the first 35 days of life or less if discharged.

THERE ARE increasing expectations and requirements from consumers, health professionals, communities, and funding agencies for detailed information about the costs of health care. The need to reduce expenses while maintaining or improving service is a challenge for all health care providers. More than ever before, the quality and cost of care must be justified through processes such as benchmarking comparisons and utilization monitoring. Reporting clinical outcomes must be accompanied with some form of economic evaluation to provide sufficient information for making decisions about the effectiveness and efficiency of treatment programs.

Lewit, Schuurmann-Baker, Corman, and Shiono (1995) suggested that although there is concern about the costs of health care, thorough economic evaluations have not been conducted. Further, the authors noted that when costs of health care are reported, the methodology for determining these costs has not been rigorous. For example, Lewit et al. reported that the financial impact of hospitalization for preterm infants has historically been established by subtracting the costs associated with treating normal birth weight infants from the costs of treating premature infants. While this approach provides the cost differ-

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ence between two groups, it does not provide a meaningful comparison about the appropriateness of this difference. Further, the costs of health care for preterm infants are affected by their severity of illness and complexity of care, neither of which are relevant for normal newborns. Given the magnitude of the costs to treat this population, a comprehensive economic evaluation is required.

The purpose of this article is to compare the costs of nursing care for preterm infants when two different approaches to care are provided. A methodology for determining nursing costs for infants receiving "conventional" versus "developmental" care in a neonatal intensive care unit (NICU) will be presented. Information about infant severity of illness and complexity of care will be included in the economic evaluation.

Review of the Literature

Approximately 11% of infants are born prematurely each year (Als, 1996). Lewit et al. (1995) reported that in 1988, of the children in the United States less than 15 years of age, approximately 4 million infants were low birth weight (LBW) (between 1,500 and 2,500 grams) and very low birth weight (VLBW) (less than 1,500 grams). The authors also noted that in the United States, the incremental costs incurred by VLBW infants during the first year of life ($4 billion) accounted for one-third of the estimated $11.4 billion spent on health care (incremental costs are costs beyond those incurred by normal birth weight infants). For VLBW infants, the high costs of health care are being questioned in relation to the effectiveness of hospital treatment and the potential long-term burden of illness on society (Als, 1996; Lewit et al., 1995; Petryshen & Stevens, 1995; Stevens, Petryshen, Hawkins, Smith & Taylor, 1997; Stevens, Petryshen, & Smith, 1995; Shiono & Behrman, 1995).

Developmentally sensitive care for preterm infants was introduced in the early 1980s (Als et al., 1986; Als, Lester, Tronick, & Brazelton, 1982). However, it has only been since the early 1990s that this approach has been adopted across North America. Developmental care differs from conventional care in that it involves an individualized approach to caregiving, such as coordinating clinical interventions to prevent frequent interruptions during infant sleep and positioning/bundling the infant to prevent disorganization and promote self-regulation (Als, 1992; Als et al., 1986; Als et al., 1994; Als et al., 1982; Grunwald & Becker, 1991). Also, the environment is structured such that light and noise levels are reduced (Als et al., 1982). Als et al. (1994) reported that infants receiving developmental care, when compared to infants receiving conventional care, had significantly less severe lung disease, fewer bleeds in the brain, and an improved weight gain. Als (1996) later reported that infants receiving developmental care had a reduced length of hospital stay and health care costs that were less per infant by approximately $90,000.

Before the introduction of developmental care, Boyle, Torrance, Sinclair, and Horwood (1983) reported that for infants weighing 1,000 to 1,499 grams, the cost of health care was $59,500 per survivor (in Canadian dollars, 1978). For infants weighing 500 to 999 grams, the cost of health care was $102,500 per survivor (in Canadian dollars, 1978). Lewit et al. (1995) took the costs of VLBW infant care reported by Boyle et al. (1983) and reported the incremental costs for these infants at the 1978 U.S. exchange rate inflated to 1988 costs using the health care component of the gross domestic product deflator. The authors reported that the total costs of care for infants less than 1,000 grams were almost three times higher than the costs for VLBW infants greater than 1,000 grams ($33,900 U.S. ver. $11,900 U.S., respectively). The authors also reported that infants with birth weights between 1,000 and 2,500 grams without respiratory distress syndrome were, on average, six times as costly as infants of normal birth weight ($11,900 U.S. versus $1,900 U.S., respectively). Although Boyle et al. (1983) provided important information to begin to understand the costs for VLBW infant care, clarification is required about how the costs were obtained and what type of economic evaluation was used.

Fleisher et al. (1995) randomly assigned infants (n = 40) with birth weights less than 1,250 grams to a control group (traditional care) or a treatment group (developmentally orientated care plans). The investigators found that infants in the treatment group required fewer days of intermittent mandatory ventilation and continuous positive airway pressure, and achieved full enteral feeds sooner. As well, these infants achieved a lower level of acuity and thereby obtained a lower nurse-to-patient ratio and a consequent reduction in total nursing charges. Also, these infants had fewer days in hospital and their charges for care were less. There were six infants in the control group whose charges for care exceeded $600,000 each; only one infant in the treatment group accrued such high charges (charges for care did not include physician fees or the fees for providing developmental assessments). The investigators reported an average reduction of charges of $128,670 per treatment patient; and that for 17 infants in the treatment group, the charges for care were $2,187,390 less than the charges for the same number of infants in the control group. To fully understand the relevance of the findings reported by Fleisher et al., clarification is required about the difference between charges versus costs; how the charges were determined and over what period of time (pre and postdischarge); and what method

Table 1.
Mean Scores for Gestational Age, Weight, Head Circumference, and Infant Stability for Conventional (n = 61) and Developmental (n = 63) Care Groups at Birth

Demographic Variable	GROUP		t	p
	Conventional Care	Developmental Care		
Gestational Age (weeks)				
M	28.43	28.56	-0.36	.73
SD	(2.38)	(1.73)		
n	61	63		
Weight (grams)				
M	1078.36	1140.40	-1.62	.11
SD	(224.41)	(201.64)		
n	61	63		
Head Circumference (cm)				
M	26.07	26.58	-1.50	.14
SD	(1.88)	(1.72)		
n	51	62		
Infant Stability (PSI)				
M	17.25	16.21	0.78	.44
SD	(7.07)	(7.81)		
n	61	63		

of economic evaluation was used.

Establishing the costs of health care has received considerable attention over the past 10 years. The emergence of national classification systems, for example, case-mix groups (CMGs) in Canada and diagnosis-related groups (DRGs) in the United States, have provided a basis for government reimbursement of hospital costs for patient care (Botz, 1991). O'Brien-Pallas et al. (1995) and O'Brien-Pallas, Giovannetti, Peereboom, and Marton (1995) point out that CMGs are not good predictors of nurse resource use.

In Canada, the potential hospital funding for VLBW infants based on CMGs is adjusted for birth weight and length of stay (Botz, 1991). For example, CMG 625 (typical infants weighing less than 750 grams at birth with an average length of stay of 104.8 days) are assigned a resource intensity weight (RIW) of 24.0532 (Canadian Institute for Health Information, 1995) and a funding potential of approximately $73,000. CMG 626 (typical infants weighing between 750 and 999 grams at birth with an average length of stay of 74.9 days) have an RIW of 15.8196 and a funding potential of approximately $48,012. CMG 628 (typical infants weighing between 1,000 and 1,499 grams with an average length of stay of 42.2 days) have an RIW of 7.6898 and a funding potential of $23,338. (This potential funding was determined based on the CMG peer hospital costs for the study hospital, as presented later in this article.) If the actual cost of care is beyond this funding potential, the result is that the hospital is in a deficit budget. Because CMGs are not adjusted for complexity of care, they do not explain variability in costs due to severity of illness. Thus, it is necessary to also measure severity of illness to explain patient-specific cost variances.

O'Brien-Pallas et al. (1995) reported that because hospitals are not able to provide detailed costs of care, nursing workload measurement systems (NWMS) are being used to determine estimates of labor costs which are patient specific (for example, hours of nursing care required/provided). The authors stated that in the nursing research, there is evidence that nursing hours and nursing costs per CMG show significant variability. Therefore, understanding the relationship between CMGs and patient-specific costs (as determined by nursing workload measurements) is important when conducting a full economic evaluation.

Purpose

The objective of this economic evaluation was to compare the cost minimization and cost benefit of two treatment approaches for treating VLBW infants. The cost-minimization evaluation compared the costs for conventional versus developmental care to determine which approach cost less when accounting for infant severity of illness (physiologic stability). The cost-benefit evaluation compared the costs of conventional versus

Table 2.
Actual Direct and Indirect Nursing Costs Per Day for Infants Receiving NICU Acute and Transitional Care

NICU - Acute Care			
Classification	**Direct Nursing Costs**	**Indirect Nursing Costs**	**Total Costs**
Type VI	$1042	$729	$1773
Type V	$796	$485	$1281
Type IV	$521	$362	$887
Type III	$348	$242	$590
Type II	$283	$197	$480
Type I	N/A	N/A	N/A
NICU - Transitional Care			
Classification	**Direct Nursing Costs**	**Indirect Nursing Costs**	**Total Costs**
Type VI	N/A	N/A	N/A
Type V	$542	$348	$890
Type IV	$419	$267	$686
Type III	$275	$175	$450
Type II	$184	$118	$302
Type I	N/A	N/A	N/A

NOTE: For the N/As, none of the infants in the study received this classification, therefore no corresponding nursing costs were available.

developmental care to determine differences in resource use according to patient complexity of care (required hours of nursing care).

Method

Although the study method is briefly described below, further details about the setting, characteristics of the sample and sample-size estimation, data collection procedures, and data reduction/management, are described in the article by Stevens et al. (1997).

Sample

The research for this economic evaluation was conducted at the Mount Sinai Hospital (MSH), Toronto, Canada, a university-affiliated institution with a 50-bed NICU (30 acute and 20 transitional beds). The criterion for including infants into the study was a birth weight between 750 and 1,500 grams and appropriate weight for gestational age at birth. Infants with chromosomal and/or other major genetic anomalies, and/or congenital infections were excluded. In the case of multiple births, the first born was entered into the study. All infants in the study were born at the hospital. At MSH, the process for documenting nursing workload is automated (MEDICUS Systems Corporation, 1990) and interfaces with an automated costing system (Transition Systems Inc., 1985) which, in turn, enables detailed information about patient-specific nursing costs to be obtained.

A comparison of the infants in the conventional and developmental care groups according to gestational age, weight, and head circumference revealed no significant differences between the groups at birth (see Table 1) (Stevens et al., 1997).

Design

The conventional care group (n = 61) received traditional care which included primary nursing, standardized care plans, and unadjusted noise and lighting levels. Data for the conventional care group were collected over an 8-month period before implementing developmental care (Stevens et al., 1997).

Developmental care was implemented over a 3-month period; data were collected over the next 8-month period (Stevens et al., 1997). This care included: (a) providing the infant with physical supports and aids for self-regulation, (b) ensuring time-out for infant stabilization following periods of stress, (c) clustering caregiving activities, (d) containing the infant's limbs to reduce random movement and provide support against gravity, (e) placing the infant in a flexed position, and (f) providing pacifiers (Als, 1992; Als et al., 1982). The developmental care group (n = 63) received care from nurses and trained developmental care specialists. The infants also had individu-

Table 3.
Mean Scores on PSI by Care Group and Day

Demographic Variable	GROUP		t	p
	Conventional Care	Developmental Care		
Admission				
M	17.25	16.21	0.78	.44
SD	(7.07)	(7.81)		
n	61	63		
Day 7				
M	13.82	12.03	1.25	.22
SD	(7.60)	(8.29)		
n	61	63		
Day 14				
M	13.32	11.09	1.52	.13
SD	(7.95)	(7.54)		
n	56	56		
Day 21				
M	12.43	11.74	0.43	.67
SD	(8.05)	(8.02)		
n	51	50		
Day 28				
M	12.14	9.68	1.42	.16
SD	(7.92)	(8.24)		
n	44	44		
Day 35				
M	9.49	10.00	-0.30	.77
SD	(7.66)	(7.61)		
n	39	39		

NOTE 1: Higher scores on the PSI indicate greater infant instability.

NOTE 2: From "Developmental versus Conventional Care: A Comparison of Clinical Outcomes for Very Low Birth Weight Infants," by B. Stevens, P. Petryshen, J. Hawkins, B. Smith, and P. Taylor, *Canadian Journal of Nursing Research, 28*(4), p. 196. Copyright 1977 by McGill University, School of Nursing. Reprinted with permission.

alized care plans with developmental interventions; lighting and noise levels were reduced.

Data Collection

The NWMS (MEDICUS Systems Corporation, 1990) and the costing system (Transition Systems Inc., 1985) provided patient-specific nursing workload data and costs of nursing care for each day of the infant's hospitalization. The first 35 days of hospital stay were included in the study because they represented the most costly days of care for VLBW infants. Also, these infants were sometimes transferred to community hospitals after 5 weeks of hospitalization; thus, it seemed most relevant to use the first 35 days of hospitalization for this research.

For each hospital day until day 35, a measure of nursing workload, as determined by the infant's complexity of care, was generated by the NWMS. The nurse who was caring for the patient classified the infant each day at 1000 hours according to standardized workload indicators. Some examples of these indicators were: infant on a respirator (yes-no), infant tube fed (yes-no), infant receiving intravenous therapy (yes-no), and multi-system instability (yes-no) (MEDICUS Systems Corporation, 1990). For costing purposes, nursing products were defined for each of the standardized nursing workload indicators. The NWMS provided a daily classification of the infant's complexity of care (Level I = "least complex" to Level VI = "most complex"). Based on the patient's classification, the cost for each nursing workload product was determined according to the hours of nursing care required for that infant and the actual cost of nursing care. The cost of these required nursing hours of care was

Table 4.
Number of Days, on Average, in NICU Acute and Transitional Care for Conventional (n=61) and Developmental (n=63) Care Groups for Each Level of Nursing Workload Classification

	Care Groups	
	Conventional	Developmental
Nursing Workload Classification	Mean Number Days	Mean Number Days
NICU Acute Care		
Type V1	.24	.07
Type V	9.49	2.67
Type IV	12.57	15.91
Type III	2.22	2.14
Type II	.06	nil
Type I	nil	nil
Total	24.58	20.79
NICU Transitional Care		
Type V1	nil	.nil
Type V	.02	.02
Type IV	.08	.61
Type III	3.25	6.84
Type II	1.94	1.39
Type I	nil	nil
Total	5.29	8.86
Overall Length of Stay	29.87	29.65

determined by obtaining the actual salaries of the nurses (variable direct costs) and the actual salaries of support staff such as unit secretaries and the nursing unit administrator (fixed indirect costs) for each 24-hour day. This costing analysis was conducted using an automated costing system (Transition Systems Inc., 1985) (see Table 2).

The Physiologic Stability Index (PSI) (Georgieff, Mills, & Bhatt, 1989) was used to assess the level of infant physiologic stability (Stevens et al., 1997). The PSI was developed from data related to the infant's severity of illness collected from laboratory results, nursing notes, and medical record graphs. By quantifying physiologic stability, the PSI provided an overall assessment of the infant's severity of illness. Examples of PSI items include vital signs, oxygen saturation level, platelet counts, and test results for sodium, potassium, and creatinine levels. For this research, infant physiologic instability was measured using the PSI within 72 hours after the infant's birth and on hospital days 7, 14, 21, 28, and 35.

Results

For infant physiologic stability, the higher the PSI (Georgieff et al., 1989), the more unstable the infant (maximum score = 30). On average, infants in the conventional care group were more unstable, when compared to those in the developmental care group. The mean PSI and standard deviations for the conventional versus developmental care groups are reported in Table 3. This suggests that although the physiologic stability of the conventional and developmental care groups were not significantly different at birth, the developm[illegible] group was somewhat more [illegible] throughout the first 35 days of hospitalization (Stevens et al., 1997).

Although many of the infants were in hospital beyond the 35 days of the study, the average number of days in the study did not differ for the conventional (=29.87) and developmental (=29.65) care groups. However, the average number of days the conventional care group spent in the NICU receiving acute care (=24.58) differed from the average number of days the developmental care group spent in the NICU receiving acute care (=20.79) (see Table 4).

Because the conventional care group spent, on average, more days in the acute care NICU, the average nursing for infant care in the NICU was higher than the developmental care group (=$25,072 versus =$18,919, respectively) (see Table 5).

The decision to transfer an infant from the NICU to the transitional care unit occurred when [illegible] infant was classified as Type [illegible] (acute care) indicating that the infant was stable and no longer required intensive care. (In Table 4, there are no infants classified as Type II, infants were transferred to transitional care whereby they were then classified according to the workload indicators for this type of unit). The developmental care group spent more time in the transitional care unit than did the conventional care group (=8.86 and =5.29, respectively). When accounting for the overall costs, the developmental care group spent less time in the NICU acute care unit than did the conventional care group (= 20.79 and =24.58, respectively). The total NICU acute and transitional care costs for the developmental care group were lower than the conventional care group (=$22,853 vs. =$27,193, respectively). This difference demonstrates a cost-benefit for developmental care by an average of $4,340 per infant during the first 35 days of hospitalization or less if discharged.

Discussion

Changes in the costs of health care for VLBW infants may be the result of new clinical interventions, advances in technology, and shifts from cost estimates to actual charges for care (Lewit et al., 1995). It is important to recognize that this change from "cost estimates" to "actual charges" have occurred because of advanced computerized systems which use clinical and financial information to obtain the costs of health care. For example, automated information about staff scheduling and payroll is available to identify types of care providers and actual salaries to determine patient-specific costs. Also, automated NWMS provide an estimate of patient-specific complexity of care which justifies the required/provided hours of nursing care. This information can provide nurse administrators with valuable information for decision support.

Health care costs can be determined using different methodologies (Drummond, Stoddart, & Torrance, 1987). Various types of economic evaluations can be conducted: (a) *cost-minimization* analysis is the comparison of costs between two programs using outcome measures such as physiologic stability to determine which program yields better patient outcomes at the lowest cost; (b) *cost-effectiveness* analysis is the comparison of costs between two programs in relation to evaluating program objectives such as reduced morbidity rates; (c) *cost-utility* analysis is the comparison of costs between programs for long-term outcomes such as quality-adjusted life years; and (d) *cost-benefit* analysis is the comparison of costs between programs to measure more generic outcomes such as the average hours of care provided to patients (Goerre, 1994; Torrance, 1986).

This study attempted to conduct a partial economic evaluation using two approaches — a cost-minimization and cost-benefit analysis. For two clinical programs (conventional vs. developmental care), the relationship between nursing workload (required nursing hours based on complexity of care) and infant severity of illness (physiologic stability) was determined. During the first 35 days of NICU acute and transitional care, infants receiving developmental versus conventional care were more stable from a physiologic perspective. This has implications for the long-term neurological and physical development of these infants and their potential burden of illness on society. Further, the hours of nursing care were reduced which resulted in reduced costs, as explained by developmental care infants being classified as having lower complexity of care and increased physiologic stability. Based on the cost-benefit and cost-minimization analysis, the findings reported in this article support the implementation of developmental care for VLBW infants.

Table 5.
Costs of Nursing Care, on Average, for NICU Acute and Transitional Care Based on Costs for Workload Classification Levels [Table 2] and the Mean Number of Days at a Classification Level [Table 4] for Conventional (n=61) and Developmental (n=63) Care Infants During First 35 Days of Hospitalization

	Care Groups	
	Conventional	Developmental
Nursing Workload Classification Levels	Nursing Costs Based on Mean Number Days From Table 4	Nursing Costs Based on Mean Number Days From Table 4
NICU Acute Care		
Type V1	$ 426	$ 124
Type V	$12,157	$ 3,420
Type IV	$11,150	$14,112
Type III	$1,310	$1,262
TypeII	$29	nil
Type I	nil	nil
Total	$25,072	$18,919
NICU Transitional Care		
Type V1	nil	nil
Type V	$17	$18
Type IV	$55	$418
Type III	$1,463	$3,078
Type II	$586	$420
Type	nil	nil
Total	$2,120	$3,934
Total NICU Acute and Transitional Care Costs	$27,193	$22,853

THE TREND toward automated costing systems has increased the opportunity for nurse administrators to obtain detailed, patient-specific costs of care. However, this information alone does not provide a comprehensive economic evaluation. One of the major challenges to

Core staff would still exist in the inpatient, outpatient, and home health areas so not to disrupt care delivery. However, this restructuring allows nursing administrators the added flexibility for enhanced staffing during busy inpatient, outpatient, or home health census or floating staff when census declines. Staff nurses in these roles are given more job security because of their flexibility. The implementation of these roles also helps the hospitals prepare for the shift from inpatient care to outpatient and home health by creating a seamless organization.

A rural integrated delivery system could create a unified data base for evaluating patient outcomes. Patient profiles of each individual could be developed from hospital, emergency room, primary care, and home care data. Costs could be tracked more efficiently, critical pathways developed, and logical plans for addressing cost containment could be achieved over a broad and deep continuum of care.

For the rural hospital outlier group, expanding community-based interventions for high resource groups is paramount in containing costs. Examples of specific programs for the outlier group in this study could include an expansion of outpatient programs with oncology patients. For example, nurses could expand oncology programs to include intensive multifocal interventions for chemotherapy outpatients. The multidisciplinary oncology team such as nurses, pharmacists, and nutritionists, could offer outpatient support, medication, and dietary education with telephone service for additional questions when patients are at home. For smaller, rural hospitals, a chronic disease case manager could provide care and followup with teaching, support, and treatments.

In summary, further examination of the day outlier group and implementation of the rural integrated delivery system are essential for reducing hospital costs in the competitive health care market. Nurse administrators need to rethink traditional rural hospital-based nursing care delivery for the integrated delivery system. Nursing roles must become more flexible, and to span the continuum of care. Nursing case managers must not only identify day and cost outliers, but also create and use cost-effective interventions to decrease high resource use.$

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