

**Effectiveness of Systematic Care Management on
Length of Stay in Neonatal Care Units**

Abbreviated running header: Effectiveness of Systematic Care Management

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Condensation: An average six-day reduction in NICU (Neonatal Intensive Care Unit) length of stay (pro forma savings of between \$15,306 and \$24, 222 per hospitalization) was achieved by ParadigmHealth as compared to a severity matched sample of neonates from Milliman USA national database.

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Effectiveness of Systematic Care Management on NICU Length of Stay

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Objective: To evaluate the effectiveness of the Systematic Care ManagementSM system in reducing the length of stay of high-risk neonates

Study Design: A two-group, specialized management versus traditional management comparison designed was used, with the two groups matched on severity

Patients and Methods: 431 neonates representing a broad spectrum of clinical severity were managed by ParadigmHealth Corp using the Systematic Care ManagementSM - system. The overall outcome and length of stay in the NICU of this sample was compared to a sample of 169,646 neonates from the Milliman USA national database of neonates. The two samples were matched for severity using the All Patients Revised-Diagnostic Related Groups (APRDRG) classification system. The primary dependent measure of comparison was length of stay in the Neonatal Intensive Care Unit (NICU). The data were analyzed using a

ⁱ Authors have a financial interest in ParadigmHealth Corporation

paired t-test comparing the Paradigm managed to the Milliman USA national sample

Results: The results of the paired t-test revealed that the Paradigm LOS was 5.59 days, on average, lower than the Milliman USA national LOS for severity-matched neonates

Conclusions: These results suggest that the application of a systematic case management process can be effective in reducing costs without compromising the integrity of the overall clinical outcome for high-risk neonates.

The net cost of both preterm and problem related births has reached over \$5.6 billion per year. Payer organizations continue to search for ways to manage these costs more effectively. ParadigmHealth Corporation's Systematic Care ManagementSM is a process that provides economic savings, improved clinical results, and high levels of family, provider, and payer endorsement. This systematic process is both data and outcome driven and relies on clinical experts to apply a structured management approach. Results of over two years of applying this process to complex, high-risk neonates revealed that ParadigmHealth, when compared to a severity matched group of neonates using Milliman USA national data, was able to achieve a reduction in length of stay, on

an average of six days. Pro forma cost savings estimates average between \$15,306 and \$24,222 per hospital stay.

Key Words: outcomes, neonates, savings, systematic care management

Introduction

Medical care is increasing in cost and complexity in the United States. HCFA projects that national healthcare expenditures will reach \$2.3 trillion or 15.5% of GDP by 2008¹. The increases in cost and complexity are occurring in concert with major breakdowns in the organization and delivery of medical care. In addition, there is increased morbidity secondary to unnecessary, inadequate, inexpert or inefficient care. *A recent publication* by the Institute of Medicine concluded that, “research on the quality of care reveals a health care system that frequently falls short in its ability to translate knowledge into practice, and to apply new technology safely and appropriately”. The report further emphasizes a fragmented delivery system that lacks appropriate clinical and administrative information systems and stressed that fundamental reform of the healthcare delivery system was urgently required².

Past efforts to improve the healthcare system, such as peer review, capitation, utilization review, and other techniques have achieved limited results in improving quality and controlling rising medical care costs³. These methods are widely perceived to be too often heavy-handed, inefficient, disliked, and frequently simply inappropriate, by both patients and practitioners. While traditional methods may have slowed the long-term rise in costs, these current management methods may have achieved their limits.^{4,5} Health care costs are again rising at double-digit rates^{6,7}. Further, any such efforts that do not account for the complexity of many severe conditions or illnesses, can have unintended effects which increase morbidity and net costs.⁸

High-risk births, which are increasing in frequency and complexity, are among the leading conditions contributing to the rise in costs. National statistics reveal that the delivery rates of preterm and low birth weight (LBW) infants have been slowly increasing over the past 20 years⁹. These infants comprise the major percentage of Neonatal Intensive Care Unit (NICU) admissions. The increasing rates would have been expected to lead to an increase in neonatal mortality rates. However, continuing improvements in neonatal intensive care have served to consistently improve mortality rates across all birth weights¹⁰. It has been reported that, as early as 1990, the net cost (in excess of cost over that of normal birth) of both premature and problem related births had reached approximately \$5.6 billion per year – an estimated 3% of aggregate after tax corporate profits. The rapid advances in technologic capabilities are not only making the care of such high-risk births more expensive, but confound efforts to produce generally applicable guidelines for care.

Buoyed with this positive affirmation of improved mortality, the practitioners of neonatal intensive care have been somewhat sheltered from the cost-containment methods of Managed Care. It is believed, however, that, as with areas of adult intensive care, the delivery of neonatal intensive care remains below obtainable levels of basic safety, and customer value. Given the costly nature of care for these critically ill infants, payer organizations continue to search for ways to manage these costs more effectively.

ParadigmHealth Corporationⁱⁱ (PHC) has developed an integrated management structure to address these management issues. It is termed *Systematic Care Management*SM. (SCM) Preliminary descriptions of this process have been published^{11,12,13} The premise of this system is that by reliably promoting the most expert and most efficient care for these very complex babies, significant reductions in morbidity will occur, and that these will translate into reduced need for and reduced cost of NICU and subsequent care. The process is both data and outcome driven and relies on clinical experts to apply a structured management approach across all cases. The principles of this system are:

1. *The provision of clinical expertise to collaboratively assist in the care process.*

Founded on the view that the clinical complexities of care for high-risk neonates can only be adequately understood by clinicians who are expert in the field, Paradigm identifies and retains expert neonatologists, neonatal nurse practitioners, and neonatal nurses to work as a team in managing cases. These clinicians collect, analyze and interpret the data and work collaboratively with the attending physicians and nurses who are treating the infant to develop an effective and efficient care path. The Paradigm neonatal team also provides support, education and consultation to the parents of the infant to assure that they are fully apprised of the care being provided to their infants and to assist them in preparation for discharge home. They also provide support to the family during the critical initial period at home post

ⁱⁱ ParadigmHealth Corporation is a privately-held, for profit health care management company with corporate headquarters located in Concord, California

discharge from the NICU. On occasion, when clinically indicated, this core team is expanded to include pediatric surgeons, cardiologists or other subspecialties to consult with the Paradigm team to assure optimal outcome achievement.

2. *A data system that aggregates detailed relevant clinical and financial information to allow correlations of clinical conditions, medical management and financial and clinical outcomes.* The Paradigm database and data collection tools are crucial to the prediction and management process and the care path development necessary to achieve a successful outcome. The database has been built in collaboration with Milliman USA and is comprised, in combination, of approximately 320,000 neonatal cases from throughout the United States. The patients in the database include those managed by Paradigm as well as those not managed by Paradigm who are utilized for comparison purposes. The information included in the database ranges from discrete physiological measures to ICD-9 diagnosis and procedure codes, as well as detailed billed and paid NICU cost data.

3. *Structured management processes which assure reliable and efficient application of clinical knowledge and care across multiple and extended clinical settings and over prolonged periods of time.* These processes include: (a) the establishment of a specific outcome to be achieved in each case. For neonates, the outcome is successful discharge from the NICU with

a minimum of 30 days of stability within the home environment. (b) standardized data collection tools that are utilized for all cases, therefore, the same data are available across all cases irrespective of diagnoses and severity; (c) a proprietary Levels of Acuity system that is applied across all levels of severity of neonates. This system has five levels of care ranging from Extreme Care or ECMO(need to spell out completely?) to Continuing Care. It delineates the criteria that must be met for an infant to be assigned to a particular acuity level and also specifies the criteria the infant must achieve to move from one level of acuity to the next; (d) a standardized set of discharge criteria; and (e) a standard set of outcome achievement criteria, also applied consistently across all diagnoses and severity of neonates.

Hence through the use of expert clinicians who are able to collect, analyze and interpret the data, apply a systematic set of management principles and work in a collaborative and collegial manner with the families and treating clinicians of the high risk infants, Paradigm is able to efficiently achieve the desired clinical outcome of a more rapid safe discharge to home.

This report is the first analysis of this neonatal management system. It encompasses the most recent three years of PHC's experience with this population of high-risk births. The purpose of this paper is to demonstrate that the Systematic Care Management process is associated with significant reductions in the length of stay (LOS) of complex high-risk neonates during their initial NICU hospitalization.

Methods

Sample

Paradigm Sample. The Paradigm sample of cases was comprised of 431 infants referred to Paradigm from November, 1998 through May, 2001. These neonates represent a broad spectrum of clinical severity. Infants with either a birth weight of less than 2000 grams or infants greater than 2000 grams, but with significant congenital anomalies or other medically complex conditions comprised 80% of the sample.

Comparison Sample. The comparison sample used was the Milliman USA database. It is the most extensive national neonatal database currently available. Its principal underlying data source is the Healthcare Cost and Utilization Project (HCUP) database from the Agency for Healthcare Research and Quality. This nationwide inpatient sample (NIS) is the largest all-payer inpatient care database in the United States. It contains discharge data from approximately 7 million hospital stays, representing 1,000 hospitals located in 22 states, which is approximately a 20 per cent stratified sample of U.S. hospitals.

There is a total of 3,707,351 births in this sample and 318,249 NICU admits. For our study we used a sub-sample of 169,646 NICU admit sample, which were matched to our sample by All Patients Refined-Diagnostic Related Groups (APRDRG) classification. The frequency distribution of this sample by birth weight for both the Paradigm and

comparison samples is represented in Table 1. The two samples only included survivors.

Table 1 inserted here

The NIS data is supplemented by California data from the Office of Statewide Planning and Development (OSHPD). This database enhances the Milliman data sets by providing more clinical information and allowing for tracking of neonates who transferred from one acute facility to another in order to fully estimate the total length of stay associated with a given birth episode.

Measures

Length of Stay. The primary comparison measure was the length of stay in the newborn intensive care unit (NICU). Length of stay (LOS) was defined as Date of Discharge-Date of Admission.

Severity Risk Adjustment. In order for results of this comparison to be meaningful, it was critical that the two groups be severity risk adjusted. The methodology used by ParadigmHealth for risk assessment was the All Patients Refined Diagnostic Related Groups (APRDRG), Version 15.0 Classification system. The software was developed by 3M Health Information Systems and it is a significantly more sophisticated system than the DRG system which only has six categories for neonates. The software uses hospital patient discharge data (UB-92's) and computer-based logic

to assign patients to severity of illness and risk of mortality classes so that patients with the same classification can be accurately compared in terms of length of stay, resource consumption and outcomes. APR-DRG Version 15.0, the most recent version of the software is the most comprehensive and widely used patient classification system in existence. The APR-DRG system for neonates utilizes 33 primary diagnostic categories with four severity levels of each of these categories resulting in 132 APR-DRG categories or "groupers." For this study, not all of the 132 different categories were applicable as the neonates managed by Paradigm, to date, have primarily been the more complex cases. This study sample represented 81 of the categories. The primary groupers not included in this study were the severity 1 and 2 for most of the DRG's as well as the "not born here" and "organ transplant" categories. Table 2 displays the neonatal APR-DRGs.

Table 2 inserted here

Systematic Care Management SystemSM.

All infants reported on in this study underwent management using Paradigm's *Systematic Care Management System*SM. This process was discussed in detail in the introduction.

Data Analysis

The data were analyzed using two parametric approaches. The overall comparison of the Paradigm LOS to the Milliman USA national LOS, matched by severity using the APR-DRG patient classification system was done using a paired t-test analysis.

Results

The paired t-test analysis was performed by comparing each of the 81 different APR-DRG classifications. The results of the paired-t test revealed that the Paradigm LOS was 5.59 days, on average, lower than the Milliman USA national LOS for severity-matched neonates ($t=4.28$, $p < .0001$). The mean differences between the LOS reductions of the Paradigm and Milliman samples ranged from 0 to 22 days. For clarity of presentation, the multiple APRDRG categories were collapsed into birth weight groups. Table 3 summarizes the means for the two samples by birth weight and ECMO. The data are displayed graphically in Graph 1.

Table 3 inserted here (Comparison of Length of Stay by Birth Weight and ECMO)

Graph 1 inserted here (Variance from Milliman USA by Birth Weight Reduction in LOS Compared to Milliman USA)

A concern may be raised that the achievement of LOS reductions could be detrimental to the clinical quality of the outcomes. This could be evidenced by efficient discharges, but a higher than predicted number of readmissions. ParadigmHealth's outcome-based management process includes ongoing management for a minimum of 30 days after discharge from the NICU and if a readmission occurs, ParadigmHealth has a financial responsibility for that re-hospitalization. To confirm that ParadigmHealth achieved its reduction in LOS without sacrificing quality through re-hospitalizations, a comparison was made of the incidence of re-hospitalizations within the first 30 days post discharge from the NICU between ParadigmHealth and an APRDRG-matched sample. As the Milliman database did not include post discharge follow-up at 30 days, an alternative comparison sample was obtained from the OSHPD (spell out completely?) database managed by Dr. Phibbs at the Stanford office of the National Bureau of Economic Research. The results of the comparison of the severity matched groups revealed that there was no difference in the rate of re-admissions between the two groups. The percentage of re-admissions was 6% for both groups. While there were no differences in the rate of re-admissions, the average LOS of the Paradigm re-admissions was 1.6 days shorter than the comparison sample. This was probably due

to the fact that Paradigm was also accountable for the management of the re-admission as well.

Discussion

This report describes ParadigmHealth's systematic care management system. The results of this study indicate that the application of this system is associated with reductions in NICU lengths of stay for severity-matched neonates. The relatively small numbers of babies allow only tentative conclusions despite achieving statistical significance. The strength of the finding is supported, however, by the wide geographic spread of the population of neonates studied, which represents most regions of the continental United States, as well as the extended three year period over which the data were gathered. The results are also strengthened when contrasted with the general experience of increasing average lengths of stay (ALOS) as the number and survival of very low birth weight infants continues to increase.

Pro forma calculation of the reduced hospital charges associated with this reduction, using Milliman USA national data, indicates an average reduction of between \$15,306 and \$24,222. This reduction in particular is dramatic for the most complex of the neonates, those under 750 grams birth weight, who show a LOS reduction of 8 days with pro-forma savings of approximately \$36,790.

ParadigmHealth's Systematic Care ManagementSM is a process specifically designed to address the challenge of extremely complex medical problems. It has found acceptance and utility by providers, patients, and payers in a wide range of clinical conditions, including high-risk neonates. This analysis provides quantitative support that such management provides economic savings as well as suggests that clinical results are improved in the high-risk neonate population. This system achieves these desired goals while achieving very high levels of patient, provider and payer endorsement. Further experience and analysis is needed to confirm this finding.

Table 1

	Paradigm N=431	Milliman USA N=169,646
ECMO	5	177
< 750 grams	32	3,543
750-999 grams	43	6,234
1000-1499 grams	100	18,529
1500-1999 grams	111	38,608
2000-2499 grams	52	30,949
>2499 grams	88	71,606

Table 2

APR- DRG	DESCRIPTION	Severity Level			
		1	2	3	4
582	NEONATE, W ORGAN TRANSPLANT				
583	NEONATE, W ECMO				
590	NEONATE, BIRTHWT <750G W MAJOR PROCEDURE				
591	NEONATE. BIRTHWT <750G W/O MAJOR PROCEDURE				
592	NEONATE, BIRTHWT 750G-999G W MAJOR PROCEDURE				
593	NEONATE, BIRTHWT 750G-999G W/O MAJOR PROCEDURE				
600	NEONATE. BIRTHWT 1000-1499G W MAJOR PROCEDURE				
601	NEONATE, BIRTHWT 1000-1499G W MAJOR ANOM OR HEREDITARY CONDITION				
602	NEONATE, BIRTHWT 1000- 1499G W RESPIRATORY DISTRESS SYNDROME				
603	OTHER NEONATE, BIRTHWT 1000-1499G				
610	NEONATE, BIRTHWT 1500-1999G W MAJOR PROCEDURE				
611	NEONATE, BIRTHWT I 500-1999G W MAJOR ANOM On HEREDITARY CONDITION				
612	NEONATE. BIRTHWT 1500-1999G W RESPIRATORY DISTRESS SYNDROME				

Effectiveness of Systematic Care Management

APR- DRG	DESCRIPTION	Severity			
		Level			
613	NEONATE, BIRTHWT 1500-1999G W CONGENITAL OR PERINATAL INFECTIONS				
614	OTHER NEONATE, BIRTHWT 1500-1999G				
620	NEONATE, BIRTHWT 2000-2499G W MAJOR PROCEDURE				
621	NEONATE. BIRTHWT 2000-2499G W MAJOR ANOM OR HEREDITARY CONDITION				
622	NEONATE. BIRTHWT 2000-2499G W RESPIRATORY DISTRESS SYNDROME				
623	NEONATE, BIRTHWT 2000-2499G W CONGENITAL OR PERINATAL INFECTIONS				
624	NEONATE, BWT 2000-2499G NOT BORN HERE				
625	NEONATE, BIRTHWT 2000-2499G BORN HERE, W OTHER SIGNIF CONDITION				
626	NEONATE, BWT 2000-2499G, BORN HERE, NORMAL NB & NB W OTHER PROBLEMS				
630	NEONATE, BIRTHWT >2499G, W MAJOR CARDIOVASC PROCEDURE				
631	NEONATE, BIRTHWT >2499G W OTHER MAJOR PROCEDURE				
632	NEONATE, BIRTHWT >2499G W OTHER PROCEDURE				

Effectiveness of Systematic Care Management

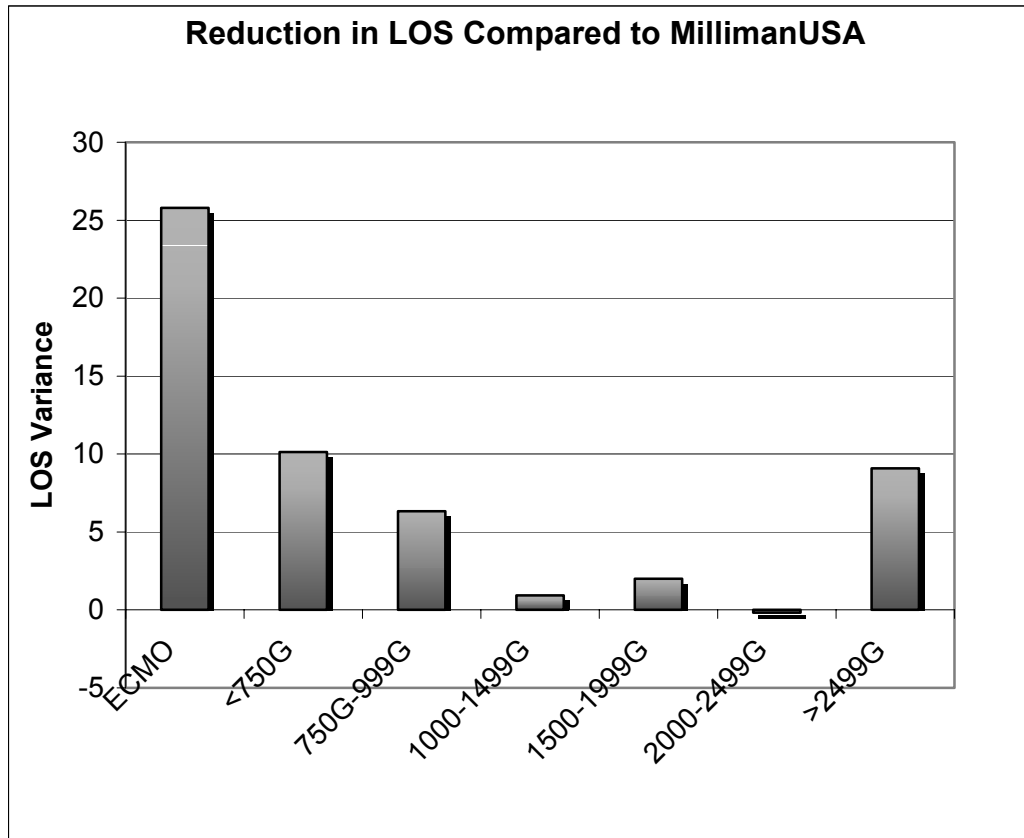
633	NEONATE. BIRTHWT >2499G W MAJOR ANOMALY OR HEREDITARY CONDITION				
634	NEONATE, BIRTHWT >2499G W RESPIRATORY DISTRESS SYNDROME				
635	NEONATE. BIRTHWT 2-2499G W ASPIRATION SYNDROME				
636	NEONATE. BIRTHWT >2499G W CONGENITAL/PERI NATAL INFECTIONS				
637	NEONATE, BWT >2499G NOT BORN HERE, PDX OTHER SIGNIF CONDITION				
638	NEONATE. BIRTHWT >2499G, NOT BORN HERE. PDX OTHER PROBLEM				
639	NEONATE. BIRTHWT >2499G, BORN HERE. W OTHER SIGNIF CONDITION				
640	NEONATE, BWT >2499G, BORN HERE, NORMAL NB & NB W OTHER PROBLEMS				

Table 3

Comparison of Length of Stay by Birth weight & ECMO

	Paradigm	Milliman USA
ECMO	51.40	77.20
< 750 grams	103.13	113.25
750-999 grams	81.65	87.98
1000-1499 grams	49.02	49.96
1500-1999 grams	24.31	26.31
2000-2499 grams	18.90	18.73
>2500 grams	22.83	31.92

Graph 1



¹ See <http://www.hcfa.gov/stats/NHE-proj/>.

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