DATA ANALYSIS OF THE BENEFITS OF AN ELECTRONIC REGISTRY OF INFORMATION IN A NEONATAL INTENSIVE CARE UNIT IN GREECE

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Abstract

Objectives: This study assesses the results of implementation of a software program that allows for input of admission/discharge summary data (including cost) in a neonatal intensive care unit (NICU) in Greece

, based on the establishment of a baseline statistical database for infants treated in a NICU and the statistical analysis of epidemiological and resource utilization data thus collected.

Methods: A software tool was designed, developed, and implemented between April 2004 and March 2005 in the NICU of the LITO private maternity hospital in Athens, Greece, to allow for the first time for step-by-step collection and management of summary treatment data. Data collected over this period were subsequently analyzed using defined indicators as a basis to extract results related to treatment options, treatment duration, and relative resource utilization.

Results and discussion: Data for 499 babies were entered in the tool and processed. Information on medical costs (e. g., mean total cost ± SD of treatment was €310.44 ± 249.17 and €6704.27 ± 4079.53 for babies weighing more than 2,500 g and 1,000–1,500 g respectively), incidence of complications or disease (e. g., 4.3 percent and 14.3 percent of study babies weighing 1,000 to 1,500 g suffered from cerebral bleeding and bronchopulmonary dysplasia, respectively, while overall 6.0 percent had microbial infections), and medical statistics (e. g., perinatal mortality was 6.8 percent) was obtained in a quick and robust manner.

Conclusions: The software tool allowed for collection and analysis of data traditionally maintained in paper medical records in the NICU with greater ease and accuracy. Data codification and analysis led to significant findings at the epidemiological, medical resource utilization, and respective hospital cost levels that allowed comparisons with literature findings for the first time in Greece. The tool thus contributed to a clearer understanding of treatment practices in the NICU and set the baseline for the assessment of the impact of future interventions at the policy or hospital level.

Key words: newborn, NICU, data management, statistical analysis, software

Introduction

Birth registries maintain useful information on the number of births and perinatal morbidity and mortality in addition to providing an overview of resource utilization from the perspective of the

health care system as a whole. Such data aid the definition of specific hospital procedures (both medical and administrative) and health policy initiatives that contribute to comprehensive, safe, and effective clinical treatment of newborns while at the same time allowing for robust estimation of the quality, effectiveness, and even cost-effectiveness of services provided in neonatal intensive care units (NICUs). Such implications become increasingly important in the light of the ever-growing sensitivity of healthcare systems toward resource consumption in the hospital setting as well as the

need for the provision of services of high quality to patients in need.[1]

In the case of premature infants treated in an intensive care unit (ICU), the availability of detailed archives is of vital importance. Two studies evaluated the causes of medication errors in NICUs and

identified a broad range of errors that affect high-risk neonates.[2,3] Data also suggest that newborn infants are more likely to experience adverse reactions than adults and that infections are associated

with high mortality among neonates.[4-6] The use of computerized hospital records may potentially reduce medical errors and improve the cost-effectiveness of treatments by revealing the

relationship between severity of illness and resource consumption in the ICU setting.[7-9] Nonetheless, the implementation of a system of detailed records and the analysis of such records are both time-consuming and difficult. User-friendly software that facilitates data entry by the NICU medical and nursing staff and evaluation of economic data in parallel with statistical analysis could be a powerful tool for ensuring precise and effective interventions in this patient group. Moreover, such tools could provide useful information for parents and caregivers of hospitalized neonates.

This study recorded the outcomes of the introduction of a computerized system for registering births and treatment data in a NICU, where all relevant data were previously maintained in paper records, in order to assess the impact on the ease and accuracy of data entry as well as the availability of statistical analyses over a one-year period. The study took place in the NICU of the LITO private maternity hospital in Athens, Greece.

Methods

In order to assess the prevalence, type, and treatment of premature neonates hospitalized in the LITO private maternity hospital, a comprehensive software program was designed that would capture all relevant data in an electronic patient record format that would in turn allow for the definition of treatment options and the calculation of total resource utilization per case.

The programming language as well as the design and development details of the software tool were approved by the scientific committee of the hospital. The software tool was developed using Visual dBase, with the minimum hardware requirements as follows: CPU: Celeron; RAM: 256 MB; HD: 500 MB free; operating system: Windows 98, 2000, or XP.

Demographic and clinical data of patients admitted into the NICU of the LITO maternity hospital

between April 1, 2004, and March 31, 2005, were loaded into the software. Data were inputted and analyzed for 499 newborn children, and the cost for their hospitalization was calculated. First-time users of the program were timed while inputting data for 100 newborns at the beginning and end of the one-year study period (at which point they were characterized as experienced users), and the time required to input data was compared. Data entry was closely monitored and assessed by computer scientists so that further improvements to the program could be made in accordance with feedback from the clinicians.

For each patient record, the software collected

(a) demographical and epidemiological data related to the mother;
(b) epidemiological data related to the premature neonate (prevalence of condition or conditions, treatment requirements, etc.) ; and
(c) resource utilization data (treatment and hospitalization cost), which were validated against data maintained in separate records at the finance department.

The tool consisted of basic, easy-to-follow steps that allowed for the capturing of relevant epidemiological and resource utilization data:

(a) The application requested a security access code. Each user had unique access codes (username and password) to ensure privacy of data.
(b) The user entered data related to the mother, including information about her clinical and personal history (see Figure 1). The user selected options, where appropriate, from drop-down menus or created new entries.
(c) The user entered data on the diagnoses and health conditions of the infant. The specific diagnosis or diagnoses could be selected from the archive of diagnoses available from the programs database (see Figure 2). Each selected diagnosis was automatically saved.
(d) Information pertaining to a neonatal group of potential interest could be selected by pressing the summarized printing button. When the analytical printing option was selected, a detailed report including individual data from each neonate could also be printed. All relevant details could be summarized in a comprehensive form (see Figure 3).
(e) Resource utilization data were entered in the relevant fields. These fields were defined in cooperation with the finance department and reflected the total cost of treatment that was charged to the family or payer (insurance fund) for the duration of the treatment of the infant. The cost was broken down to specific cost centers in order to fully reflect resource utilization according to the clinical condition of each infant.

Statistical analyses used unpaired *t*-tests for the comparison of means and x^2 tests for the comparison of percentages. Spearman correlation coefficients were calculated for selected variables. Significance was defined as *p* <. 05.

Results

Over the one-year study period, the data assembled and analyzed through the use of the software tool indicated a perinatal mortality rate of 6.8 percent. The infants in the study had been treated at normal (Level I), intermediate (Level II), and intensive-care nursery (Level III) levels as shown in Table 1. The demographic characteristics of the mothers were also entered into the software (see Table 2).

Twenty-nine percent of the babies were born at a gestational age of greater than 37 weeks. Table 3 depicts the number of infants in each of the four different categories according to their birth weights. For each weight category, the mean length of stay, the mean cost, and the most important complications were recorded (see Table 4).

Fourteen percent of the mothers had undergone in vitro fertilization. This corresponds to 72 newborn infants, of whom 16.6 percent (12 newborns) were singletons, 61.1 percent (44 newborns) were twins, and 22.3 percent (16 newborns) were triplets or quadruplets. Their mean birth weight was 1924 ± 481.8 g, and their mean gestational age was 34 ± 3 weeks. Level III nursery care was provided for 62.5 percent of the babies, and the rest received lower levels of nursery care.

As expected, both the gestational age at delivery and the birth weight decreased as the number of fetuses increased, that is, with twin or greater gestation. The cost of treatment was high when the baby suffered respiratory complications. In the category of birth weights from 1,000 to 1,499 g at Level III, bronchopulmonary dysplasia inflicted 14.3 percent of the babies.

In the category of birth weight less than 1,000 g, there were only 13 infants, eight of whom died between the first and fourth day, while the other five were transferred to other state hospitals because of financial considerations. The duration of stay and the mean cost for babies in this category apply only to the babies that passed away while in the LITO intensive care unit.

Bronchopulmonary dysplasia and cerebral bleeding inflicted 14.3 percent and 4.3 percent of babies weighing between 1,000 and 1,499 g, while the respective percentages reported by Lemons et al.

were 15 percent and 14.5 percent. [10]

The data also confirmed that twin or greater gestation, diabetes, and rupture of membranes for more than 18 hours are significantly correlated with the length of stay (see Table 5).

No significant correlation was found between birth weight and maternal smoking, p =. 778. This, however, may not be an accurate finding as only 40 mothers (8 percent) smoked during pregnancy, making the sample too small to allow for a valid conclusion. The mean weight of the babies whose mothers smoked before and during pregnancy was 2629 ± 651.3 g, their mean gestational age was 37 ± 3 weeks (range 31–40 weeks), and the mean duration of their stay in the ICU was 8 ± 5.3 days.

Finally, data were collected on costs incurred for each category of babies and compared with the

available literature. [11, 12] The mean total cost of treatment was calculated at €310.44 ± 249.17 and €6704.27 ± 4079.53 for babies weighing more than 2,500 g and 1,000–1,500 g, respectively. The study also concluded that when a babys weight is under 1,500 g, the cost for treatment and care is 60 percent higher than when the baby weighs between 1,500 and 2,499 g and 130 percent higher than the cost for a baby weighing more than 2,500 g.

Discussion and Conclusion

The importance of computerized data management to increase safety and efficacy in an ICU for premature neonates has been fully realized over the past decades. The electronic documentation of several procedures for neonates, such as parenteral nutrition in the ICU, has been referred to in the literature. [13, 14] The establishment of a monitoring system allows for outcome research as well as for management of information. [15] Calculated yearly statistical outcomes have been shown to be very important for the protection of future neonates and for the optimization of the function of an ICU. The availability of this information allows clinicians to minimize mistakes and reevaluate current clinical practices. Such analysis has become increasingly important as numbers of live births registered in most industrialized nations have remained relatively stable in recent years, but the incidence of preterm birth and low birth weight is increasing. [16]

Over the past two years a software program that combines fast report generation and a capacity for simple statistical analyses was developed and used to collect, store, and analyze data of newborns treated in all three levels of the intensive care unit of the LITO maternity hospital. Over this period the software tool enabled the breakdown of data by types of patients, different diagnoses, operations performed, and any medical or surgical complications incurred.

Data collected and managed through the tool revealed that babies weighing between 1,000 and 1,500 g who were treated in the NICU of the LITO maternity hospital suffered fewer complications than would be expected based on reports in the literature. Findings on twin or greater gestation, diabetes, and rupture of membranes of greater than 18 hours are in line with previous studies. [17] The length of stay in the NICU was shorter than that reported elsewhere, where the mean length of stay was 40 days. [18] The mean cost of hospitalization was lower than the one reported in the United States, where the mean cost amounted to USD 1,100, and approximately equal to costs estimated from a meta-analysis of 15 studies in the United Kingdom (mean cost of GBP 225). [19, 20]

Users credited the tool with harmonizing and codifying the documentation of various diseases and treatment pathways of premature infants. The software tool thus simplified the registration process for all employees involved, as they had to select from previously defined options. It also allowed for automatic archiving of data as well as for automatic retrieval of data to prepare statistical reports.

Complete and accurate summaries of all admissions could be prepared at the time of a babys discharge or upon request. At the service provision level, the program offered an overview of the efficacy of clinical practices, as treatment pathways could be recorded in full and compared against best-practice guidelines. The production of periodic reports of each departments and each practitioners activities offered a clearer understanding of currently established practices and initiated discussions at the administrative level to harmonize practices, define benchmarks for service quality and cost, and optimize efficiency.

This study evaluated the introduction for the first time in Greece of an electronic registry of information for premature infants. The software tool thus developed and implemented has the potential to assist all caregivers in NICU settings, as it allows for harmonized, codified collection of data on the treatment pathway of each infant as well as the systematic and consistent production of activity reports. Data thus stored and analyzed can be a useful tool for parents and can help hospital administrators, insurance companies, and government agencies to design health policy interventions that comply with best-practice guidelines.

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Notes

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