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ORIGINAL ARTICLE

Use of technology as an evaluation tool of clinical care in preterm newborns

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Abstract

Objective: To assess the use of the Neonatal Therapeutic Intervention Scoring System (NTISS) as a tool to quantify the use of technology in neonatal intensive care units, in order to detect discrepancies in the care provided to high-risk newborn infants.

Methods: Prospective, descriptive, observational study about the use of technology in two neonatal intensive care units (one public and one private). The NTISS was calculated on a daily basis up to the discharge or death of preterm newborns with gestational age equal to or less than 32 weeks. We gathered data about prenatal clinical conditions, birth characteristics, and conditions on admission to the intensive care unit, as well as about the morbidities developed during the hospital stay. The risks of preterm newborns were adjusted by means of the Score for Neonatal Acute Physiology, Perinatal Extension, Version II (SNAPPE-II). Student's *t* test, chi-square test, Fisher's exact test, and the Mann-Whitney/Wilcoxon's test were used for the descriptive analysis. The study was approved by the local Research and Ethics Committee.

Results: We assessed 44 newborn infants from the public intensive care unit and 52 from the private one. On admission, the severity score (SNAPPE-II) and the overall NTISS were statistically similar in both care units. The curve for the use of technology showed a gradual and progressive decreasing pattern in both care units up to the 31st day. Thereafter, there was a continuous downward trend in the private care unit, but a significant increase in the overall NTISS in the public care unit. The patients from the public care unit developed more morbidities than those from the private unit.

Conclusion: Patients with similar clinical pictures can be treated with different levels of technological resources. This may have a direct impact on morbidities and on healthcare costs. The NTISS allowed monitoring healthcare and proved efficient in detecting discrepancies in practices that could influence clinical outcomes and operating costs.

J Pediatr (Rio J). 2006;82(5):371-6: Severity scores, use of technology, evaluation of clinical practices, preterm newborns, intensive care.

Introduction

In the last few decades, the healthcare provided in neonatal intensive care units (NICU) has remarkably changed, especially due to the use of new technologies, contributing to an increase in the survival of preterm newborns (NB) that are too small for gestational age and have very low birth weight.[1]

Simultaneously, healthcare practices in the NICU have been constantly submitted to evaluations, being widely described in the national and international literature. This shows a concern with methods that should allow well-founded clinical and administrative decisions so as to improve the quality of healthcare in neonatology, especially with regard to the implementation of several complex technologies and their impact on clinical outcomes and on operating costs.[2-8]

The technologies used in critically ill preterm NB demand a great amount of financial resources. Given the economic hardships experienced by developing countries, public and private managers, after analyzing the

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expenditures with neonatal care, have opted to cut down on these costs by enhancing the appropriate use and allocation of available resources, without preventing better results from being obtained.

However, neonatal intensive care has characteristics that are specific to its structure, process, and results, which require a standardized tool that includes all the processes involved in the provision of healthcare to high-risk NB for the assessment of discrepancies in healthcare practices.[9,10]

In this regard, the Neonatal Therapeutic Intervention Scoring System (NTISS) can be used as an efficient indicator of the use of technology. This scoring system assesses the following healthcare parameters: respiratory, monitoring, cardiovascular, drug therapy, metabolic/nutrition, procedural, transfusion and vascular access.[11]

The aim of this study is to assess the use of the NTISS to detect discrepancies in the clinical care provided to preterm NB admitted to NICUs.

Material and methods

A prospective, descriptive observational study was carried out from January to August 2004 in order to assess the use of technology in two NICUs (one public and one private). The NTISS was used as a tool to gauge the amount of technology used, and was calculated on a daily basis by the same researcher, from the time of NICU admission to the discharge or death of the NB.

The study included all preterm NB admitted to the NICU whose gestational age was equal to or less than 32 weeks. We chose NB within this gestational age range because of the severity of their condition and also because their clinical care requires the use of several technologies available in the NICU.

The exclusion criteria were the following: birth weight less than 500 grams, multiple congenital malformations, genetic syndromes, and deaths within less than 24 hours after admission.

The selection of the care units was based on similar characteristics regarding their organization and availability of advanced diagnostic and therapeutic technologies. The units have the same technical committee and are referral centers for the qualification and training of healthcare workers.

One of the units is public, whereas the other one is privately owned. The public NICU has 26 beds, with approximately 15 admissions/year/bed, whereas the private unit has 35 beds, with around 14 admissions/year/bed.

In both units, we collected information about prenatal conditions, clinical characteristics related to birth, data about NICU admission, and information about morbidities developed by NB during their hospital stay. Risk adjustment was made by means of the Score for Neonatal Acute Physiology, Perinatal Extension, Version II (SNAPPE-II),[12] which was applied within the first 12 hours of NICU admission.

In this study, we analyzed the overall NTISS score and its categories up to the 42nd day of hospital stay. We decided for this length of analysis because it represents the average time NB stay in the NICU.

We carried out a prospective observational study. Since this was a descriptive analysis, we did not calculate the sample size previously. The descriptive data analysis was made using SPSS version 12.[13] A 5% level of significance was established for Student's *t* test, chi-square test, Fisher's exact test and the Mann-Whitney/Wilcoxon's test. However, we used Kolmogorov-Smirnov nonparametric test to compare the curves for use of technology (overall NTISS) in the analyzed units, supposing that the observations of each sample are independent of one another.

To assess the evolutionary behavior of the use of technology (overall NTISS) and its categories during the NICU stay, we used mean values instead of the median, since the curves for use of technology obtained through the mean were smoother, thus allowing a better assessment.

A formal consent was obtained from the clinical management board of the investigated units, and the study was approved by the Research Ethics Committee of Instituto Fernandes Figueira (protocol 063/03).

Results

Ninety-six NB were recruited during the study period. Of these, 44 were admitted to the public NICU and 52 to the private NICU. Except for maternal age, there was no statistically significant difference between demographic and prenatal characteristics of the NB in any of the care units. On admission, the severity-of-illness score (SNAPPE-II) and other clinical characteristics of the NB were similar in both units. Nevertheless, in the public care unit, the one-minute Apgar score was significantly lower and the incidence of small-for-gestational-age newborns was higher. Mortality rate did not differ between the analyzed groups (Table 1).

Initial severity of illness and the overall score for use of technology (overall NTISS) on admission were similar in both units. However, on their first day, the NB admitted to the public NICU had a larger use of technology in the cardiovascular and metabolic/nutrition categories of the NTISS than those admitted to the private NICU (Table 2).

The curve for use of technology, according to the mean daily value for the overall NTISS, showed a gradual and

progressive downward trend up to the 31st day in both units. Thereafter, the curves for use of technology began to differ between the care units. Whereas the downward trend persisted in the private NICU, there was a significant increase in the overall use of technology in the public NICU (Figure 1). The Kolmogorov-Smirnov test revealed a statistically significant difference ($p < 0.001$) between the curves when we considered the observations of each unit to be independent of each other.

The same curve patterns were observed in the respiratory, drug therapy, and metabolic/nutrition categories of the NTISS. In the respiratory category, the curves for use of technology had already shown different tendencies between the analyzed units from the first week of admission.

In an attempt to clarify the differences in the curves for use of technology after the 31st day of NICU stay, we assessed demographic, prenatal, and clinical

Table 1 - Characteristics of newborns admitted to the NICUs analyzed

Variables	Public NICU (n = 44)	Private NICU (n = 52)	p
Demographic			
Maternal age *	23 (14-41)	34 (15-44)	< 0.01
Born in the NICU (n)	42	44	0.10
Prenatal			
PROM (n)	18	23	0.74
HDP (n)	14	14	0.60
Antenatal corticosteroids (n)	34	38	0.63
Infection (n)	22	21	0.34
C-section (n)	29	40	0.23
Clinical			
Birth weight (g) *	1,255 (510-2,130)	1,390 (600-2,200)	0.15
Ballard score (weeks) *	31 (24-31)	31 (25-32)	0.20
Male gender (n)	27	22	0.07
Twin pregnancy (n)	15	16	0.83
SGA (n)	12	4	0,01
SNAPPE-II *	9 (0-75)	8 (0-54)	0.24
One-minute Apgar score *	5 (1-9)	7 (1-9)	0.03
Five-minute Apgar score *	9 (2-9)	8 (6-10)	0.34
Deaths	6	3	0.29

PROM = premature rupture of membranes; HDP = hypertensive disorder of pregnancy; SGA = small for gestational age; SNAPPE-II = Score for Neonatal Acute Physiology, Perinatal Extension, Version II.
* Median values (minimum, maximum) and statistical significance for the Mann-Whitney/Wilcoxon's test.

Table 2 - Overall NTISS and its categories on NICU admission

NTISS	Public NICU (n = 44)			Private NICU (n = 52)			p*
	Mean	Median	Range	Mean	Median	Range	
Total	15.18	14.5	8 - 27	13.19	12.5	8 - 24	0.15
Respiratory	4.25	4.5	0 - 25	3.38	2	0 - 6	0.65
Drug therapy	1.54	2	1 - 2	1.57	2	1 – 2	0.65
Metabolic/nutrition	0.91	1	0 - 3	0.63	0	0 - 4	0.03
Monitoring	6.77	7	5 - 8	6.65	7	4 – 8	0.37
Cardiovascular	0.86	0	0 - 3	0.35	0	0 - 3	0.03
Transfusion	0.05	0	0 - 2	0	0	0 - 0	0.27
Procedural	0.05	0	0 - 2	0.08	0	0 - 2	0.66
Vascular access	2.02	1	1 - 5	1.52	1	0 - 4	0.23

NTISS = Neonatal Therapeutic Intervention Scoring System.
* Mann-Whitney/Wilcoxon's test.

characteristics of the NB who were still hospitalized in the units on that day.

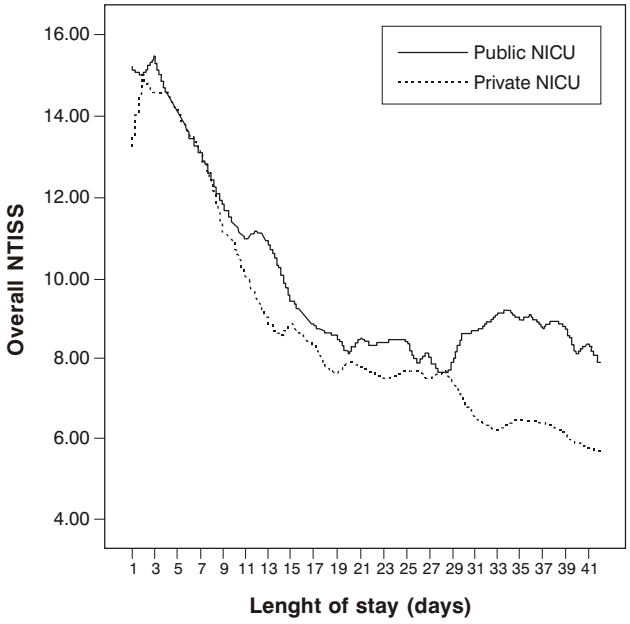

Figure 1 - Mean daily values for use of technology obtained through the overall NTISS
NICU = neonatal intensive care unit; NTISS = Neonatal Therapeutic Intervention Scoring System.

Among the patients who were still in the public NICU on the 31st day, there was a male predominance and a large number of small-for-gestational-age newborns. In addition, birth weight and the one-minute Apgar score were lower than those of NB in the private NICU. Although this subgroup of NB had similar severity scores on admission in both units, the overall NTISS was higher on admission of NB to the public NICU than for those in the private NICU (Table 3).

The subgroup of patients in the public NICU developed more morbidities, such as hypoglycemia, pneumothorax and bronchopulmonary dysplasia, during their hospital stay, than those in the private NICU (Table 3).

The NB who were discharged from either unit before the 30th day did not differ in terms of gestational age, birth weight, SNAPPE-II and overall NTISS on admission.

In the study period, mortality was similar between the care units (p = 0.29).

Discussion

The growing demand for neonatal intensive care and the lack of beds and of available resources justify the investigation of discrepancies in clinical practices.

Due to its diversity and complexity, the cost of intensive care of very low birth weight preterm newborns is extremely

Table 3 - Characteristics of newborns on the 31st day of NICU stay

Variables	Public NICU (n = 24)	Private NICU (n = 38)	p
Demographic			
Maternal age (years) *	22	32	0.06
Clinical			
Male gender (n) †	18	11	< 0.01
Birth weight (g) *	1,085	1,317	< 0.01
Ballard score (weeks) *	31	31	0.50
SGA (n) †	10	4	0.02
One-minute Apgar score *	4	7	0.03
Five-minute Apgar score *	8	8	0.35
SNAPPE-II *	20	8	0.07
Overall NTISS on admission *	17.5	13.5	0.00
Overall NTISS on the 31st day *	8	6	0.01
Morbidities			
Hypoglycemia (n) †	7	1	< 0.01‡
Pneumothorax (n) †	3	0	0.02‡
Bronchopulmonary dysplasia (n) †	11	4	< 0.01
Retinopathy of prematurity (n) †	9	6	0.05
Suspected sepsis (n) †	19	21	0.05
Death (n) †	1	0	0.38‡
Length of stay (days) *	55	47	0.08

NTISS = Neonatal Therapeutic Intervention Scoring System; SGA = small for gestational age; SNAPPE-II = Score for Neonatal Acute Physiology, Perinatal Extension, Version II.
* Mann-Whitney/Wilcoxon's test.
† Chi-square test.
‡ Fisher's exact test.

high, something around US$ 1,500 to US$ 1,700 a day.[14] In case of developing countries, where the conditions for use of technology are not usually ideal, it is necessary to assess clinical practices so as to detect elements that may be later improved either clinically or administratively.

Very low birth weight NB tend to be more severely ill, as birth weight less than 1,500 g is a great risk factor for mortality and morbidity among NB. The profile of a public NICU, with a lower one-minute Apgar score than in the private unit, indicates possible problems in the delivery room. Speculation about this finding includes from primary apnea to the arguable use of the Apgar score in preterm NB, due to its characteristic reduction in muscle tone. Other risk factors, such as younger maternal age, higher incidence of small-for-gestational-age newborns and male predominance, were observed in the public NICU.[15]

Severity scores are important predictors of clinical outcomes.[11,16,17] In this study, the severity score on admission, measured by the SNAPPE-II, and mortality rate were similar in both units. However, use of technology showed different mean values on admission and on the 31st day of NICU stay.

Georgief et al.[18] were the first to explore the possibility of adapting the Therapeutic Intervention Scoring System (TISS), used in the intensive care of adults, and the Physiology Stability Index (PSI), used in pediatric intensive care, to evaluate healthcare in the NICU. Gray et al.[11] modified the TISS and the PSI and applied them as a new evaluation method in 1,643 NB admitted to three NICUs. The authors showed that the NTISS was significantly associated with estimates of clinical outcome, of risk of death, and of prediction of high healthcare costs with NB in the NICU.

Since high-risk NB are critically ill on NICU admission, the use of several technologies is expected. With time, as the clinical status improves, these technologies are gradually withdrawn.

The results of our study confirm this finding. The use of technology, which is initially high, gradually decreases in both NICUs during the first month. After that, NB in the public NICU require significantly more use of technology than those in the private NICU.

When observing NB who were still in the public NICU after the 31st day, we noted that they had significantly more morbidities (hypoglycemia, pneumothorax and bronchopulmonary dysplasia) than those in the private NICU.

According to Sinclair,[5] to understand the effectiveness of technology, one should not take only clinical outcomes into account, but also partial outcomes resulting from the therapeutic process. The higher incidence of morbidities can be regarded as a critical point for the tendency to use more technological resources in the respiratory, drug therapy, and metabolic/nutrition categories of the NTISS observed in the healthcare provided in the public NICU.

One of the major reasons for the use of respiratory technologies concerns apnea of prematurity, but the greater possibility of use of this category of the NTISS by the public NICU can also be explained by other diseases or concomitant intercurrent events, whose etiology can be related to other factors than prematurity alone. The higher incidence of bronchopulmonary dysplasia among NB in this NICU may have been influenced in part by the significant increase in the use of respiratory technologies by these patients during their hospital stay.

The larger number of small-for-gestational-age newborns, the clinical consequences of adverse effects (e.g.: pneumothorax and hypoglycemia), as well as the more frequent use of drugs such as xanthines, diuretics, antibiotics, and intravenous nutrition, may have contributed to the increment observed in the curve for use of technology regarding the drug therapy and metabolic/nutrition categories of the NTISS in the public NICU (Table 2). Although the larger use of technologies did not influence the length of stay in the public NICU, it certainly contributes towards increasing healthcare costs.[14]

In Rio de Janeiro, neonatal intensive care is provided by public and private institutions. NB born in public hospitals and who require intensive care may stay in the hospital of origin or be transferred to private hospitals accredited by the State Department of Health. In this study, regardless of the place of birth, the NB admitted to the analyzed NICUs showed the same severity of illness on admission; however, they had a different clinical outcome. The NTISS demonstrated sensitivity in this regard.

Despite the small number of analyzed cases, the results of this study are important to the diagnosis of the quality of healthcare provided by the analyzed NICUs, regardless of their insertion in the Brazilian health system. The curves for use of technology obtained by the systematic use of the NTISS allow monitoring healthcare processes, optimizing resource allocation, and defining the best way to improve the quality of care in neonatal units.[19]

The present study is a groundbreaking work in our setting, using the NTISS as a tool to determine use of technology, and thus allowing for the comparison of healthcare practices in NICUs.

Our results suggest that the regular monitoring of the use of technology (NTISS) can detect discrepancies in healthcare practices that may influence clinical outcomes and operating costs.

The importance of the systematic application of the NTISS lies in providing an opportunity to reassess healthcare in the NICU and to optimize resource allocation for the treatment of high-risk NB.

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