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SCORING SYSTEMS IN PAEDIATRIC INTENSIVE CARE UNITS

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Summary

Scoring systems in medicine serve to estimate the severity of disease. In this way, it is possible to equalize the characteristics of patients being treated in different departments and in different health care institutions. In paediatric intensive care units (PICUs), groups of patients differ significantly in relation to age and diagnostic groups, and patient mortality is generally low. PICUs use several scoring systems based on physiological indicators, and scoring the severity of injury involves anatomical characteristics of the injury. Application of scoring systems in PICUs is of particular importance because only their use allows for systematic patient monitoring and comparison of results between different departments.

Keywords: scoring systems; children; intensive care.

INTRODUCTION

The purpose of scoring systems for determining the severity of disease is to enable objective, accurate, comparable and reliable measurements of the severity of disease. Scoring systems measure the clinical condition of a patient, which is otherwise difficult to specify in other subjective or objective ways. They are particularly useful in intensive care units, where the severity of diseases and mortality is very diverse and subjective assessment of the clinical condition of patients is unreliable (1).

Development of a successful scoring system requires clear, easily determinable and significant outcome indicators, compliance with well-defined methodological standards and special needs. There are three general criteria for judging the clinical system: reliability, data needs, and validity. Verification of data reliability is achieved by checking the reliability of one observer (explorer's repeat measurements) and checking the reliability of multiple observers (by measuring a person other than the investigator him/herself), (2). The need for data should, as far as possible, be based on regularly used indicators, especially when the system is applied to large populations. Clinical systems should be acceptable for medical professionals and consistent with follow-up of clinical thinking. Apgar Score or Glasgow Coma Scale are broadly accepted precisely because they "make sense" (3). The longest test of a system is external evaluation. This means applying the scoring system to another population, other than the one in which the system is developed.

Clinical scoring can be applied to patient populations or to patients individually. Functional comparison refers to efficacy of different methods, techniques or treatment procedures applied to patients suffering from the same disease (e.g. comparison of length of hospital treatment), (1). Clinical systems can be used to compare the severity of the disease among the investigated and control groups of patients (4). If there is no control group, the examined group of patients can be compared to the patient sample that served for the creation of this scoring system (5).

Standardized mortality ratio is the ratio of the observed mortality and predicted mortality calculated by using the chosen scoring system. Predicted mortality shows what the result would be if the investigated group of patients was treated the same way used in the departments where the model came about. If the standardized mortality rate is less than 1.00 this means that the results of the surveyed populations are better than expected. A standardized mortality ratio of more than 1.00 means that results are worse than expected.

The variable we want to foresee has only two values: death and survival. Discrimination determines the ability of a system to separate a group of patients who will survive from the one who will die. Calibration is a comparison of the expected number of deaths with the observed number of deaths within ten mortality groups. In order to perform an equation describing the relationship between predictor variables (such as pH or arterial blood pressure and mortality), we use logical regression analysis (Receiver Operating Characteristic Curve, ROC). ROC surface below the curve shows the discriminatory ability of the model, sensitivity and specificity of each individual value obtained by the model calculation. A surface of 1.00 shows the model's perfection, whereas a surface of 0.50 appears to be completely random. An area of 0.70-0.79 is acceptable, 0.80-0.89 is good, and 0.90 and higher is excellent. The ROC curve does not show how the model predicts mortality for the less sick in relation to the worse sick patients. The Hodmer-Lemeshow test serves to estimate the calibrating ability of the model. The results of the predicted mortality are divided into ten groups. Within each group the number of predicted deaths is compared with the number of really deceased, and the predicted number of survivors with real survivors. When the standardized mortality ratio is significantly different from 1.00 then the p value will be less than 0.05. This finding shows that quality of treatment in the investigated department is worse than the quality of treatment in the departments where the model was derived. More important than p is a similarity of predicted and observed number of deaths in all ten groups (6).

PAEDIATRIC INTENSIVE CARE MORTALITY SCORING SYSTEMS

Paediatric Risk of Mortality III (PRISM III), the third generation of the aforementioned scoring system, is the most widely used scoring system for seriously ill children in PICUs in the United States. PRISM III was generated from PRISM by classifying and analysing data of 11,165 patients from 32 intensive care units in the United States. After evaluating the limits of physiological indicators, mortality estimates can be done by using 14 indicators collected within the first 12 hours, or within the first 24 hours. PRISM III is the first scoring system protected by licences and patents. Such a process has sparked a lot of questions about appropriation of ownership of tools used in health care research (7).

The second most commonly used scoring system in PICUs is the Paediatric Index of Mortality (PIM). The model was developed by researching data on 5,695 children treated in PICUs in Australia and the UK (8). The incentives to create a PIM were multiple. Firstly, a large number of data are needed to calculate a PRISM score. Most intensive care units do not regularly collect this information. The worst indicators within the first 24 hours can actually diagnose a patient's death, thus wiping the difference in quality across departments. For PIM, only eight data, collected within the first hour of admitting the patient, are needed. In contrast to PRISM, the data used for PIM will not be affected by the quality of the initial treatment. A newer version, PIM 2, was created based on analysis of data for 2,529 patients from 14 PICUs in Australia, New Zealand and the UK. The incentive to create a PIM2 system was the need to modernize the relationship between physiological indicators and outcomes, due to the improvement of treatment procedures (9).

Several studies have been published in which the accuracy of mortality predicted by PRISM and PIM systems has been checked and compared. In children after cardiac surgery treatment and in children treated for meningococcal infection, the results were similar. Both systems, PRISM and PIM, have accurately predicted mortality. PRISM was more sensitive, and PIM more specific (10,11). Five studies have been carried out in groups of patients with mixed diagnoses. The first of these studies, conducted on a population of 1,182 children treated in seven PICUs in Australia and one in the UK, showed that PRISM predicted a 66% higher mortality than PIM (8). This is explained by the difference in the PICU structures in Australia and the US. In Australia, PICUs are centralized and most children are treated in one of only eight such departments. A study involving 928 children showed similarity between the PRISM and PIM discriminatory ability. The calibration capability was poor and the mortality rate in the middle-degree risk groups was too high (12). In a population of 303 children both calibration and discrimination features of PRISM III and PIM systems were similar. The predicted risk of mortality was underestimated in the low risk group (1% to 5%) and overestimated in patients with very high risk (≥ 30%), (13). Ten PICUs from Australia and New Zealand participated in the most extensive research on the ability to predict mortality of existing paediatric systems. Comparison of results showed that PRISM III has the best ability to discriminate between survival and death. Standardized mortality rate was highest for PIM2 (0.97), and three systems overestimated the observed mortality: PRISM (189%), PRISM III (130%), and PIM (116%). Calibration capability of the system in decile groups of mortality risk showed the best settings for PIM2 (17.53), then PIM (36.41), PRISM III (89.10) and PRISM (446.56). Mortality predicted by the PIM2 system is closest to the diagonal line of equality between the observed and predicted mortality (14).

INJURY SEVERITY SCORING SYSTEMS

Injury severity scoring systems are divided into two groups. In the first group are the systems that facilitate delivery of patients to hospital care. These systems are simple because of the need for rapid implementation. Other scoring systems more precisely measure severity of injury and serve for predicting mortality. Data that is recorded is often complex and cannot be obtained at the site of injury. Data used to calculate the severity of injury can be demographic (e.g. age), physiological indicators (e.g. arterial pressure) and anatomical findings (e.g. body part laceration), (15).

Glasgow Coma Scale (GCS) is the most often used and best-known system for assessing severity of injury (16). The GCS system's validity has been tested in many studies. Initially, GCS served for longitudinal monitoring of the severity of consciousness disorders. It has been applied in different populations of patients, where positive relationship of GCS findings with mortality and functional outcome has been proven. The original GCS is not applicable to children, primarily because of inadequate verbal response assessment. Therefore, the paediatric GCS is used in children, which is a version of the original GCS adapted to childhood. (17). The reliability of the GCS findings can fluctuate, depending on the age of the child and the speech expression ability, in addition to the sedative effect of the intubated patient. A GCS evaluated on the department better predicts severity of injury than a GCS calculated at the site of injury, and the motor response finding most accurately predicts outcome (18, 19). The Abbreviated Injury Scale (AIS) is an anatomic scoring system that measures severity of injuries by scores from one to five injuries in five body regions (20). The Injury Severity Score (ISS) is based on AIS and serves to show total severity of the patient's injury (21). Namely each injury affects the final outcome, death or survival of the patient. In addition, AIS injury calculations show an exponential effect on mortality risk. For these reasons, ISS calculates the sum of the squares of the three most seriously injured regions, estimated by weighting the severity of the AIS injury. ISS is commonly used in injured children because it credibly expresses severity of the injury (22).

OUR EXPERIENCE

University Hospital Split is a public, university-affiliated hospital that serves a population of approximately 1,000,000 people from Southern Croatia. The Paediatric Department has 120 beds, with an average of 3,100 admissions per year, and a separate NICU, where inborn patients are treated. The PICU is a 7-bed, multidisciplinary unit with additional three step-down beds, where children who need chronic ventilation are monitored. The unit admits all children from newborns up to and including 18 years of age. All medical and surgical patients, and newborns transported from outside of Split, are admitted to the unit. With the exception of extracorporeal membrane oxygenation, all other modes of management are available in the unit, including conventional ventilation, high-frequency oscillatory ventilation, NO therapy, peritoneal dialysis, venovenous hemodiafiltration, and invasive pressure monitoring.

Between June 2002 and July 2004, data was obtained prospectively from 591 consecutively admitted patients aged ≤ 18 years, but excluding preterm infants. Demographic data, such as age, gender, need for ventilator support and length of stay, were collected. Parameters for determination of the Paediatric Index of Mortality (PIM2) score were recorded during the first hour of admission, and mortality risk for each patient was calculated according to the equations developed and published by the PIM Study Group (9). Each patient's principle reason for PICU admission was recorded as one of 6 diagnostic categories, in accordance with the Australia and New Zealand Paediatric Intensive Care Registry (ANZPIC Registry) of diagnostic codes (8). In spite of a relatively small patient sample, both calibration assessed by the Hosmer-Lemeshow goodness of fit test and predictive power for PIM2 expressed as area under the ROC curve, were satisfactory. This was the first published evaluation of PIM2 in Europe (23). Models of scoring systems that predict risk of death are designed on mixed patient populations that can vary substantially among institutions. We conducted a study that showed that system accuracy is significantly weaker when the system is applied to smaller and homogeneous groups of patients (24). Injuries are the main cause of death and common cause of disability during childhood. The results of our study showed that children with head injuries and children from road traffic accidents had significantly worse health-related quality of life (HRQL) than other injured children. HRQL correlated significantly with GCS, but not with ISS and PIM2 (25). Children with chronic health conditions form a high share of paediatric morbidity in the contemporary world, and a significant part of children treated in PICU (26). We have shown that the most endangered group of children are those with neurodevelopmental illnesses, although the severity of their clinical condition expressed by PIM2 on admission did not differ significantly from other patients (27). The actual mortality rates in PICUs in published studies differ substantially among departments (28). Furthermore, the differences in the severity of diseases and the structure of patients are considerable among PICUs, so the observed mortality rates can vary widely (29).

CONCLUSION

Quality of treatment for life-endangered patients depends on the institution. Various treatments are used in different institutions for patients with a similar clinical condition. Differences in the outcome of treatment due to various applied procedures are the subject of intensive research, including government agencies funded by healthcare institutions.

The simplest outcome indicator of the quality of the department's work is the observed death rate. The observed mortality is a rough and unreliable indicator of the quality of the department's work. Namely, death in PICUs is relatively rare and mortality is generally less than 10%, which is too small for comparison among institutions. Trustworthiness of benchmarking among departments is enabled with the application of systems that score alterations of physiological functions or anatomical damages of ill and injured patients and predict mortality of groups of patients treated in those departments. Scoring systems reveal the effect of differences in treatment procedures in relation to outcome and thus point to the best procedures. This approach provides the most efficient allocation of resources in relation to the desired effects of treatment, while avoiding endangering therapies.

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Sažetak

Bodovni sustavi u jedinicama intenzivnog liječenja djece

Bodovni sustavi u medicni služe procjeni težine bolesti. Na taj način moguće je ujednačiti značajke bolesnika koji se liječe na različitim odjelima i u različitim zdravstvenim ustanovama. U jedinicama intenzivnog liječenja djece skupine bolesnika se bitno razlikuju u odnosu na dob i dijagnostičke skupine, a smrtnost bolesnika je općenito mala. U jedinicama intenzivnog liječenja djece se koristi nekoliko bodovnih sustava koji se temelje na pokazateljima fizioloških pokazatelja, a bodovanje težine ozljede uključuje anatomske karakteristike ozljede. Primjena bodovnih sustava u jedinicama djece osobito je važna, jer samo njihova primjena omogućava sustavni nadzor bolesnika i usporedbu rezultata između različitih odjela.

Ključne riječi: bodovni sustavi; djeca; intenzivno liječenje.

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