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Using Score for Neonatal Acute Physiology Perinatal Extension II (SNAPPE II) in Neonates with Acute Kidney Injury

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Abstract

BACKGROUND: Acute kidney injury is a severe clinical condition. It is common in neonates in intensive care unit. It is defined as a sudden deterioration in kidney function resulting in derangements in fluid balance, electrolytes, and waste products. The score for neonatal acute physiology perinatal extension in critically sick neonates with kidney injury is a useful tool for assessing the severity of the disease.

AIM: This study aimed to determine the incidence of AKI and the role of SNAPPE 2 score in predicting mortality and morbidity of kidney injury in neonates.

METHODS: The study was designed as a prospective clinical investigation performed in the period of three years, which included 100 neonates (50 with AKI and 50 without AKI) hospitalised in intensive care unit of University Clinic of Children Diseases in Skopje. The severity of the illness of hospitalised newborn infants was estimated with SNAPPE 2 score realised in the first 12 hours of admission to NICU. Medical data records of admitted neonates with AKI were analysed. The material was statistically processed using methods of descriptive statistics.

RESULTS: During the study period, 770 new born's were hospitalised in the intensive care unit due to various pathological conditions and 50 new born's were selected with AKI. The control group consisted of 50 neonates with comparable associated pathological conditions, but without kidney injury. The calculated prevalence of AKI in neonates was 6.4%. Most of the involved neonates in the study in both groups (AKI and non-AKI) were born at term (64% and 54%) with a predominance of male neonates (68% and 60%). The mortality rate was significantly higher in newborns with AKI than in the control group (36% vs 24%) ($p < 0.01$). The mean SNAPPE 2 score value in neonates with AKI was higher than in the control group (58.72 vs 40.0), and the difference was significant ($p = 0.00001$). Difficult score level predominated in half (50%) of newborn infants with AKI, while median score level predominated in control group (42%). There was a significant difference between the mean score value in neonates with AKI and lethal outcome compared to neonates with AKI without lethal outcome (70.73 ± 18.6 vs 40.2 ± 16.6) ($p < 0.0001$).

CONCLUSION: Acute kidney injury is a life-threatening condition with still high mortality rate. The severity of the illness of hospitalised neonates in an intensive care unit is estimated by SNAPPE 2 score. Also, the risk of mortality is estimated too, taking into consideration the fact that higher values of the score are associated with higher mortality. Appropriate treatment of neonates with severe kidney injury improves the outcome and reduces the mortality of the disease.

Introduction

Acute kidney injury (AKI) is a severe clinical condition. It is common in neonates in an intensive care unit (NICU). It is defined as a sudden deterioration in kidney function resulting in derangements in fluid balance, electrolytes, and waste products.

The diagnosis of AKI is based on a rise of serum creatinine (sCr) and urine output of fewer than 1.0 ml/kg/h. Serum creatinine has different value in neonates because of the presence of maternal creatinine, lower glomerular filtration rate (GFR) and differences in maturation [1], [2], [3], [4], [5], [6], [7], [8].

The incidence of kidney injury in children is significantly lower than in adults except in neonates where it occurs in 8 to 24% with mortality rates between 10% and 61% [9], [10].

Predisposing factors associated with acute kidney injury in neonates are certain clinical conditions such as asphyxia, sepsis, prematurity, meconium plaque syndrome, congenital heart diseases, invasive procedures and some nephrotoxic drugs. Appropriate

treatment of associated comorbidities, limited use of nephrotoxic drugs reduces the risk of kidney injury in neonates hospitalised in the intensive care unit [8], [9], [10], [11], [12].

The scoring system in critically sick neonates with kidney injury is used as a tool for predicting morbidity and mortality of the disease. It assesses the severity of the disease concerning the levels of deviation from normal physiology through the evaluation of numerous physical and laboratory tests. The most commonly used scoring system is Score for Neonatal Acute Physiology Perinatal Extension II (SNAPPE 2 score). It can predict the outcomes in critically ill newborns. It was developed by Ridsrtson in 1993 as an index for the severity of the disease. It is performed within the first 24 hours of admission of newborns to NICU and contains 34 clinical tests and vital signs. In 2001 Rittersson simplified the score by creating a second generation of SNAPPE 2 score containing 6 physiological parameters and 3 parameters for assessing perinatal mortality [13].

SNAPPE 2 is a useful tool for assessing the severity of the disease that correlates with neonatal mortality in intensive care units. A higher level than 40 is associated with a higher mortality rate. The parameters associated with perfusion as a mean arterial pressure and acidosis are significantly associated with greater organ dysfunction and higher mortality [14], [15], [16].

This study aimed to determine the incidence of AKI and the role of SNAPPE 2 score in predicting mortality and morbidity of kidney injury in neonates.

Methods

The study was designed as a prospective, clinical, epidemiological investigation performed in three years, which included 100 neonates (50 with AKI and 50 without AKI) hospitalised in NICU of University Clinic of Children Diseases in Skopje.

Criteria for inclusion in the study were: neonates up to 28 days of postnatal age; neonates treated in NICU due to certain pathological condition with or without the development of kidney injury. AKI was defined by elevated serum creatinine (> 130 μmol/L in neonates younger than 33 weeks and > 90 μmol/L in neonates older than 33 weeks) and the presence of oliguria (less than 1.0 ml/kg/h). According to our criteria, all neonates who were older than 28 days of age, who had less than 24 hours of hospitalisation and neonates who had cardio-surgical interventions were excluded from the study.

Medical data records of admitted neonates with AKI were analysed. The neonates were analyzed according to gender, birth weight, and gestational age. The laboratory examinations of serum creatinine values were done in the biochemical laboratory of the Clinic of Children Diseases using Kodak camera dry biochemistry. The severity of the illness of hospitalised neonates was estimated with SNAPPE 2 score realised in the first 12 hours of hospitalisation to NICU. Also, the risk of mortality was estimated, taking into account the fact that higher values of the score are associated with a higher mortality rate. Table 1 shows the examined variables in SNAPPE 2 score.

Table 1: Score systems in NICU

SNAPPE	SNAPPE 2
arterial pressure	mean arterial pressure
cardiac frequency	temperature
respiratory rate	pO2 / FiO2
temperature	Ph. Blood
PCO2	convulsions
PO2 / FiO2	diuresis
PCO2	
leukocytes	
platelets	
urea in serum	
creatinine in serum	
diuresis 24 hours	
indirect bilirubin	
direct bilirubin	
sodium in serum	
potassium in serum	
calcium total	
calcium ionizing	
glycemia	
bicarbonate	
Ph. Blood	
convulsions	
apnea	

The material was statistically analysed using the methods of descriptive statistics. To determine the significance of differences in the parameters, the tests for independent samples were analysed. Statistical significance was determined for the values of $p < 0.05$.

Results

During the study period, 770 newborns were hospitalised in NICU due to various pathological conditions and 50 newborns were selected with AKI. The control group consisted of 50 neonates with comparable associated pathological conditions, but without kidney injury. The calculated prevalence of AKI in neonates was 6.4%. The mean gestational age of newborns with AKI was 37.42 ± 3.1 weeks and 36.26 ± 3.8 weeks in the control group. The mean birth weight of neonates with AKI was 2890.8 ± 898.1 grams, while in the control group was 2699.4 ± 894.6 grams.

Most of the involved neonates in both groups were born at term (64% and 54%) with a predominance of male (68% and 60%). Figure 1 and figure 2 show the distribution of neonates with AKI and non-AKI depending on age and gender.

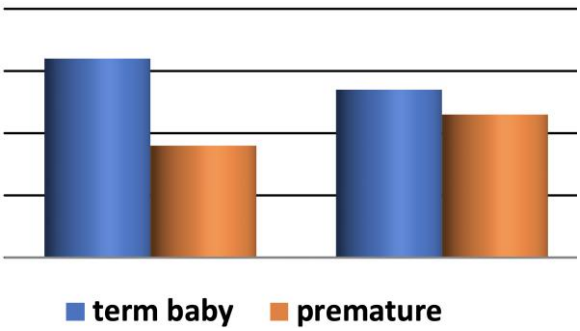

Figure 1: Distribution of newborns with AKI and Non-AKI depending on age

According to the outcomes of the disease, 18 neonates with AKI and 12 neonates of the control group had a lethal outcome. So, the mortality rate in neonates with AKI was 36%, while 24% in the control group. This difference was not statistically significant ($p < 0.01$).

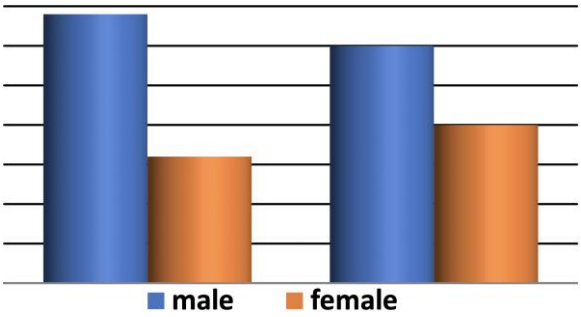

Figure 2: Distribution of newborns with AKI and Non-AKI depending on gender

All neonates were evaluated by SNAPPE 2 score within the first 12 hours of admission in the intensive care unit. The score values were analysed in 4 categories: light (score 1-20), medium (score 21-40), difficult (41-70) and very difficult (over 70). The results showed that the mean score value in neonates with AKI was 58.72 ± 20.4, while 40.0 ± 20.0 in the control group. The difference of 18.72 between AKI group and control group was confirmed as significant ($p = 0.00001$) (Table 2).

Table 2: Distribution of SNAPPE 2 score values in neonates in NICU

	AKI	Non-AKI	
Mean ± SD	58.72 ± 20.4	40.0 ± 20.0	T = 4.6
Min	29	8	P = 0.0000001
Max	97	78	

Table 3 shows the distribution of neonates with AKI depending on score levels compared to the control group. In half (50%) of neonates with AKI predominate difficult score level, while the median score level predominated in 42% neonates of the control group.

Table 3: Distribution of neonates with AKI depending on score levels compared to the control group

Score	AKI / Non-AKI	Mean ± SD	Min-Max
Light	AKI N = 0	0	0
	Non-AKI N = 8	14.0 ± 3.9	8-19
Medium	AKI N = 10	33.8 ± 3.3	29-38
	Non-AKI N = 21	28.7 ± 4.8	22-39
Difficult	AKI N = 25	52.24 ± 7	42-67
	Non-AKI N = 16	43.18 ± 5.8	38-52
Very difficult	AKI N = 15	86.13 ± 8.3	77-97
	Non-AK N = 5	81.6 ± 8.3	72-91

There was a significant difference between the mean score value in neonates with AKI and lethal outcome compared to newborn infants with AKI without lethal outcome (70.73 ± 18.6 vs 40.2 ± 16.6) ($p < 0.0001$) (Figure 3).

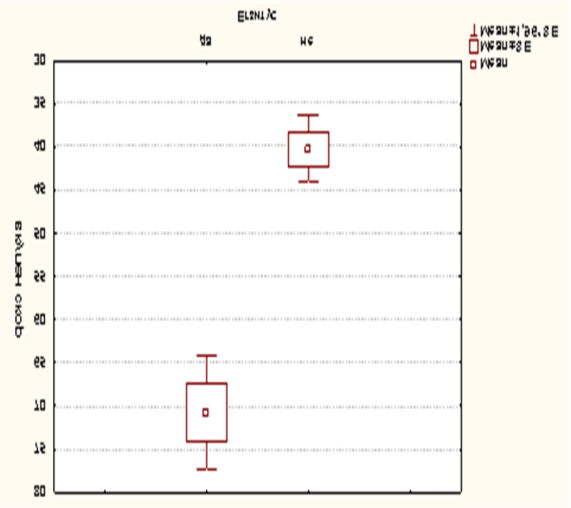

Figure 3: Distribution of mean score values in neonates with AKI and lethal outcome and neonates with AKI without lethal outcome

Figure 4 shows the distribution of score values in neonates compared to control group, depending on lethal outcomes. 66% of neonates with AKI and lethal outcome had a very difficult score level, as opposed to 59% survived neonates with AKI who had a lower score level. Compared to the control group, 54% neonates with lethal outcome had a difficult score level, and 51% of survived neonates had a medium score level.

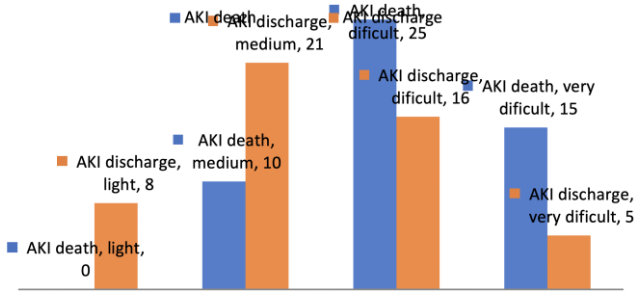

Figure 4: Distribution of score values in neonates with AKI compared to control group, depending on lethal outcomes

Discussion

This study presents a clinical, epidemiological study that evaluated neonates who were treated in intensive care at the Universiti Clinic of Children Diseases. During the period of three years, a high number of neonates with various pathological conditions and AKI were hospitalised. But this study included 50 neonates with documented kidney injury, as well as other 50 neonates, as a control group, with comparable associated pathological conditions, but without kidney injury. The calculated prevalence of kidney injury in neonates was 6.4% [16], [17].

This data correlates with data presented in the literature, where the incidence of AKI in neonates has the highest rate (6-24%) compared to other age groups (infants, children and adults). The occurrence of AKI in neonates is influenced by various factors, such as gestational age, birth weight and co-morbid conditions present during and immediately after birth. A similar finding as in our study has been published in other studies done in various neonatal centres. In the study of *Vachvanichsanong et al.,* the incidence of kidney injury in newborn infants was 6.3%, while in *Bolat et al*., and *Stapleton et al.,* it was 8% and 8.4%, respectively [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29].

However, there are opposite findings. Thus, in the study of *Momtaz et al.,* the incidence of kidney injury was 1.5%; in the studies of *Mortazavi et al*., 2.7%; in *Agras et al.,* 3.4%, and in the *Mohkam et al*., 3.2%. We assume that these differences can be due to differences in the criteria for diagnosing AKI in neonates [30].

According to the sex distribution, for all gestational ages, in both groups of neonates (with AKI and control group), the majority of neonates were male (68% and 60%). A different finding was presented in the study of *Momtaz et al.,* where female predominated in 87.7% of cases [21], [22], [23], [24].

According to the distribution of gestational age, the majority of neonates in both groups were term neonates (64% and 54%). The mean gestational age of neonates with AKI was 37.42 ± 3.1 weeks of gestation and the control group 36.26 ± 3.8 weeks of gestation. The mean birth weight of neonates with AKI was 2890.8 ± 898.1 grams and of the control group 2699.4 ± 894.6 grams. In both groups, predominated neonates with a birth weight over 2500 grams (64% and 54%, respectively).

There were no significant differences in the mortality rate in both groups of neonates (36% vs 24%). This finding of 36% of mortality in neonates with AKI correlates to the data presented in the study of *Gharehbaghi et al.* In our study, the mortality was significantly higher in neonates with AKI and congenital heart disease as comorbidity, and they underwent invasive therapeutic procedures (umbilical catheterisation and assisted ventilation). Special attention needs to be paid in the application of invasive procedures in neonates due to the association of these procedures with the risk of AKI. Critically sick neonates are at risk of having kidney injury, as they are commonly exposed to nephrotoxic medications and invasive therapeutic intervention such as assisted ventilation [25], [26], [27], [28].

In our study, neonates with AKI and lethal outcome have had severe SNAPPE 2 score. The high score level was significantly associated with the severity of the disease. Especially, very ill neonates with AKI and other co-morbid conditions were significantly associated with higher-level score and higher mortality. These findings correlate with the data presented in the study of *Mortazavi et al.* The mortality rate was significantly higher in neonates with difficult score level when admitted to the NICI, in whom further co-morbid conditions developed [29], [30], [31]. [32], [33].

In conclusion, acute kidney injury is a life-threatening condition with still high mortality rate. The severity of the illness of hospitalised neonates in the intensive unit is estimated by SNAPPE 2 score. Also, the risk of mortality is estimated too, taking the fact that higher values of the score are associated with higher mortality. Appropriate treatment of neonates with severe kidney injury improves the outcome and reduces the mortality of the disease.

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