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# THE RISK FACTORS FOR POSTOPERATIVE OUTCOMES IN NEONATAL CARDIAC SURGERY

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**Abstract**

In the last three decades a neonatal cardiac surgery has improved the aproach and methods for adequate treatment of complex congenital heart defects. Although we have advances in fetal cardiac imaging and improved perioperative cardiac procedures, the postoperative outcomes in neonates are still present.

We present our experience of operated neonates with congenital heart defects in a tertiary referral center, University Clinic for Pediatric Diseases, Neonatal Intensive Care Unit (NICU) in Skopje N. Macedonia.

This is a retrospective study including neonates who underwent surgical intervention between January 2013 and December 2015. We analyzed perioperative and postoperative variables, duration of cardiopulmonaly bypass (CPB), and x-cross of aorta, duration of mechanical ventilation, intensive care unit stay and postoperative complications.

Out of a total of 85 children, 15/85 (17.6 %) were neonates; the overall mortality was 1/15% (6.6%).There were 13/15 (86.6%) corrective procedures and 2/15 (13.3%) palliative ones.

The mean duration of CPB was 46.6 min., duration of x-cross of aorta was 17.5 min. The mean duration of mechanical ventilation was 3.4 days, duration of inotropic support was 4.2 days, and ICU stay 5.8 days. Postoperative complications were confirmed in 3 neonates.

Due to adequate cardiac surgery, signicant technological advances, devices and increasing experience in neonatal cardiac surgery we have improved postoperative outcomes.

***Keywords:*** cardiac surgery, neonates, cardiopulmonaly bypass, inotropic support

## Introduction

Congenital heart defects (CHD) are the most common birth anomalies, occurring in approximately 6 per 1000 live births [1,2].

Developed countries have reported expectedly good postoperative outcomes after neonatal cardiac surgery, with mortality of less than 5% [3,4]; for example, in USA 6.61 per thousand live births, in Australia 4.31 and in Canada 12.5 per 1000 live birth. In the European Union the annual occurrence of congenital heart defects is 7.97% per 1000 newborns (in the UK 3.17, in Finland 1.95, in Denmark 6.18, in Sweden 3.57, etc.). This was a result of the improvement in technological devices and advances, and understanding the physiology and pathophysiology of CHD. In the present study the mortality was 1/15 (6.6%).

Neonates with complex cardiac diseases characterized by ductal dependency usually undergo cardiac surgery in the first days of their life. Unfortunately, the same cardiac defects are still associated with a high risk of morbidity and mortality.

Thus, there is a need to examine potential risk factors for poor outcomes. Inadequate antenatal recognition of CHD and delayed surgical intervention are common for prolonged duration of mechanical ventilation, inotropic support and NICU stay [4- 6].

Neonates with complex congenital heart defects, who undergo congenital cardiac surgery, requiring cardiopulmonary bypass (CPB) and x-cross of aorta are at a higher risk of significant postoperative outcomes due to the worsening of myocardial perfusion, increase of inflammatory cells level, damage of myocardial function and in some cases delayed and minimized postoperative improvements [7,8].

Although the latest innovations in medical devices have been developed to improve cardiac surgery, still postoperative outcomes in neonatal patients are associated with in-hospital mortality of 5-10%.

The aim of our study was to report the postoperative outcomes after cardiac surgery, total corrective and palliative cardiac surgery, in 15 neonates in a tertiary neonatal intensive care unit in N.Macedonia.

**Materials and methods**

The present retrospective study was conducted at the University Clinic for Pediatric Surgery in Skopje between January 2013 and December2015. In this study all neonates (age <30 days) who underwent corrective and palliative surgery for CHD during this period were included.

The diagnosis of CHD was established by antenatal recognitions and examinations, clinical examinations (hyposaturation, general and acrocyanosis, presence of murmur) and echocardiography. The analysis included neonatal's age, cardiac diagnosis, palliative procedures, corrective operative procedures with duration of cardiopulmonary bypass (CPB), and x-cross of aorta. Additionally, duration of mechanical ventilation, and inotropic support, ICU stay, necessity of reintubation and postoperative complications were evaluated.

Mortality was defined as death within the first 7 days after surgery or before hospital discharge.

**Results**

Of the total of 85 patients, 15/85 (17.6%) were neonates who underwent corrective or palliative cardiac surgery at our center during the study period from January 2013 through December 2015. Male patients were 12/15(80%) female 3/15 (20%). Overall mortality was 1/15% (6.6%). Preoperatively, 9/15 neonates were with hyposaturation (75-80%), 4/15 neonates were with general cyanosis, acrocyanosis was confirmed in 3/15 neonates, and presence of murmur in 6/15 neonates.

Details of the cardiac diagnoses and numbers of patients are presented in Table 1. There were 13/15 (86.6%) corrective procedures and 2/15 (13.3%) palliative procedures (aortopulmonary shunt and pulmonary artery banding).

**Table 1.** Cardiac diagnoses and number of patients

| Cardiac diagnoses | Number of patients |
|---|---|
| Patent ductus arteriosus | 2 |
| Coarctation of aorta | 2 |
| Ventricular septal defect | 3 |
| Single ventricle | 2 |
| Transposition of the great arteries | 3 |
| Tetralogia of Fallot | 1 |
| Total anomalous systemic venous connection | 1 |
| Hypoplastic left heart syndrome | 1 |

Details of the cardiac diagnoses,palliative and corrective operative procedures and number of patients are summarized in Table 2.

**Table 2.** Cardiac diagnoses, palliative and corrective operative procedures and number of patients

| Cardiac diagnoses | Palliative and corrective operative procedures | Number of patients |
|---|---|---|
| Patent ductus arteriosus | PDA closure | 2 |
| Coarctation of aorta | coarctation repair | 2 |
| Ventricular septal defect | VSD closure | 3 |
| Single ventricle | Norwood procedure | 2 |
| Transposition of the greatarteries | arterial switch operation | 3 |
| Tetralogia of Fallot | closure of the ventricular septal defect with a patch | 1 |
| Total anomalous systemic venousconnection | complex intracardiac repair with rerouting of the veins | 1 |
| Hypoplastic left heart syndrome | Norwood procedure | 1 |

The mean duration of CPB was 46.6 min. (18±296 min.) and the mean duration of x-cross of aorta was 17.5 min. (10±65 min.). Details of intraoperative procedures are summarized in Table 3.

**Table 3.** Intraoperative variables

| Intraoperative procedures | Mean duration in minutes |
|---|---|
| cardiopulmonary bypass (CPB ) | 46.6 18±296 |
| x-cross of aorta | 17.5 10±65 |

Postoperatively, the mean duration of mechanical ventilation was 3.4 days (1±15 days), duration of inotropic support was 4.2 days (1± 16 days) and ICU stay was 5.8 days (7.9 ± 14days). After the operation, 2/15 (13.3%) neonates required reintubation in the ICU. Details of postoperative variables are presented in Table 4.

**Table 4.** Postoperative variables

| Postoperative variables | Mean duration in days |
|---|---|
| mechanical ventilation | 3.4 1±15 |
| Inotropic support | 4.2 1± 16 |
| ICU stay | 5.8 7.9 ± 14 |

Postoperative complications were confirmed in 3 neonates (intracranial bleeding with seizures, block nodes AV, and pneumonia). After 5.8 days in the ICU, 14 neonates were discharged.

Postoperative complications are presented in Table 5.

**Table 5.** Postoperative complications

| Postoperative complications | Number of patients |
|---|---|
| intracranial bleeding with seizures | 1 |
| block nodes AV | 1 |
| pneumonia | 1 |

**Discussion**

In this retrospective study we have presented postoperative outcomes in 15 neonates in a tertiary intensive care unit in Skopje, after they underwent neonatal cardiac surgery. The overall mortality of all 15 operated neonates was 1/15 (6.6%).

In the last several decades, development of devices, significant advances in cardiac surgery and postoperative care, reduced the rate of mortality among operated neonates [9]. To improve the outcomes the collaborative efforts of neonatal surgeons, intensive care doctors and cardiologists acting as "one team" are also very important.In addition, the growing experience and clinical practice have been reported as essential in improving the postoperative outcomes in some studies [10,11].

The proportion of palliative procedures in 2/15 (13.3%) neonates compared with 13/15 (86.6%) neonates with corrective procedures did not affect morbidity and mortality. In our study we presented the practice and experience in performing corrective operations, such as arterial switch operation, coarctation repair, VSD closure, complex intracardiac repair with rerouting of the veins, etc.

The utilization of CPB and x-cross of aorta are main surgical procedures during an open-heart surgery with different effects on body organs. Although the safety and development of devices during the past decades has significantly improved, there are still a large number of complications [12].

Kansy *et al.*[13] in their study revealed that prolonged intraoperative procedures (duration of CPB and x-cross of aorta) and cardiac defect complexity were significant risk factors for an increased number of postoperative complications. These observations are partly in agreement with those published in previous studies.

In our study we confirmed that neonates with complex heart defects had prolonged duration of CPR and x-cross of aorta. As mentioned earlier, they are recognized as risk factors associated with prolonged postoperative variables such as ICU stay with mechanical ventilation and duration of inotropic support [14]. Longer ICU stay is a major indicator of postoperative management of neonates. Some studies have demonstrated that impact and effects of mechanical ventilation require prolonged inotropic support and additionally cause worsening of the general condition and complicated postoperative outcomes [15,16]. Our study results revealed that ICU length of stay caused prolonged need of mechanical ventilation and inotropic support.

After surgery, 2/15 (13.3%) neonates with postoperative complications in the first 48 hours required reintubation. The first neonate had intracranial bleeding with seizures, and the second one had massive pneumonia, which required prolonged ICU stay and inotropic support.

Although in the last few decades the progress in technology and devices has been improved, the correlation between usage of CPB and intracranial bleeding with clinical sings of seizures was manifested. In many cases, the disorder is caused by damage of brain during surgery. The incidence of neurological disorders in some studies was in range of 4-15% [12, 17]. In our study the incidence of postoperative clinical seizures was 6.6%.

Several studies confirmed that one of the most common complications was pneumonia. In the study by Maryam *et al.* [12], the incidence of pneumonia was 6.24% and in the study by Hornick *et al*. [18] the incidence of postoperative pneumonia was much less (2.2%). Unfortunately, the incidence of nosocomial pneumonia after cardiac surgery in some studies varied between 9.6 to 21.5% [19], which is a very unpredictable outcome. In our study the incidence of pneumonia was 6.6%. Another

recorded postoperative complication that had been confirmed without reintubation was block nodes AV as a result of atrio-ventricular canal defect repair. In the study by Hornik*et al.* [18-20] the incidence was 2.8%. In our study the incidence of block nodes AV was 6.6%.

The main purpose of the present study was to examine the correlation between perioperative procedures and postoperative outcomes. The postoperative outcomes are poor, having in mind the number of operated neonates (3/15). In the future we should focus on larger multicenter studies to confirm the correlation between perioperative risk factors and postoperative complications in neonatal cardiac surgery.

Our study of postoperative outcomes after cardiac surgery even though a small one confirmed that with adequate, timely realized cardiac surgery, appropriate usage of perioperative devices and postoperative treatment improvement of postoperative outcomes was achieved. However, we need larger studies in order to confirm the postoperative outcomes.

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