and significant residual shunting, hemodynamic embarrassment can be caused by preexisting pulmonary hypertension. Because of the possibility of development of pulmonary vascular obstructive disease, most patients will require surgical intervention during the first year of life (5) to avoid further complications.

In this small group of patients 2 patients died suddenly, respectively after some period of good postoperative recovery. Both had rhythm disorders, starting with complete heart block in theater, later changing into nodal rhythm or instable sinus rhythm alternating with atrioventricular dissociation. In both cases with otherwise unremarkable postoperative course we suggest that the rhythm disorder finally resulted in early death. As a consequence, decision for permanent pacemaker implantation should be handled more liberal.

The majority of patients were those with Down's syndrome. These children did not show an increased mortality, yet there was a tendency to a slightly longer period of ventilator dependency, mainly due to increased amount of secretion in the respiratory tract and more frequent signs of pulmonary infections. In general, patients with trisomy 21 usually had well-developed atrioventricular leaflets providing favourable conditions for the repair of the mitral valve, whereas some children without genetic defect presented with partially hypoplastic leaflets. According to the short time of follow up less than 8 years, no statement is possible concerning long-term results. So far, no further operation was required, especially no late mitral valve reconstruction or replacement or late pacemaker insertion. In conclusion, single-stage total correction in symptomatic children should be performed early in order to avoid pulmonary vascular complications. Comparably low risk supports the concept of primary repair. Above all, precise reconstruction of the mitral valve, avoidance of residual septal defects, and maintenance of sinus rhythm are essential for successful repair and good functional results.

References

(1) Bailey SC, Watson DC: Atrioventricular septal defect repair in infants. Ann Thorac Surg 1991;52:33-37.

(2) Berger TJ, Blackstone EH, Kirklin JW, Bargeron LM, Hazelrig JB, Turner ME: Survival and probability of cure without and with operation in complete atrioventricular canal. Ann Thorac Surg 1979;27:104-111.

(3) Bove EL, Sonderheimer HM, Karey R, Byrum CJ, Blackman MS: Results with the two-patch technique for repair of complete atrioventricular canal defect. Ann Thorac Surg 1984;38:157-161.

(4) Mavroudis C, Weinstein G, Turley K, Ebert P: Surgical management of complete atrioventricular canal. J Thorac Cardiovasc Surg 1982;83:670-678.

(5) Merrill WH, Hammon JW, Graham TP, Bender HW: Complete repair of atrioventricular septal defect. Ann Thorac Surg 1991;52:29-32.

(6) Rastelli GC, Ongley PA, Kirklin JW, McGoon DC: Surgical repair of the complete form of persistent common atrioventricular canal. J Thorac Cardiovasc Surg 1968;55:299-308.

From the Departments of Pediatrics (Head: Prof. Dr. *R. Kurz*), [1]Cardiac Surgery (Head: Prof. Dr. *J. Kraft-Kinz*) and [2]Anesthesiology (Head: Prof. Dr. *W. List*), University Graz

Postoperative Intensive Care in Infants and Children After Cardiac Surgery

G. Zobel, B. Rigler[1], H. Metzler[2], D. Dacar[1], J. I. Stein, A. Beitzke, and H. M. Grubbauer

Key-words: Cardiac surgery – low cardiac output – intensive care – infants – clinical scoring systems.

Schlüsselwörter: Herzoperation – Herz-Kreislaufversagen – Intensivpflege – Kinder – klinische Scoresysteme.

Background: The postoperative course of infants and children after open heart surgery is often complicated by cardiopulmonary insufficiency or low cardiac output.

Methods: From January 1989 to April 1992 441 infants and children with congenital heart disease underwent cardiac surgery. 128 of these patients (29%) required prolonged or extensive intensive care because of cardiopulmonary insufficiency or low cardiac output. Aortic cross clamp and cardiopulmonary bypass times were measured in all patients. In the postoperative period duration of mechanical ventilation, duration of intensive care, special monitoring and therapeutic strategies and clinical scores were documented.

Results: The overall mortality rate was 9.9%, the mortality rate in patients with postoperative cardiopulmonary insufficiency or low cardiac output was 34%. The mortality rate increased significantly up to 73% when the cardiopulmonary bypass time exceeded 200 min. Mean duration of intensive care of survivors (S) and nonsurvivors (NS) was 10.3 ± 0.8 and 4.1 ± 1.2 days, respectively ($p < 0.01$), mean duration of mechanical ventilation was 7.1 ± 0.5 (S) and 4.1 ± 1.2 (NS) days, respectively ($p < 0.01$). NS had a significantly higher degree of physiologic derangement assessed by the Acute Physiologic Score for Children and needed more monitoring and therapeutic interventions assessed by the Therapeutic Intervention Scoring System than S.

Conclusion: Complex cardiac surgery, a cardiopulmonary bypass time over 200 min, high catecholamine infusion rates combined with a persisting low mean arterial pressure are associated with a high postoperative mortality rate in infants and children with congenital heart defects.

(Acta Chir. Austriaca 1993;25:102-105)

Postoperative Intensivpflege bei Kindern mit angeborenen Herzfehlern

Zusammenfassung:

Grundlagen: Der postoperative Verlauf bei Kindern nach Operationen am offenen Herzen ist oft durch ein Herz-Kreislauf- bzw. Herz-Lungenversagen gekennzeichnet.

Methodik: Von Jänner 1989 bis April 1992 unterzogen sich 441 Kinder mit angeborenem Herzfehler einer Operation am offenen Herzen. Wegen eines postoperativen Herz-Lungenversagens benötigten 128 Kinder (29%) eine verlängerte bzw. besonders aufwendige Intensivpflege. Die Aortenabklemmzeit und die Herz-Lungenmaschinenzeit wurden bei allen Kindern angegeben. Postoperativ wurden die Beatmungsdauer, Dauer der Intensivpflege, spezielle Überwachungs- und Therapieformen und klinische Scores festgehalten.

Ergebnisse: Während die Gesamtmortalität 9,9% betrug, lag die Mortalität bei Kindern mit postoperativen Herz-Lungenversagen bei 34%. Bei langem Einsatz der Herz-Lungenmaschine (> 200 min) stieg die Mortalität bis auf 73% an. Die mittlere Dauer der postoperativen Intensivpflege betrug bei den Überlebenden 10,3 ± 0,8 Tage und bei den Nichtüberlebenden 4,1 ± 1,2 Tage ($p < 0,01$). Die mittlere postoperative Beatmung dauerte 7,1 ± 0,5 Tage bei den Überlebenden und 4,1 ± 1,2 Tage bei den Nichtüberlebenden ($p < 0,01$). Die Nichtüberlebenden benötigten einen deutlich größeren Therapieaufwand, gemessen am „Therapeutic Intervention Score", als die Überlebenden. Zusätzlich war der Schweregrad der Erkrankung, gemessen am „Akuten Physiologischen Score für

Corresponding address: Doz. Dr. G. Zobel, Department of Pediatrics, University Graz, Auenbruggerplatz, A-8036 Graz.

Kinder", bei Nichtüberlebenden ausgeprägter als bei Überlebenden.

Schlußfolgerung: Langdauernde und komplexe Operationen an der Herz-Lungenmaschine, ein hoher postoperativer Katecholaminbedarf, kombiniert mit niedrigen mittleren arteriellen Blutdruckwerten, gehen bei Kindern mit angeborenem Herzfehler mit einem hohen postoperativen Mortalitätsrisiko einher.

Introduction

Advances in diagnostic modalities, pharmacology, anesthesia, and surgical techniques, a greater understanding of pathophysiologic processes resulted in an improved prognosis for patients with congenital heart disease (1). Despite this, cardiovascular, respiratory, and renal problems are still existing in the postoperative period. We describe the differences between survivors and nonsurvivors in the perioperative management of infants and children with postoperative cardiopulmonary insufficiency or low cardiac output (LCO).

Patients and methods

From January 1989 to April 1992 441 infants and children with congenital heart disease underwent cardiac surgery at the Department of Cardiac Surgery, University of Graz. Because of postoperative cardiopulmonary insufficiency 128 (29%) infants and children required mechanical ventilation and dopamine infusion rates > 5 mcg/kg/min longer than 2 days. Demographic data of the patients are given in Table 1. All had 2 central venous lines, 1 for continuous catecholamine infusion and 1 for CVP recording and fluid administration, 1 arterial line for continuous blood pressure monitoring and intermittent blood gas measurements. 39 patients had a pulmonary artery and 42 a left atrial catheter for pressure tracings. In addition, ECG and pulse oxymetry were recorded continuously. Fluid in- and output was measured on an hourly basis. All patients were on mechanical ventilation and needed inotropic support. In patients with low blood pressure and a CVP < 10 mm Hg a colloid or cristalloid solution (10 ml/kg) was infused in 15 to 60 min. When the hemodynamic did not improve at a CVP > 10 mm Hg the catecholamine infusion rate was increased. In patients with high preload and peripheral vasoconstriction a vasodilator was added to the catecholamines. Calcium chloride 10% (0.2 ml/kg) was infused according to the ionized blood calcium levels. Slow continuous ultrafiltration (SCU) or continuous hemofiltration (CHF) was started immediately in hypervolemic patients with persisting LCO despite maximal pharmacologic support (2). Fentanyl (0.015 mcg/kg/min) and midazolam (0.25 mg/kg/h) were continuously infused for analgesia and sedation. Initially blood

Table 1. Demographic data in infants and children after cardiac surgery (n = 128).

	S (n = 84)	NS (n = 44)
Age (years)	1.5 ± 0.2	1.5 ± 0.3
body weight (kg)	8.1 ± 0.6	7.5 ± 0.7
sex (m/f)	53/31	29/13
diagnoses		
AVC	12	11
TGA	12	9
TGA + VSD	8	1
SV	4	5
TF, DORF	15	2
VSD	22	6
TRUNCUS	1	1
PST/PA + IVS	0	2
PST/PA + VSD	1	1
TAPVR	2	1
AST	1	2
other	6	3
surgery		
reparative	77	39
palliative	7	5

AVC = atrioventricular canal, TGA = transposition of the great arteries, VSD = ventricular septal defect, AST = aortic stenosis, SV = single ventricle, TF = tetralogy of fallot, DORV = double outlet right ventricle, PST = pulmonary valve stenosis, PA = pulmonary atresia, IVS = intact ventricular septum, TAPVR = total anomalous pulmonary venous return.

chemistry was routinely measured 4 to 6 times a day. Acute Physiologic Score for Children (APSC) and Therapeutic Intervention Scoring System (TISS) were recorded during the first 4 postoperative days (3, 4). The patients were divided into survivors (S) and nonsurvivors (NS). Perioperative hemodynamic and respiratory data and medical support were compared to find out differences between S and NS.

Data are given as mean ± SEM. Student's t-test for paired and unpaired samples (two way analysis), Chi-square analysis, and simple regression were used as statistical methods.

Cardiac diagnoses are given in Table 1.

Anesthetic management

Anesthesia was usually induced with etomidate (0.6 mg/kg i.v.), fentanyl (10 mcg/kg i.v.), and pancuronium (150 mcg/kg i.v.). Thereafter, fentanyl and pancuronium were used to maintain anesthesia. Patients were under controlled mechanical ventilation with an oxygen/air mixture. ECG, arterial and central venous pressures, nasopharyngeal and rectal temperatures were monitored continuously. Pulse oxymetry and capnography were applied to all infants and children. Sometimes pressure lines were inserted into the pulmonary artery and/or left atrium after cardiopulmonary bypass.

Table 2. Postoperative intensive care in infants and children after cardiac surgery (n = 128).

	S (n = 84)	NS (n = 44)
Days on ventilator	7.1 ± 0.5	4.1 ± 1.2*
days in the ICU	10.3 ± 0.8	4.1 ± 1.2**
hemofiltration (intraop.)	65	35
SCU/CHF (postop.)	12	6
IABP + HF	0	2
ECMO + HF	1	2
pacing transient	9	5
pacing permanent	6	8
antiarrhythmics	9	5
vasodilator	27	22
PA-catheter	26	13
LA-catheter	24	18

* $p < 0.05$
** $p < 0.01$
SCU = slow continuous ultrafiltration, CHF = continuous hemofiltration, IABP = intraaortic balloon pumping, ECMO = extracorporeal membrane oxygenation; vasodilators: prostaglandin E1, nitroglycerine, nifedipine; antiarrhytmics: propafenone, verapamil, lidocaine; PA = pulmonary artery catheter, LA = left atrial catheter.

Intraoperative management

In most operations extracorporeal circulation was instituted with an aortic cannula and two venous cannulas placed through the right atrium into the superior and inferior caval veins. Direct bicaval cannulation or a single venous cannula was also used depending on patients underlying lesions

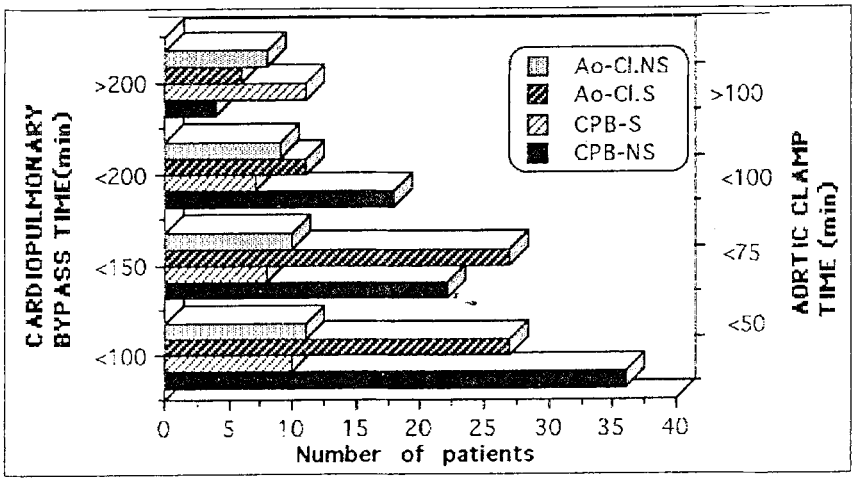

Fig. 1. Cardiopulmonary bypass and aortic clamp times during cardiac surgery.

Table 3. Hemodynamic data pre and post slow continuous ultrafiltration in infants and children after cardiac surgery (n = 23).

	pre-SCU	post-SCU	p-value
MAP (mm Hg)	41.8 ± 1.4	53.4 ± 2.8	< 0.01
CVP (mm Hg)	16.1 ± 0.8	10.2 ± 0.7	< 0.01
HR (beats/min)	153 ± 2.8	142 ± 2.4	< 0.01
body weight (kg)	8.8 ± 1.2	7.6 ± 1.3	< 0.01
dopamine (mcg/kg/min)	18.3 ± 1.9	13.1 ± 1.9	< 0.05
epinephrine (mcg/kg/min)	0.31 ± 0.03	0.17 ± 0.04	< 0.025
pH	7.27 ± 0.02	7.39 ± 0.02	< 0.01
PaO_2/FiO_2 (mm Hg)	99.7 ± 9.1	159 ± 12.7	< 0.01

SCU = slow continuous ultrafiltration, MAP = mean arterial pressure, CVP = central venous pressure, HR = heart rate.

and age. Myocardial protection almost exclusively consisted of multiple dose crystalloid cardioplegia. In older children a bloodless prime was preferred when appropriate hematocrit levels preexisted. During standard cardiopulmonary bypass (CPB) systemic temperature was often lowered to 20 to 25°C, while flow rates varied between 0.5 to 3 L/m^2/min. Profound hypothermia (12 to 20 °C) was only used in 10% of the patients. Phenoxybenzamin 0.1 mg/kg i.v. was given to the majority of the patients to achieve more uniform cooling. Hematocrit levels were kept above 15 to 20%. Perioperative hemofiltration was done in half of the patients to avoid extensive fluid overload, particularly in small infants and patients with complex or long-lasting repair.

Surgery included a variety of operative techniques according to the afore mentioned diagnoses. Corrective surgery procedures included primary as well as two-stage repairs. Most of these patients underwent standard surgical operations. Among those having simple or complex TGA 30 underwent anatomic repair. Definitive palliation of various types of univentricular heart (UVH) included atriopulmonary Fontan-type repair but also total cavopulmonary connections. Valved homografts, pericardial tubes, and non-valved PTFE-prostheses were inserted after patch-closure of the VSDs in patients with truncus arteriosus, PA + VSD, and complex TGA. Major associated lesions complicating the surgical repair were coarctation, interrupted aortic arch, multiple VSDs, hypoplastic right ventricular structures, cardiomyopathy, incompetent truncal valve, periphereal pulmonary artery stenosis, and dextrocardia.

Results

Cardiac surgery was performed in 441 infants and children. Of these 128 (29%) developed postoperative cardiopulmonary insufficiency or LCO. 29 patients had major associated lesions. 21 were on mechanical ventilation preoperatively. Demographic data of the patients are presented in Table 1. The overall mortality rate was 9.9%, the mortality rate in infants and children with postoperative cardiopulmonary insufficiency or LCO was 34%. Whereas the mortality rate was 55% in neonates, it was below 30% in infants older than 1 month. After the first year of life the mortality rate ranged between 30 and 35%. Death was directly related to duration of CPB time. In patients with a CPB time below 200 min mortality rate was below 25%, whereas mortality rate increased significantly over 73% when CPB time was longer than 200 min ($p < 0.01$) (Fig. 1). Mortality rate in patients with an aortic cross-clamping time in excess of 100 min was 58%. There was no significant correlation between type of operation and outcome. The lowest mortality rate was observed in patients with tetralogy of Fallot (11%).

The mean duration of vasopressor support in S was 6.2 ± 0.3 days. The mean dopamine infusion rates of S and NS were 8.4 ± 0.4 and 16.6 ± 1.6 mcg/kg/min, respectively ($p < 0.0001$). In addition, 38% of the patients required a continuous infusion of epinephrine. However, none of these patients with an epinephrine infusion rate higher than 0.45 mcg/kg/min could be weaned from vasopressor support and subsequently died because of persisting low cardiac output. Despite significantly higher catecholamine infusion rates, the mean arterial pressure of NS (MAP: 48 ± 1.9 mm Hg) was significantly lower than of S (MAP: 57.9 ± 0.9 mm Hg, $p < 0.001$). The CVP of NS increased up to 14 mm Hg during the first 3 postoperative days, whereas it remained stable at 10 mm Hg in S ($p < 0.01$). Vasodilating agents were infused in 27 S and 22 NS. Because of transient or permanent postoperative atrioventricular block pacing was necessary in 15 S and 13 NS. Antiarrhythmic drugs were infused in 9 S and 5 NS.

Mean duration of intensive care was 10 ± 0.8 days in S and 4.1 ± 1.2 days in NS ($p < 0.001$). Mechanical ventilation was necessary for 7.1 ± 0.5 days in S and 4.1 ± 1.2 days in NS ($p < 0.01$). In 29% of the patients mechanical ventilation was performed longer than 7 days. Mortality rate in these patients was only 11%. 24 hours after operation the oxygenation index (PaO_2/FiO_2) of S and NS was 214 ± 10.9 and 130 ± 21.4 mm Hg, respectively ($p < 0.01$). Mean pH of S and NS was 7.40 ± 0.01 and 7.27 ± 0.02, respectively ($p < 0.001$).

Because of hypervolemia and persisting LCO slow continuous ultrafiltration (SCU) was installed in 13 S and 10 NS. The hemodynamic situation improved transiently or permanently in all but 3 patients. The hemodynamic data pre and post SCU are given in Table 3.

The degree of physiologic derangement and the amount of monitoring and therapy are presented in Figure 2.

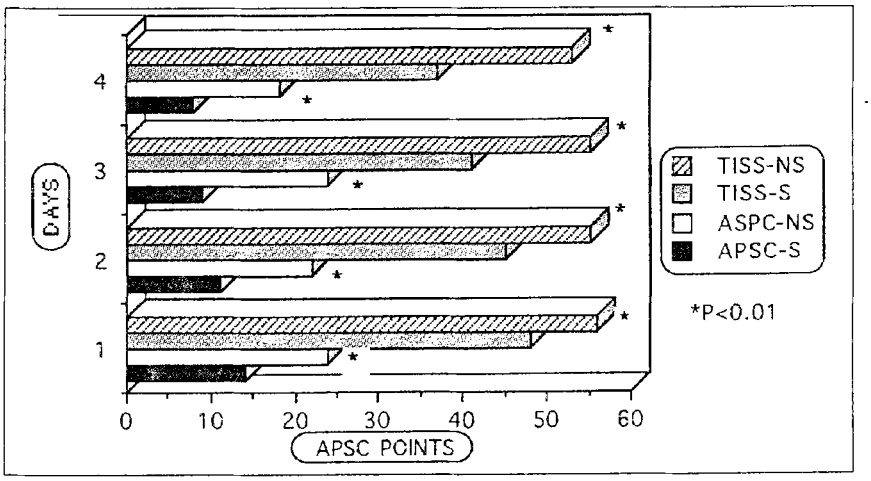

Fig. 2. Clinical scores in pediatric patients after cardiac surgery (n = 128).

Discussion

The postoperative course of infants and children after open heart surgery is often complicated by cardiopulmonary insufficiency or LCO. Because many cardiac operations performed with CPB require

cross-clamping of the aorta at some time of repair, global myocardial ischemia might occur. In 1981 *Kirklin* et al. showed an increased risk of acute cardiac death with ischemic time in excess of about 45 min (5). On the other hand no increased risk could be detected with up to 120 min of cardiac ischemia from aortic crossclamping when cold cardioplegia was used (6). Myocardial edema might also be associated with episodes of aortic cross-clamping. This reduces ventricular compliance and leads to decreased cardiac output. Myocardial insufficiency can be secondary to metabolic derangements and hypoxemia (1).

Ventriculotomy and residual defects may further enhance myocardial insufficiency. *Kirklin* et al. reported a poor preoperative condition, the presence of major associated cardiac lesions, age less than 1 month, and a long CPB time as incremental risk factors for death in infants after intracardiac surgery (5). In our patients a CPB time in excess of 200 min and an aortic crossclamp time in excess of 100 min were associated with an increased mortality of 73% and 58%, respectively. 35% of these patients died within 24 hours after cardiac surgery because of uncontrolled LCO. In the above mentioned study *Kirklin* et al. additionally demonstrated that of various postoperative factors only the strength of the pedal pulses, pedal skin temperature and the measured cardiac index in the first 5 hours after operation were significantly related to the probability of hospital death from acute heart failure (6). In our patients the MAP of S was significantly higher than of NS ($p < 0.01$). Whereas no difference in CVP between S and NS was observed during the first 48 hours after operation, CVP of NS increased significantly up to 15 mm Hg 72 hours after operation ($p < 0.01$). In addition, the catecholamine infusion rates of NS were significantly higher than of S. All patients with an epinephrine infusion rate in excess of 0.45 mcg/kg/min died. Respiratory failure after cardiac surgery is often due to ventilation/perfusion mismatch, atelectasis, infection and respiratory distress (1, 7, 8). The duration of mechanical ventilation varies from early extubation in the operating theatre to prolonged mechanical ventilation longer than 1 week (7, 9). 29% of our patients were on mechanical ventilation for longer than 1 week. In 1986 *Kanter* et al. reported that young age, longer CPB time, longer aortic crossclamping time, and preoperative mechanical ventilation were associated with prolonged mechanical ventilation (10). In our patients mean duration of mechanical ventilation was 6.9 ± 0.7 days, ranging from 1 to 40 days. The age of the patients had no influence on the duration of mechanical ventilation.

LCO causes renal hypoperfusion with fluid and sodium retention. Inotropes, diuretics, and vasodilators are usually used to improve cardiac output. When the kidneys become resistant to diuretics gross edema formation necessitates extracorporeal fluid removal. High intravascular and low plasma oncotic pressures increase fluid flux from the intravascular to the interstitial space. Fluid removal from the intravascular space will only be tolerated if there is adequate vascular refilling from the interstitial space. Therefore, intermittent hemodialysis is not well tolerated by critically ill patients with hemodynamic instability. In 1985 *Magilligan* reported the application of ultrafiltration before, during, and after cardiac surgery (11). He noticed an increase in radionuclide ejection fraction from 37% before ultrafiltration to 60% after ultrafiltration in a patient with diuretic resistant congestive heart failure. We recently described the beneficial effects of SCU on the hemodynamic in 11 hypervolemic oliguric infants and children with LCO after cardiac surgery (2). Meanwhile 23 patients with postoperative cardiopulmonary insufficiency or LCO were treated by SCU. Survival rate in patients treated by SCU was 56%.

In our patients NS had a more significant derangement of the physiologic state measured by the APSC score (3). In addition, the amount of monitoring and therapeutic interventions as assessed by TISS was significantly higher in NS (4).

Conclusion

Complex cardiac surgery, a CPB time over 200 min, an aortic crossclamping time over 100 min, high catecholamine infusion rates combined with a persisting low mean arterial pressure are associated with a very high mortality rate in infants and children after open cardiac surgery. A transient cardiac assist device such as intra-aortic balloon pumping (IABP), left ventricular assist device (LVAD) or extracorporeal membrane oxygenation (ECMO) should be taken into consideration when epinephrine levels exceed 0.4 mcg/kg/min. Clinical scoring systems are helpful to document severity of illness, therapeutic interventions and enable a better assessment of new therapeutic strategies.

References

(1) Lowe EE: Postoperative Cardiac Care, in Lake CL (ed): Pediatric Cardiac Anesthesia. Norwalk, Appleton & Lange, 1988, pp 407-439.
(2) Zobel G, Stein JI, Kuttnig M, Ring E, Metzler H, Rigler B: Continuous Extracorporeal Fluid Removal in Children with Low Cardiac Output after Cardiac Operation. J Thorac Cardiovasc Surg 1991;101:593-597.
(3) Zobel G, Kuttnig M, Rödl S, Grubbauer HM: Evaluation of Clinical Scoring Systems in Pediatric Intensive Care. Clin Intens Care 1990;1:202-206.
(4) Cullen DJ, Civetta JM, Briggs BA, Ferrara LC: Therapeutic Intervention Scoring System: a Method for Quantitative Comparison of Patient Care. Crit Care Med 1974;2:57-61.
(5) Kirklin JK, Blackstone EH, Kirklin JW, McKay R, Pacifico AD, Bargeron, LM: Intracardiac Surgery in Infants under Age 3 Months: Incremental Risk Factors for Hospital Mortality. Am J Cardiol 1981;48:500-506.
(6) Kirklin JK, Blackstone EH, Kirklin JW, McKay R, Pacifico AD, Bargeron, LM: Intracardiac Surgery in Infants under Age 3 Months: Predictors of Postoperative In-Hospital Cardiac Death. Am J Cardiol 1981;48:507-512.
(7) Tanaka K, Kumon K, Yamamoto F, Egoh Y, Naito Y, Fujita T: Respiratory Care of Pediatric Patients Requiring Prolonged Intubation after Cardiac Surgery. Crit Care Med 1986;14:617-619.
(8) Jenkins J, Lynn A, Edmonds J, Barker G: Effects of Mechanical Ventilation on Cardiopulmonary Function in Children after Open-Heart Surgery. Crit Care Med 1985;13:77-80.
(9) Heard GG, Lamberti JJ, Park SM, Waldman D: Early Extubation after Surgical Repair of Congenital Heart Disease. Crit Care Med 1985;13:830-832.
(10) Kanter RK, Bove LE, Tobin JR, Zimmermann JJ: Prolonged Mechanical Ventilation of Infants after Open Heart Surgery. Crit Care Med 1986;14:211-214.
(11) Magilligan DJ: Indications for Ultrafiltration in the Cardiac Surgical Patient. J Thorac Cardiovasc Surg 1985;89:183-189.