Turk Gogus Kalp Dama 2014;22(3):509-516
doi: 10.5606/tgkdc.dergisi.2014.9144

Original Article / Özgün Makale

Analysis of results according to the Aristotle scoring system in congenital heart surgery

Konjenital kalp cerrahisinde sonuçların Aristotle skorlama sistemine göre analizi

Ersin Erek,[1] Bilge Yılmaz,[1] Mehmet Kaya,[1] İsmihan Selen Onan,[1] Onur Şen,[1] Kürşad Öz,[1] Özgen Ilgaz Koçyigit,[2] Alper Güzeltaş,[3] Ender Ödemiş[3]

Institution where the research was done:
Departments of [1]Cardiovascular Surgery, İstanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital, İstanbul, Turkey

Author Affiliations:
Departments of [1]Cardiovascular Surgery, [2]Anaesthesiology and Reanimation and [3]Pediatric Cardiology, İstanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital, İstanbul, Turkey

Background: In this study, we evaluated our one-year results of congenital heart surgery according to the Aristotle scoring system.

Methods: Between January 2012 and December 2012, a total of 167 procedures in 163 patients who were operated by a single surgeon were analyzed. Early mortality rates were calculated. Intensive care unit stay more than one week was identified as the marker of morbidity. We adopted a threshold duration of 120 min of cardiopulmonary bypass time to evaluate the surgical technical difficulty. The patients were divided into six complexity levels based on the Aristotle basic scores (ABC) and Aristotle comprehensive scores (ACC). Complications for each procedure were classified.

Results: The mean ABC and ACC scores were calculated as 7.5±2.7 and 8.6±3.5, respectively. Thirty three patients were neonates (23.9%) and 46 patients were infants (28.2%). The overall hospital mortality rate was 12.5% (n=21 procedures). Based on the complexity level, 3.7% at ACC level 1, 4.5% for level 2, 13.6% for level 3, 18.8% for level 4, 66.6% for level 5, and 100% for level 6 (only one patient). The overall morbidity index was 33.5% (n=56 procedures). It increased form 3.7% at level 1 to 100% at level 5. The index of surgical difficulty was estimated to be 31.7% (n=53 procedures) and zero at level 1 and it increased up to 66% at level 5. A strong correlation was found between the ACC scores and mortality ($p<0.019$), indices of morbidity ($p<0.001$) and surgical difficulty ($p<0.001$). We detected 155 complications in 43.5% (n=71 patients) of the patients.

Conclusion: Our study confirms that the Aristotle scoring system offers an opportunity for a detailed analysis to evaluate the surgical results in congenital heart surgery. It is possible to compare the results yearly in a center or among the centers across the world. These data can be used to improve the quality of care.

Keywords: Congenital heart defects; data analysis; in-hospital mortality; neonate; patient outcome assessment; scoring system.

Amaç: Bu çalışmada konjenital kalp cerrahisinde elde ettiğimiz bir yıllık sonuçlar Aristotle skorlama sistemine göre değerlendirildi.

Çalışma planı: Ocak 2012 - Aralık 2012 tarihleri arasında tek cerrah tarafından ameliyat edilen 163 hastada toplam 167 işlem analiz edildi. Erken mortalite oranları hesaplandı. Yoğun bakım ünitesinde bir haftanın üzerinde yatış morbidite belirteci olarak kabul edildi. Cerrahi teknik zorluğunun değerlendirilmesi için 120 dakikanın üzerindeki kardiyopulmoner baypas süresi eşik süresi olarak kabul edildi. Hastalar Aristotle temel skorları (ABC) ve Aristotle kapsamlı skorları (ACC) temel alınarak altı zorluk seviyesine ayrıldı. Her işlemin komplikasyonları sınıflandırıldı.

Bulgular: Ortalama ABC ve ACC skorları sırasıyla 7.5±2.7 ve 8.6±3.5 idi. Otuz üç hasta (%23.9) neonatal; 46 hasta (%28.2) infant idi. Toplam hastane mortalitesi %12.5 (n=21 işlem) idi. Zorluk seviyelerine göre mortalite ACC seviye 1 %3.7; seviye 2 %4.5; seviye 3 %13.6; seviye 4 %18.8; seviye 5 %66.6 ve seviye 6 %100 (yalnızca bir hasta) idi. Toplam morbidite indeksi %33.5 (n=56 işlem) idi. Morbidite indeksi seviye 1'de %3.7 iken seviye 5'de %100'e çıkıyordu. Cerrahi zorluk indeksi ise toplamda %31.7 (n=53 işlem) idi ve seviye 1'de 0; seviye 5'de ise %66 idi. Aristotle kapsamlı skorları ile mortalite ($p<0.019$), morbidite ($p<0.001$) ve cerrahi zorluk indeksleri ($p<0.001$) arasında güçlü korelasyon tespit edildi. Hastaların %43.5'inde (n=71 hasta) toplam 155 komplikasyon tespit edildi.

Sonuç: Çalışmamız, Aristotle skorlama sisteminin, konjenital kalp cerrahisinde sonuçları değerlendirilmesi için detaylı bir analiz imkanı sunduğunu teyit etmektedir. Sonuçların hem merkezlerin kendi içinde hem de dünya çapındaki tüm merkezlerle yıllık bazda kıyaslanması mümkündür. Bu bilgiler bakım kalitesinin iyileştirilmesi amacıyla kullanılabilir.

Anahtar sözcükler: Konjenital kalp defekti; data analizi; hastane mortalitesi; yenidoğan; hasta sonuçlarının değerlendirilmesi; skorlama sistemi.

Available online at
www.tgkdc.dergisi.org
doi: 10.5606/tgkdc.dergisi.2014.9144
QR (Quick Response) Code

Received: August 03, 2013 *Accepted:* January 15, 2014

Correspondence: Ersin Erek, M.D. Acıbadem Üniversitesi Atakent Hastanesi, Kalp ve Damar Cerrahisi Kliniği, 34303 Halkalı, İstanbul, Turkey
Tel: +90 542 - 431 41 81 e-mail: ersinerek@hotmail.com

Evaluating and improving the quality of care, assessing surgical performance, and reporting the results are essential in modern congenital cardiac surgery;[1-3] therefore, an adequate risk stratification and classification method is needed. For this purpose, the Aristotle scoring system[4] was developed from 1999 to 2003 by expert pediatric cardiac surgeons representing 50 centers from different countries. This risk classification model includes both basic and comprehensive complexity scores. The Aristotle basic complexity (ABC) score, a procedure-adjusted scoring system, contains the sum of the potential for mortality, morbidity, and the anticipated surgical difficulty of the procedures (1.5-15 points), whereas the Aristotle comprehensive complexity (ACC) score contains the sum of the ABC score and patient-adjusted risks (1.5-25 points). It also includes procedure-dependent factors (0-5 points), such as anatomical factors and their associated procedures, along with procedure-independent factors (0-5 points) like general condition, clinical parameters, extracardiac anomalies, preoperative mechanical ventilation, and renal failure. In addition, the Aristotle scoring system divides the procedures into six levels according to the points of complexity, with level 1 having 1.5-5.9 points, level 2 6-7.9 points, level 3 8-9.9 points, level 4 10-15 points, level 5 15.1-20, and level 6 20.1-25 points.[4] The aim of this study was to analyze our surgical results for congenital heart diseases according to the Aristotle scoring system.

PATIENTS AND METHODS

All of the congenital cardiac surgical procedures (167 surgical procedures in 163 patients) included in this study were performed by the same surgeon in 2012, and only the primary procedure for each hospital stay was evaluated based on the Aristotle scoring system. If the interventions involved two or more procedures during the same hospital admission, the procedure having the highest ABC score was chosen as the primary procedure.[1,5,6]

The International Congenital Heart Surgery Nomenclature and Database Project was used to define the procedures and pathologies used in our study,[7] and the demographic characteristics and procedure details were collected prospectively. The ABC and ACC scores were calculated according to the Chart,[1] and the patients were divided into the six complexity levels. Early mortality was defined as death that occurred during the hospital stay while morbidity was defined as an intensive care unit (ICU) stay equal to or longer than seven days. Furthermore, the morbidity index was calculated by dividing the number of procedures with an ICU stay of at least seven days by the total number of procedures. Additionally, we defined surgical difficulty as a cardiopulmonary bypass (CPB) duration of longer than 120 minutes in patients who underwent open heart surgery or a procedure of longer than 120 minutes in patients who underwent heart operations without using CPB. To calculate the surgical difficulty index, the number of operations that were considered to be surgically difficult was divided by the total number of procedures. We also recorded all of the postoperative complications for each procedure and classified them according to the nomenclature.[7]

All statistical analyses were performed using the Number Cruncher Statistical System (NCSS) 2007 statistical software program (NCSS, LLC, Kaysville, Utah, USA), and we used Spearman's correlation analysis to make a comparison between the Aristotle scores and mortality, morbidity, and surgical difficulty. The means were given using standard deviation (SD) and percentages with a 95% confidence interval (CI), when indicated, and we compared the means between the two groups using an independent samples t-test. In addition, we utilized one-way analysis of variance (ANOVA) to compare more than two groups, and for dichotomous variables, we utilized a chi-square test. A p value of 0.05 was considered to be statistically significant.

RESULTS

Table 1 shows the detailed characteristics of the patients. According to our analysis, 39 patients were neonates (23.9%) and 46 were infants (28.2%). The overall hospital mortality rate was 12.5%, and there was an inverse relationship between the age groups and mortality ($p<0.05$), with the highest rate being for the neonates (26.2%) and the lowest for the children (age range 1-18 year) (5%). Furthermore, we determined that the neonates and early infants needed longer ICU and hospital stays than the late infants and children ($p<0.05$). Moreover, the ABC and ACC scores became significantly higher as the ages of the patients decreased.

The individual indices of mortality as well as the morbidity index and surgical difficulty index per procedure are shown in Table 2 along with the ABC and ACC scores. The most frequent procedure was ventricular septal defect (VSD) patch repair (ABC score: 6) which made up 10.1% (n=17) of all of the procedures. This was followed by both atrial septal defect (ASD) repair (n=14) and arterial switch surgery

Table 1. Characteristics of the 163 patients according to age at time of surgery

Variables	0-28 days			29-89 days			90-365 days			>365 days			Total		
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD
Number of patients	39				19.00		27			78			163		
Number of procedures	41				19.00		27			80			167		
Age at time of surgery			11.2±7.1			44.2±15.1			193.7±75.3			3149.6±2816.8			1538.7±2476.0
Body surface area (m^2)			0.6±0.4			0.5±0.4			0.6±0.4			0.6±0.4			0.6±0.5
Number of procedures with CPB	26				16.00		24			64			130		
CPB duration (minutes)			110.4±79.7			112.3±79.4			112.3±79.4			110.9±80.5			110.4±79.7
Number of procedures without CPB	15				3.00		3			12			33		
ICU stay (days)			12.1±9.6			18.1±24.4			8.8±12.5			3.5±5.5			8.1±12.4
Hospital length of stay (days)			16±10.4			23.2±24.2			14.3±12.4			10.1±7.8			13.6±12.6
Complications	42	102.4		29	152.6		37	137		47	58.8		155	92.8	
Mortality	11	26.2		4	21.1		2	7.4		4	5		21	12.5	
ABC score (points)			9.5±3.2			8.0±1.9			7.4±1.7			6.5±2.3			7.5±2.7
ACC score (points)			11.3±4.3			9.2±2.7			7.9±1.61			7.2±2.7			8.6±3.5

SD: Standard deviation; CPB: Cardiopulmonary bypass; ICU: Intensive care unit; ABC: Aristotle basic complexity; ACC: Aristotle comprehensive complexity.

(n=14), both of which occurred at a rate of 8.3%. The mean ABC score was 7.5±2.7 and ranged from 3.4 (ASD repair) to 14.5 (Norwood procedure).

Twelve of the 17 most common surgical procedures had no mortality, and there was only one in-hospital mortality for the arterial switch operation, pulmonary banding, and coarctation repair procedures (mortality rate of 7.1%, 7.7%, and 16.2%, respectively) Furthermore, these three patients had the highest ACC scores in their case categories (12.5, 14, and 10, respectively). As shown in Table 2, five out of the eight patients who underwent the Norwood procedure died, giving it the highest mortality rate at 63%. Additionally, there was no mortality for the patients who underwent surgery for an atrioventricular septal defect (AVSD), tetralogy of Fallot (TOF), ASD repair, or VSD repair or for those who underwent Rastelli and Fontan operations. Among the nine patients who died in the early postoperative period, six had complex congenital heart disease, either with or without atrial isomerism, and underwent palliation with pulmonary banding, bilateral pulmonary banding, central shunt or atrial septectomy with or without total anomalous pulmonary venous return repair. Each of these six patients were in critical condition or underwent the procedure under resuscitative circumstances. The remaining three already had severe pulmonary vascular disease and underwent palliation via an atrial septectomy (n=1) or valvuloplasty (n=2).

The mean ACC score for all of the cases was 8.6±3.5. In addition, 48 of the procedures (28.7%) were categorized as level 4 (ACC scores of 10-15 points), and one patient, who underwent the Norwood procedure, had the highest complexity level of six (ACC score of 24.5). The distribution of the procedures according to complexity levels is given in Table 3.

The overall mortality rate was 12.5% (n=21), and the following mortality ratios were recorded: level 1: 3.7% (1/27), level 2: 4.5% (2/44), level 3: 13.6% (6/44), level 5: 66.6% (2/3), and level 6: 100% (1/1) (Table 3). Furthermore, the mortality rates were significantly related to the ACC scores and complexity levels ($p<0.019$) (Figure 1), and there was an inverse relationship between the mortality rates and patient age (Table 1).

We calculated the total morbidity index as 33.5% (n=56), with a rate of 3.7% in level 1, 25% in level 2, 34% in level 3, 54.1% in level 4, and 100% in level 5. There was also one patient in level 6, but he died before the seventh postoperative day, so the morbidity level could not be calculated correctly for

Table 2. Procedures and Aristotle scores, mortality and indices of morbidity, and surgical difficulty

Procedures	*Total*	ABC score	ACC score	Mortality		Morbidity index		Difficulty index	
	n	Mean±SD	Mean±SD	n	%	n	%	n	%
Ventricular septal defect repair, patch	17	6.2±0.8	7.1±1.1	0	0	2	11.8	1	5.9
Atrial septal defect repair	14	3.4±0.8	3.9±1.2	0	0	0	0	1	7.1
Arterial switch operation	14	10.7±0.7	12.1±1.5	1	7.1	14	100	14	100
Atrioventricular septal defect repair	13	8.4±1.9	8.9±1.9	0	0	7	53.8	6	46.1
Tetralogy of Fallot total correction	13	8.0±1.0	8.2±1.3	0	0	4	30.8	5	38.5
Coarctation repair, end to end, extended	13	7.4±0.9	9.1±3.4	1	7.7	5	38.5	0	0
Shunt, systemic to pulmonary, MBTS	12	6.6±0.2	7.3±1.0	2	16.7	9	75	0	0
Norwood procedure	8	14.50	16.2±3.6	5	63	5	62.5	8	100
Total abnormal pulmonary venous return repair	7	9.00	9.5±0.9	0	0	4	57.1	2	28.6
Bidirectional cavopulmonary anastomosis	6	7.2±0.3	8.0±1.0	0	0	0	0	0	0
Pulmonary banding	6	6.00	9.5±4.1	1	16.7	3	50	0	0
PAPVD repair, with ASD repair	5	5.00	5	0	0	0	0	0	0
Kawashima operation	2	7.2±0.4	9.2±0.4	0	0	0	0	1	50
Fontan procedure	2	9.00	10.3±1.1	0	0	0	0	2	100
Rastelli operation	2	10.00	11.5±0.7	0	0	0	0	2	100
Senning operation	2	8.50	9.5±1.4	0	0	0	0	1	50
Ross operation	2	7.4±2.4	8.3±2.9	0	0	0	0	2	100
Others	29	7.4±2.7	8.5±3.5	11	34.4	3	10.3	8	27.5
Total	167	7.5±2.7	8.6±3.5	21	12.5	56	33.5	53	31.7

ABC: Aristotle basic complexity; ACC: Aristotle comprehensive complexity; SD: Standard deviation; MBTS: Modified Blalock-Taussig Shunt; PAPVD: Pulmonary arterial pressure septal defect; ASD: Atrioventricular septal defect.

level 6. In the end, we determined that there was a strong positive relationship between the complexity levels and morbidity indices ($p<0.001$) (Figure 2).

Table 4 lists the complications that occurred during the hospitalization period, and a total of 155 complications were observed in 71 patients (43%; mean 0.95 per patient). The most frequent complication was a sternum which was left open in 14.4% of the patients (n=24). Other frequent complications included the following: 12% (n=20) spent more than one week on mechanical respiratory support, 10.8% (n=18) had postoperative low cardiac output, 6% (n=10) needed postoperative mechanical circulatory support (ECMO), 4.2% (n=7) had arrhythmia, and 4.2% (n=7) had septicemia. The complication rate was the lowest in level 1 (19%) while it increased to 90.9% in level 3 and reached 166.7% in level 5. Moreover, the complication rate rose significantly when the level of complexity increased ($p<0.05$).

The surgical technique difficulty indices for each procedure and complexity level are displayed in Tables 2 and 3, respectively. The overall index for the cases was 31.7% (n=53) while it was 0% in level 1 and 100% in level 6. Figure 3 also illustrates the relationship between the ACC scores and the surgical difficulty index, with a positive correlation being found between the level of complexity and surgical difficulty indices ($p<0.001$).

DISCUSSION

The Aristotle scoring system was developed to evaluate and classify congenital cardiac procedures according to mortality, morbidity, and surgical difficulty levels.[4] The ABC score for any procedure is constant, but the ACC score includes procedure-dependent and procedure-independent factors.[4] Because of this, the ACC score is used more often for estimating mortality and morbidity.[5,6,8] The preoperative condition and comorbidities of the patients clearly affect the postoperative performance; hence, the ACC score provides a more detailed analysis of the patients by adding these preoperative conditions to the risk calculation.[8,9]

When the mortality, morbidity, and surgical difficulty scores of the ACC are considered, mortality is constant, whereas evaluating morbidity is more difficult. It should ideally be based on the observed postoperative complications that affect the patient's quality of life (QoL). O'Brien et al.[6] chose "prolonged hospital stay" (>21 days) as a marker of morbidity and observed a significant positive correlation with the ABC score. Clarke et al.[1] recently proposed that morbidity scores should be made up of the following four components: postoperative hospital length of stay, postoperative time on the ventilator, postoperative mechanical circulatory support [extracorporeal membrane oxygenation (ECMO)] and/or ventricular

Table 3. Characteristics of 167 procedures according to Aristotle basic complexity levels

Variable	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6		*Total*		
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	n	%	n	%	Mean±SD
Number of patients	27			44			43			46			2			1		163		
Number of procedures	27			44			44			48			3			1		167		
Age at time of surgery (days)			3880.7±2723.4			1006.1±2032.6			1530.3±2501.3			876.9±2016.3			7.5±7.8	2				1538.7±2476.0
Body surface (m^2)			0.6±0.4			0.5±0.3			0.6±0.4			0.4±0.3			0.2±0.0	0.16				0.6±0.5
Number of procedures with CPB	21			27.00			35			44			2			1		130		
CPB duration (min)			60.8±21.1			63.8±17.5			122.9±80.5			176.6±98.7			202.3±80.8	143				110.4±79.7
ICU stay (days)			1.4±2.2			7.8±14.0			8.3±10.2			11.9±14.8			13±4.2	3				8.1±12.4
Hospital length of stay (days)			6.1±5.4			14.1±14.1			14.4±10.7			17.0±14.8			13±4.2	3				13.6±12.6
Complications	5	19		41	93.2		40	90.9		62	129.2		5	166.7		2	200	155	92.8	
ABC score (points)			3.7±1.0			6.5±0.6			7.8±1.1			10.1±2.4			10.5±2.1	14.50				7.5±2.7
ACC score (points)			3.9±1.0			6.7±0.7			8.6±0.5			11.9±1.6			19.1±1.8	24.50				8.6±3.5
Mortality	1	3.7		2	4.5		6	13.6		9	18.8		2	66.6		1	100	21	12.5	
Morbidity index		3.7			25			34			54.1			100			ø	3	3.5	
Surgical difficulty index	0				4.5			34			68			66			100		31.7	

Level 1: 1.5-5.9; Level 2: 6-7.9; Level 3: 8-9.9; Level 4: 10-15; Level 5: 15.1-20; Level 6: 20.1-25 points; SD: Standard deviation; CPB: Cardiopulmonary bypass; CPB: Cardiopulmonary bypass; ICU: Intensive care unit; ABC: Aristotle basic complexity; ACC: Aristotle comprehensive complexity.

assist device time, and major complications. Like us, Heinrichs et al.[5] chose the ICU stay as a determinant of morbidity and found a high correlation between the ACC scores and morbidity indices. According to the original Aristotle score principles, we selected an ICU stay of longer than seven days as a marker of morbidity and also found a significant correlation with these scores.

Estimating surgical technical difficulty is a controversial undertaking. Heinrichs et al.[5] accepted 120 minutes as the threshold value to calculate the surgical difficulty index. We agreed with them and used the same threshold in our study. The same surgeon performed all the procedures that we considered, but our results cannot be generalized and applied to every clinic[2] because the parameters depend strongly on local circumstances and the surgeon who performs the procedure.

In this study, our aim was to evaluate our unit's performance because a clinic's performance demonstrates the quality of care in congenital heart surgery and the requirements needed to have excellent results. Our findings indicate that we used the ABC and ACC scores efficiently for two years and took preventions to improve quality, including providing ICU education to our nurses and doctors, being attentive during follow-up visits, giving more detailed preoperative evaluations of the patients, preventing infections, and making improvements in surgical techniques. The mortality rate of the Norwood procedure was 63% in this study, but we have reduced this ratio to approximately 30% the last 10 times we have performed this procedure.

Another scoring system that has been used in congenital heart surgery is the Risk Adjustment for Congenital Heart Surgery (RACHS-1) method, which also categorizes the patients into six complexity levels.[9] However, Özkan et al.[10] detected no correlation between mortality and morbidity in patients that weighed under 3 kg who underwent open heart surgery when using the RACHS-1 or the Aristotle scoring system. We recently published our overall results based on the RACHS-1 risk assessment model[2] and noted a strong association between in-hospital mortality and hospital length of stay. However, surgical performance should not be measured only by postoperative mortality and the complexity of the procedures. It also requires a thorough determination of patient-specific, procedure-dependent, and procedure-independent factors.[4,11] Thus, we believe that the Aristotle scoring system provides a more accurate way of evaluating surgical

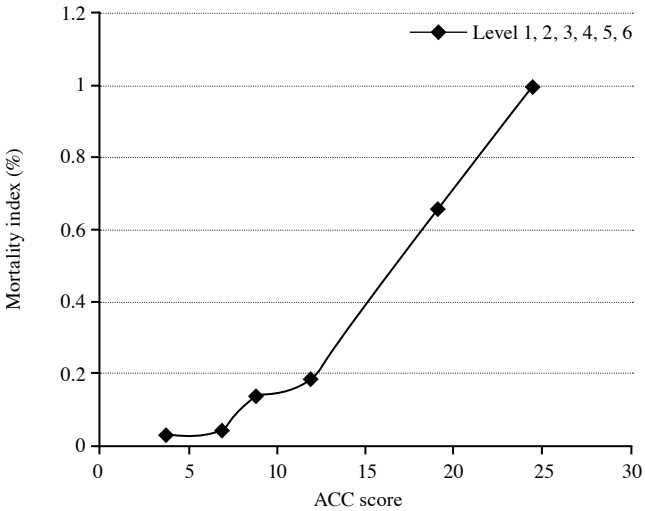

Figure 1. Aristotle comprehensive score and mortality index. ACC: Aristotle comprehensive complexity score.

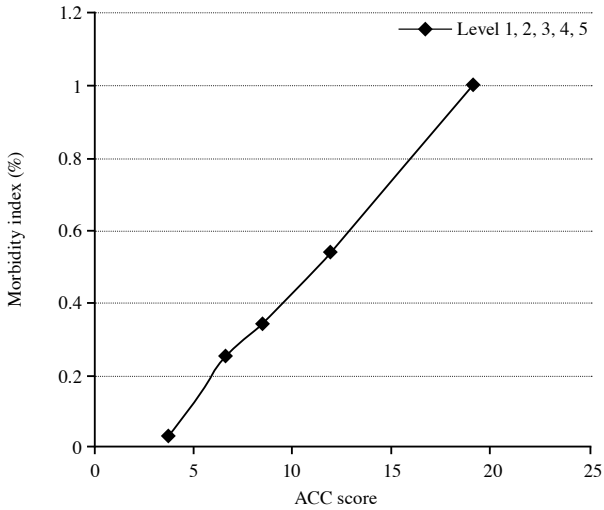

Figure 2. Aristotle comprehensive score and morbidity index. ACC: Aristotle comprehensive complexity score.

performance because it includes those parameters.[8,9] In addition, both the RACHS-1 and Aristotle scoring systems allow for the classification of congenital heart surgery units according to the complexity of surgical procedures that are carried out.

Our center is a member of the European Association of Cardiothoracic Surgery (EACTS) Congenital Database. This collects data from all over the world, and it is possible to see all procedures and results of their members on their website.[12] The quality of care chart shows the comparative results of the centers that are a part of that database, and Figure 4 shows the volume of the centers as well as the individual surgeons. The complexity levels of our patients were higher than average, but we still need to improve our outcomes. Our hospital is a tertiary center and accepts all kinds of patients from all over the country; therefore, emergency surgery and salvage operations were included in our study. Furthermore, complex palliations, such as the Norwood procedure and heterotaxy syndromes, are important causes of mortality. Nevertheless, our results with the Norwood procedure are improving, which might significantly contribute to a reduction in mortality for our patients.

Mechanical circulatory support, such as ECMO, is another vital component when attempting to reduce mortality in patients undergoing congenital heart surgery. In this study, 10 patients needed ECMO in the early postoperative period due to cardiac arrest or low cardiac output. Three of them (one who underwent the Norwood procedure, one who needed a central shunt, and one with pulmonary banding) were successfuly weaned from support and discharged without significant sequelae. We believe that more patients can be salvaged with increased experience. Our policy is to use mechanical circulatory support

Table 4. Postoperative complications of primary procedures (n=167)

Factors	n	%
Sternum left open	24	14.4
Postoperative respiratory insufficiency requiring mechanical ventilatory support >1 week	20	12.0
Postoperative low cardiac output	18	10.8
Postoperative cardiac arrest	18	10.8
Postoperative pulmonary hypertension crisis	10	6.0
Postoperative mechanical circulatory support	10	6.0
Postoperative arrhythmia	7	4.2
Postoperative complete atrioventricular block requiring temporary pacemaker	7	4.2
Postoperative septicaemia	7	4.2
Bleeding requiring reoperation	5	3.0
Acute renal failure requiring temporary dialysis	5	3.0
Pneumonia	5	3.0
Pleural effusion requiring drainage	4	2.4
Chylothorax	3	1.8
Pericardial effusion requiring drainage	3	1.8
Postoperative neurological deficit persisting at discharge	3	1.8
Postoperative complete atrioventricular block requiring permanent pacemaker	2	1.2
Wound infection	2	1.2
other complications	2	1.2
Total	155	92.8

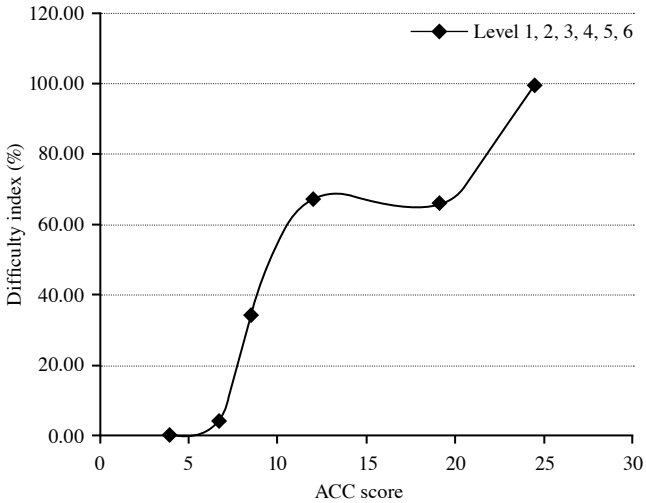

Figure 3. Aristotle comprehensive score and surgical diffculty index. ACC: Aristotle comprehensive complexity score.

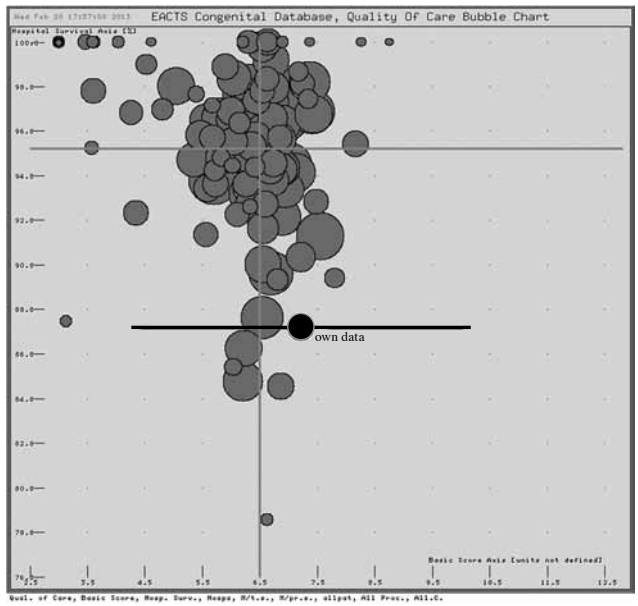

Figure 4. European Association of Cardiothoracic Surgery (EACTS) Congenital Database, quality of care bubble chart showing individual congenital heart surgeon's comperative results. X axis shows complexity; y axis shows hospital survival; magnitute of a bubble shows case volume.

for all patients without genetic anomalies or other contraindications who have unexpected cardiac arrest or low cardiac output in the early postoperative period after congenital heart operations, especially when all conservative methods have failed to improve the patients' status.[13]

Unfortunately, there is limited available data concerning the volume, complexity, and results associated with congenital heart surgery in Turkey.[3,14] In our opinion, a national program and database project should be developed to evaluate the current status of patients having congenital heart operations, and future planning is needed to improve the quality of care for these patients,[3,14] This data could then be used to determine the minimal requirements for an efficient pediatric cardiac program.

Not only can the Aristotle scoring system be used for congenital heart surgery, but it is also an appropriate tool for evaluating many adult cardiac procedures. For example, the basic score of a coronary bypass operation is 7.5 points, while it is 8 points for mitral valvuloplasty and 11 for aortic dissection repair. In addition, an arterial switch operation accounts for 10 points while the Norwood procedure has the highest score at 14.5 points. Accurate scoring of all cardiac procedures may also help when considering reimbursement issues, which is a major obstacle to building and sustaining a congenital heart center in Turkey.[14]

Conclusion

This study confirms that the Aristotle scoring system provides a detailed, adequate analysis for evaluating the surgical results associated with congenital heart surgery because it makes it possible for yearly monitoring of a center's surgical performance, and it provides a way to compare results from centers around the world. Furthermore, the data obtained from this instrument can be used to improve the quality of care for patients with congenital heart disease.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

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