ORIGINAL RESEARCH

The Application and Benefits of C-CHEWS in Infants with Left-to-Right Shunt Congenital Heart Disease during the Transition Period after Surgery

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ABSTRACT

Objective • This study aimed to explore the predictive value of various indicators in the application of C-CHEWS (Cardiac-Children's Hospital Early Warning Score) during the transition period of infants with left-to-right shunt congenital heart disease after surgery.

Methods • A retrospective study was conducted on 229 infants who underwent surgery for left-to-right shunt congenital heart disease at a tertiary pediatric hospital in Anhui Province from January 2019 to March 2022. The infants' status was evaluated using C-CHEWS scores within 1 hour of transfer from the ICU to the transitional ward. A cutoff score 6 was used, with scores ≤6 defining the control group and scores ≥7 defining the observation group. The predictive value of various indicators during this period was analyzed.

Results • The 229 infant patients were divided into the control group (n = 154) and the observation group (n = 75). All infants received sufficient oxygen inhalation, and 210 infants underwent VIS (Vasoactive-inotropic Score) evaluation, with 137 in the control group and 73 in the observation group, showing a statistically significant difference between the two groups. All infants were discharged without recurrence of ICU admission within 48 hours. In the C-CHEWS evaluation, medical staff attention and parental concern were assigned 1 point, while the consciousness level received 0 points. The respiratory system scores ranged from 2 to 3 points without a statistically significant difference, whereas the cardiovascular system scores ranged from 0 to 3 points and showed a statistically significant difference. Among the 75 observation group patients, 43 were boys, accounting for 57.33%.

Conclusions • During the transition period after surgery for congenital heart disease in infants, monitoring the cardiovascular system, along with the effective application of VIS, through C-CHEWS scoring, can help detect warning signs. Focusing on managing cardiovascular function is crucial to reduce the risk of disease deterioration, promoting comfort, and aiding in the infants' recovery. (*Altern Ther Health Med.* 2023;29(7):155-159).

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INTRODUCTION

Infant left-to-right shunt congenital heart disease poses significant challenges in pediatric cardiology, with abnormal blood flow patterns and potential complications that require comprehensive management strategies for optimal patient outcomes.[1-2] Early identification of congenital heart disease (CHD) in infants is crucial for timely intervention and improved long-term prognosis. In a study conducted by Claus Sixtus Jensen,[1] it was observed that 33% of children readmitted to the ICU were infants under one-year-old, highlighting the vulnerability of this age group and the need for closer observation. Ruiz et al.[2] developed a clinical deterioration risk model for identifying ICU heart patients using vital sign data, medication, laboratory testing data, and other indicators. The model achieved an AUROC (Area Under the Receiver Operating Characteristic Curve) of 0.92 within 4 hours before deterioration, suggesting that most clinical deterioration may exhibit warning signs at least 4 hours in advance and can be identified through risk factors.

The Cardiac-Children's Hospital Early Warning Score (C-CHEWS), proposed by McLellan et al.,[3,4] is an early warning scoring system specifically designed for pediatric heart disease based on the Brighton Paediatric Early Warning Score (BPEWS). C-CHEWS has been further refined and implemented in cardiovascular specialties worldwide, demonstrating a certain level of sensitivity and specificity.[5-7]

The application of the Vasoactive-Inotropic Score (VIS) can play a preventive and supportive role in the cardiac function of pediatric patients, with its predictive value potentially influenced by factors such as dosage complexity and the type of disease. Maintaining cardiovascular function through the utilization of VIS is of utmost importance. In a questionnaire survey conducted by Gong Xiaolei et al.[8] among 17 domestic centers specializing in the diagnosis and treatment of congenital heart disease, it was found that 16 centers had already implemented VIS for preventive purposes. While their usage strategies aligned with those abroad, significant variations in medication practices were observed among different centers.

Literature suggests that a VIS score exceeding 20 points signifies poor cardiac function and can serve as a valuable indicator for predicting prognosis.[9] A previous study revealed that in children with total anomalous pulmonary venous connection (TAPVC), those exhibiting a maximum VIS score of ≥29 within 24 hours after surgery faced a higher risk of early postoperative mortality.[10] However, the prognostic significance of VIS scores below 20 points remains unclear.

Therefore, our study aims to investigate the importance of VIS and other indicators in monitoring the post-surgical condition of infants with congenital heart disease. It also aimed to provide insights into the predictive value and effectiveness of C-CHEWS in monitoring the post-surgical condition of infants with congenital heart disease, thereby contributing to improved patient care and outcomes.

METHODS

Study Design

A retrospective study was performed by our department. A cohort of 229 infants who underwent surgery for left-to-right shunt congenital heart disease and were subsequently discharged from the hospital between January 2019 and March 2022 was included in this study. C-CHEWS scores were assigned to data collected within 1 hour of transferring infants with congenital heart disease from the ICU to the transitional ward.

Inclusion and Exclusion Criteria

Inclusion criteria: (1) infants within the age range of 1 month to 12 months; (2) those who underwent congenital heart disease surgery and were transferred from the ICU to the ward; (3) nursing records that met the C-CHEWS scoring criteria; and (4) axillary temperature measurements between 36.0°C and 37.3°C. Exclusion criteria: (1) infants outside the age range of 1 month to 12 months; (2) those with axillary temperatures below 36.0°C or above 37.3°C; (3) and data with incomplete C-CHEWS assessments.

Data Collection

The general data collected for each infant included gender, age, and weight. Observational data encompassed various parameters related to C-CHEWS, such as the behavior of the nervous system, respiratory system (monitored artificially), oxygen inhalation, cardiovascular system data (monitored using pulse oximetry), attention from medical staff, parental concerns, and additional indicators like the use of vasoactive drugs VIS, length of hospital stay post-surgery, and outcomes. Notably, all infants in the study remained free of ICU readmission within 48 hours and were discharged following recovery.

C-CHEWS Scoring and Criteria

The C-CHEWS scoring system determined age-appropriate heart and respiratory rate ranges referencing the 5th edition of "Pediatric Nursing." A heart rate of 110 to 130 beats/min and a respiratory rate of 30 to 40 breaths/min were considered within the normal range for infants. A score of 0 indicated normalcy, while a score of 1 or higher suggested an abnormal finding. Both medical staff attention and parental worries were assessed and assigned scores within the C-CHEWS framework. Additionally, the respiratory and cardiovascular systems were evaluated based on nursing records.

Cutoff Score and Grouping

To account for the subjective nature of scoring medical staff attention and parental worries, previous studies[11,12] employed a cutoff score of 6. Accordingly, ≤6 points were assigned to the control group, while ≥7 points were assigned to the observation group. This grouping approach allowed for an analysis of the scores for various indicators among infants during the designated period; refer to Figure 1.

Figure 1. The Cardiac-Children's Hospital Early Warning Score table

Cardiac-Children's Hospital Early Warning Score					
	0	1	2	3	score
Behavior/Neuro	laying/sleeping appropriately; Alert, at patient's baseline	Sleepy, somnolent when not disturbed	Irritable, difficult to console; Increase in patient's baseline seizure activity	Lethargic, confused, floppy; Reduced response to pain; Prolonged or frequent seizures; Pupils asymmetric or sluggish	
Cardiovascular	Skin tone appropriate for patient; Capillary refill ≤2 seconds	Pale; Capillary refill 3-4 seconds; Mild* tachycardia; Intermittent ectopy or irregular HR (not new)	Grey; Capillary refill 4-5 seconds; Moderate* tachycardia	Grey and mottled; Capillary refill >5 seconds; Severe* tachycardia; New onset bradycardia; New onset/increase in ectopy, irregular HR or heart block	
Respiratory	Within normal parameters; no retractions	Mild* tachypnea/ increased WOB (flaring, retracting); Up to 40% supplemental oxygen; Up to 1L NC > patient's baseline need; Mild desaturations < patient's baseline; Intermittent apnea self-resolving	Moderate* tachypnea/ increased WOB (flaring, retracting, grunting, use of accessory muscles); 40-60% oxygen via mask; 1-2 L NC > patient's baseline need; Nebs q 1-2 hr; Moderate desaturations < patient's baseline; Apnea requiring repositioning or stimulation	Moderate* tachypnea/increased WOB (flaring, retracting, grunting, use of accessory muscles); 40-60% oxygen via mask; 1-2 L NC > patient's baseline need; Nebs q 1-2 hr; Moderate desaturations < patient's baseline; Apnea requiring repositioning or stimulation	
Staff Concern		Concerned			
Family Concern		Concerned or absent			
					Total

	Mild*	Moderate*	Severe*
Infant	≥10%↑ for age	≥15%↑ for age	≥25%↑ for age
Toddler and Older	≥10%↑ for age	≥25%↑ for age	≥50%↑ for age

Note: Figure 1 presents the Cardiac-Children's Hospital Early Warning Score (C-CHEWS) table, which provides a comprehensive scoring system for evaluating the condition of infants with congenital heart disease during the postoperative transitional period. The table includes various indicators and corresponding scoring criteria used to assess different aspects of the patient's health status.

Table 1. General data of infants after left-to-right congenital heart disease surgery

Group	Control Group (n = 154)	Observation Group (n = 75)	χ^2/t test	*P* value
Gender (male/female)	76/78	43/32	1.288	.256
Body weight (Kg)	6.52 ± 1.67	6.68 ± 1.50	-0.676	.500
Age (month)	6.36 ± 2.97	6.27 ± 2.44	0.210	.834

Note: The table presents the general data of infants after left-to-right congenital heart disease surgery, with gender distribution analyzed using the chi-square test and body weight and age compared using *t* tests, showing no statistically significant differences between the control and observation groups.

Table 2. Observation Data of C-CHEWS, VIS Application Scores, and Length of Stay After ICU

Group		Control group (n = 154)	Observation group (n = 75)	χ^2/t test	*P* value
C-CHEWS	Respiratory rate score (Yes/No abnormal)	1(0.65%)	2(2.67%)	1.588	.208
	Cardiovascular system score (Yes/No abnormal)	58(37.66%)	75(100%)	80.500	<.001
VIS	VIS (Yes/No application)	137(88.96%)	73(97.33%)	4.657	.031
	VIS score	8.64±4.63	9.84±4.03	-1.913	.057
	VIS applied dose (whether ≤10 points)	33(21.43%)	21(28.00%)	1.209	.272
Length of Stay	Length of stay after ICU (days)	6.50±1.77	6.67±2.00	-0.615	.539

Note: The table presents the observation data of C-CHEWS (Cardiac-Children's Hospital Early Warning Score), VIS (Vasoactive-inotropic Score) application scores, and length of stay after ICU (Intensive Care Unit). The control group comprised 154 infants, while the observation group included 75 infants. The data were analyzed using chi-square tests and *t* tests

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics version 26 (IBM, Armonk, NY, USA). Descriptive statistics such as mean and standard deviation were used to summarize metric data with a normal distribution. To compare between two groups or examine single-factor variation within a group, independent sample *t* tests were utilized. For count data requiring category analysis, the chi-square test was employed. A *P* value of $P<.05$ was considered indicative of a statistically significant difference.

RESULTS

Demographic Characteristics and Comparison between Study Groups

The control group comprised 154 pediatric patients, while the observation group comprised 75 pediatric patients based on their respective C-CHEWS scores. Gender, age, and weight did not exhibit statistically significant differences between the control and observation groups ($P>.05$). Within the observation group were 43 male and 32 female patients, with males accounting for 57.33% of the total (Table 1).

Evaluation of C-CHEWS Scores and Comparison between Study Groups

Regarding the C-CHEWS scores of the experimental pediatric patients, the medical staff's attention and the parents' concerns items received a score of 1 point. The behavior and nervous systems were assessed as clear, resulting in 0 points. For the C-CHEWS, the respiratory rate score indicated whether abnormal respiratory rates were present, with 1 case (0.65%) in the control group and 2 cases (2.67%) in the observation group, while the remaining cases scored 0 points. The chi-square test did not reveal a statistically significant difference ($\chi^2=1.588$, $P=.208$). Since all patients were receiving oxygen inhalation, individual scores of 2-3 points were assigned to the respiratory system without summing them up. The highest individual score determined the overall respiratory system score. The respiratory system mainly relied on oxygen flow rate for scoring, and no significant difference was observed between the two groups ($P>.05$).

The cardiovascular system scores ranged from 0 to 3 points, with a high heart rate being the main contributor. The cardiovascular system score indicated the presence of abnormalities, with 58 cases (37.66%) in the control group and 75 cases (100%) in the observation group. The chi-square test showed a significant difference between the groups ($\chi^2=80.500$, $P<.001$).

Application of VIS and Dosage Comparison

The VIS score was calculated using the formula dopamine (ug·kg-1·min-1) + dobutamine (ug·kg-1·min-1) + milrinone (ug·kg-1·min-1) × 10 + epinephrine (ug·kg-1·min-1) × 100 + norepinephrine (ug·kg-1·min-1) x 100 + vasopressin (u·kg-1·min-1) × 10000.[13] Out of the total 154 cases in the control group, 137 (88.96%) accepted the application of VIS, while in the observation group, 73 out of 75 cases (97.33%) underwent VIS application, indicating a significant difference between the two groups ($P<.05$).

Regarding the dosage of VIS application, using a cutoff of 10 points as reported previously,[14] 33 cases (21.4%) in the control group and 21 cases (28%) in the observation group met the criteria, with no significant difference observed between the two groups in this comparison ($P>.05$); refer to Table 2.

Length of Hospital Stay after ICU Discharge

The length of stay after ICU was 6.50±1.77 days in the control group and 6.67±2.00 days in the observation group, with no statistically significant difference (t=-0.615, P=.539). For more detailed information, refer to Table 2.

DISCUSSION

The findings of our retrospective study investigating the C-CHEWS score in infants with left-to-right shunt congenital heart disease during the postoperative transition period highlight the significance of monitoring the cardiovascular system. Our study indicates that infants in this transition period exhibit notable cardiovascular abnormalities. Specifically, a fast heart rate was the primary manifestation observed, likely attributed to the physiological response to the trauma, repair, and compensatory mechanisms following heart surgery.

The findings reveal that approximately 5% of patients experience unexpected readmission to the ICU within the same hospitalization period following recovery and transfer from the cardiac intensive care unit (CICU). Among the reasons for readmission, cardiovascular symptoms emerge as the most common. These findings underscore the continued importance of closely monitoring the cardiovascular system during the postoperative transition period of infants with congenital heart disease, emphasizing the need for vigilant postoperative management.

It is important to note that during the initial hour of the transition period, several factors come into play, including activity, crying, and pain, as the child undergoes the process of leaving the ICU. These factors can contribute to an increase in heart rate. Considering these influences is crucial when interpreting cardiovascular observations during this critical period. Hence, relying solely on data from a single time point may be insufficient to determine whether the child is in a compensated state accurately. To ensure a comprehensive assessment, it becomes crucial to consider factors that could interfere with interpreting observations. It involves excluding interfering elements, incorporating the child's previous medical history, and seeking additional supportive data for a more holistic judgment. Using C-CHEWS aligns well with these requirements, enabling healthcare providers to continue monitoring the infant's condition attentively.

The C-CHEWS serves as an appropriate tool for monitoring the condition of pediatric cardiovascular patients, enabling early identification and treatment to prevent cardiac arrests. Given the unique characteristics of infants compared to adults, the C-CHEWS builds upon the BPEWS tool, incorporating age-specific considerations. Since infants are unable to communicate directly through words, C-CHEWS includes specific components to assess staff and family concerns. However, further validation of this tool is necessary to ensure its effectiveness and reliability.[15]

However, despite the widespread application of the C-CHEWS tool in various settings abroad, there remains a lack of comprehensive clinical research on its application. In an effort to address this research gap, our study collected a diverse range of clinical examples, including both control and observation groups, providing further evidence to support its use. Additionally, our institution has conducted follow-up studies to investigate the potential long-term impact of implementing the C-CHEWS tool, specifically examining whether there is a sustainable reduction in unplanned transfers to the CICU. By validating the reliability of the C-CHEWS score tool within the context of China, our study contributes to filling the existing research void.

In the postoperative transition period of infants with CHD, the respiratory system remains stable with adequate support from oxygen therapy. Monitoring the respiratory rate serves as an early indicator of respiratory dysfunction. However, it is important to note that manually measured respiratory rates, without electrocardiogram (ECG) monitoring, can be influenced by subjective and objective factors, limiting their reliability compared to electrocardiogram data. Oxygen inhalation effectively alleviates respiratory distress, enhances blood oxygen levels, and ensures sufficient oxygen supply to myocardial cells for metabolic and repair needs.

In evaluating the respiratory system of the patient group under study, a score of 100% was obtained based on the "oxygen flow rate" criterion. Meanwhile, the results indicated that the "respiratory rate" criterion yielded a score of 0.65% in the control group and 2.67% in the observation group. Overall, the two patient groups observed no significant difference in respiratory function. It is important to emphasize that the presence of oxygen therapy support does not necessarily indicate a positive or negative clinical condition. Rather, it could reflect the extent of respiratory and circulatory dysfunction, which warrants further investigation. Hence, it is crucial to monitor various factors such as the child's complexion, blood oxygen saturation, and mental status during the transition period. Periodic or regular assessments, including blood gas analysis, are recommended, particularly for children in this critical phase. Consequently, evaluating respiratory system function alongside relevant indicators becomes essential for a comprehensive assessment.

This study highlights the positive significance of applying the VIS in infants with congenital heart disease after surgery. Upon comparing our study's VIS scores with those previously reported, the average score in our study was below 20, and the P value was .057, indicating no statistically significant difference. These findings suggest that the application of VIS can effectively reduce the warning scores of pediatric patients, playing a preventive and supportive role in cardiac function that is not dependent on dosage. It is important to note that the observed disease type in this particular group was a simple left-to-right shunt congenital heart disease, excluding more complex congenital heart disease types.

Various objective factors, including the type of illness, indications for admission and discharge, and contextual considerations, can influence the relationship between C-CHEWS scores and readmission to the ICU. Gu Xiaorong et al.[5] reported that patients with C-CHEWS scores of 5 or higher were more likely to be admitted to the ICU, with 35% of them activating the emergency system. This finding may be attributed to factors such as the specific type of illness, indications for admission and discharge, assessment period, and bed availability during the study. Furthermore, a foreign study suggested that ICU readmission characteristics are associated with factors such as age, weight, chromosomal abnormalities, type of illness, and indications for admission.[16] Another study focusing on ICU readmissions revealed that 55% of the cases involved male patients, indicating that this group may exhibit a higher vulnerability and require closer observation.[1] In our study, boys accounted for 57.33% of the observation group, which aligns with the study's findings mentioned above, thus confirming this trend.

Thus, the findings of this study emphasize the importance of close monitoring and early intervention in the cardiovascular system during the postoperative transitional period of infants with left-to-right shunt congenital heart disease. Implementing the C-CHEWS and VIS can contribute to improved patient outcomes and enhanced care for this vulnerable population.

Study Limitations

It is important to acknowledge the limitations of this study. Firstly, the findings may be influenced by the specific postoperative time period examined, which may limit the generalizability of the results. Future research should consider including a broader range of postoperative time periods to obtain a more comprehensive understanding of the topic. Additionally, this study solely analyzes the application of the C-CHEWS tool using a cutoff point of 10 (VIS), which may not capture the full range of potential variations and nuances in its application. Future studies should explore different cutoff points or thresholds to ensure a more comprehensive assessment of its clinical utility. The limitations outlined in this study highlight the need for further research to enhance the general applicability and overall significance of the findings.

CONCLUSION

Our study identified that during the postoperative transitional period of infants with left-to-right shunt congenital heart disease, the cardiovascular system emerges as a key focus of patient management, displaying warning signs and providing valuable insights. The administration of the general dosage of the VIS demonstrates a preventive and supportive effect on the cardiovascular system, effectively reducing the warning score. It is important to note that the C-CHEWS score at a specific time point can be influenced by objective factors, necessitating regular and comprehensive monitoring to track changes and trends in the child's condition. The respiratory system remains stable with adequate support from oxygen therapy. Objective factors, including disease type, admission and discharge indications, and course stages of the course may influence the relationship between the C-CHEWS score and readmission to the ICU. By quantifying the potential harm associated with deviations from normal physiological indicators in pediatric cardiac patients, the C-CHEWS serves as a standardized and objective evaluation tool, providing a homogeneous assessment approach. This finding aids novice nurses in promptly identifying and prioritizing care for critically ill children.

CONFLICT OF INTEREST

The authors have no potential conflicts of interest to report relevant to this article.

AUTHORS' CONTRIBUTIONS

AM and LZ designed the study and performed the experiments; SD, JZ, and QZ collected the data, AM and LZ analyzed the data, and AM prepared the manuscript. All authors read and approved the final manuscript. AM, and LZ contributed equally.

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