A retrospective study of surgical outcomes of various congenital heart diseases at tertiary care center, SMS Hospital, Jaipur, Rajasthan, India

ABSTRACT
Paediatric cardiac surgery is still in growing phase in India and the expert and trained personnel for paediatric cardiac surgery is insufficient for congenital heart defects (CHD) cases. Moreover, various types of surgeries have been performed for different CHDs, and the surgical outcomes vary according to the complexity of CHD. There is continuous improvement in outcome of CHD surgery as advancement of surgical technique and post operative care with the time. However, the available data on CHD surgical outcome is limited in India. This paper defines procedure performed for particular CHD, their weightage, age group-wise distribution and the outcome of respective procedures. The paper also analyses result of surgeries performed for CHD at tertiary care centre.

Keywords: Challenges, congenital heart disease, pediatric heart surgery, surgical outcome

INTRODUCTION
Congenital heart disease (CHD) refers to the presence of a structural abnormality of the heart and/or great vessels, which is present at birth and is of actual or potential functional significance.[1] CHD is one of the major causes of infant mortality. In ~90% of the CHD cases, there is no identifiable cause that can be attributed as multifactorial defects, and most cases are asymptomatic and discovered during routine neonatal checkups.[2] CHD is the most common congenital problem in children accounting for nearly 25% of all congenital malformations.[3] Early recognition of such diseases is of immense importance as clinical presentation and deterioration can lead to sudden collapse.[4] Considering a birth prevalence of CHD as 9/1000, the estimated number of children born with CHD in India is more than 200,000/year. Of these, about one-fifth is likely to have a serious defect, requiring an intervention in the 1st year of life.[5] Approximately 25,000 surgeries are done every year for CHD in India. Thus, every year, a large number of children suffering from CHD are added in the already-existing massive disease pool. Ventricular septal defect (VSD) is the most common CHD, followed by atrial septal defect (ASD). In cyanotic group, tetralogy of Fallot (TOF) is the most common subgroup.[6] Limited number of studies and data are available about the surgical outcome of CHD in our country. Rapid advances have taken place in the diagnostic and treatment modalities of CHD over the last six decades. With the currently available treatment modalities, over 75% of infants born with critical heart disease can survive beyond the 1st year of life and many can lead normal lives thereafter. However, this privilege of early diagnosis and treatment is limited to children of developed countries only. Majority of children born in developing countries are not getting proper care, leading to high morbidity and mortality.[7] Most centers in the developed...
world have reported excellent outcomes for neonatal cardiac surgery, with an in-hospital mortality of <5%.[8]

MATERIALS AND METHODS

SMS medical college is the largest tertiary care center in Rajasthan, also serving patients from the neighboring states of Uttar Pradesh, Haryana, and Punjab. We performed a retrospective study on the surgical outcome of CHD patients operated during the year 2018 at the CTVS Department of SMS hospital. A total of 308 cases of CHD were treated, and their outcome was analyzed. We enrolled all categories of CHD for surgical repair after proper clinical assessment and desirable investigations, and necessary consent was taken. The study was analyzed with the background of the following points:

1. Age group distribution of the patient
2. Sex-wise distribution
3. Type of congenital heart defect
4. Type of surgery performed
5. Average pump and cross-clamp time
6. Intensive care unit (ICU) stay
7. Mortality.

Figure 1 shows the age group distribution of patients. The graph analyzes the number of cases of different types of disease for particular age group.

Figure 2 shows the pattern of average pump time for different types of CHDs.

Figure 3 shows the average cross-clamp time for respective CHD.

The average ventilation time for ASD and VSD was 10 h; for TOF, it was around 12–15 h. The average ventilation time for rest of the other CHDs was 15–18 h. For patent ductus arteriosus (PDA), it was 2 h approximately.

The average ICU stay for ASD was 36 h; for VSD, it was 36 h. The average ICU stay for TOF was 72 h and for PDA, it was 24 h. The ICU stay for other diseases was approximately 48–72 h.

RESULTS

A large number of cases (308) have been operated during this year, as compared to previous years in the department of cardiothoracic surgery. The largest group was ASD including both secundum and sinus venous types of ASD for which patch repair was performed. And, the result was analyzed in terms of postoperative mortality, ICU stay, and reexploration. Four cases of TOF and one case of VSD were reexplored for postoperative bleeding.

| Age group (years) | Number of cases for different congenital heart defects |
|-------------------|-------------------------------------------------------|
| <1                | TAPVC, ASD, TOF, VSD, PDA, Complex, ASD              |
|                  |                                                        |
| 1-5              | Complex, VSD, TOF, ASD, PDA, Complex, ASD            |
|                  |                                                        |
| 5-10             | Complex, VSD, TOF, ASD, PDA, Complex, ASD            |
|                  |                                                        |
| 10-20            | DORV, VSD, TOF, ASD, PDA, Complex, ASD, Ebstein anomaly |
|                  |                                                        |
| 20-30            | VSD, TOF, ASD, PDA, Complex, ASD, Ebstein anomaly     |
|                  |                                                        |
| 30-40            | VSD, TOF, ASD, PDA, Complex, ASD, Ebstein anomaly     |
|                  |                                                        |
| >40              | ASD, VSD                                             |

TOF: Tetralogy of Fallot, VSD: Ventricular septal defect, ASD: Atrial septal defect, TAPVC: Total anomalous pulmonary venous connection, PDA: Patent ductus arteriosus, DORV: Double-outlet right ventricle

The mortality rate was low for both ASD and VSD. A large number of cases of TOF were also performed. Double ligation for PDA was done with zero postoperative mortality. In age group distribution defined in Table 1, most patients fell between 5 and 20 years. The ratio of male and female patients was approximately equal [Table 2].
The average pump time and cross-clamp time were also calculated from the available data. The cross-clamp time was minimum for ASD 28.95 min and maximum for total anomalous pulmonary venous connection which was 115 min. The pump time and cross-clamp time were higher for complex diseases as shown in Table 3.

**DISCUSSION**

SMS hospital is the largest tertiary health center in Rajasthan, also covering the adjoining neighboring states of Uttar Pradesh, Haryana, and Punjab. There is already an overload of adult cardiac surgery. We performed a large number of CHD surgeries in the last year, with good comparative results as depicted in Table 4. Except for complex CHD such as TOF which has a high mortality rate, complex surgery was associated with a 30% higher risk of mortality. This association appears at least partially causative, as complex surgery may be associated with longer cardiopulmonary bypass time and higher complication rates. Several parameters emerged as significant predictors of postsurgical mortality, particularly the relationship of age, pump time, cross-clamp time, hematocrit (Hb) of the patient, and type of surgery related to mortality is interesting from a clinical perspective. Mortality risk declined with age in children, with a nadir at 15–18 years for both elective and
nonelective surgeries; it increased at a slow rate with age in adults.\(^9\)

We are planning to perform CHD cases as many as possible because there is a huge waiting list of CHD patients at our institute. Higher referral centers have also a long waiting list of CHD patients. With available resources where there is also a load of adult cardiac cases, and short trained pediatric ICU nursing staff, we are trying to operate CHD cases with low morbidity and mortality.

The data available on congenital heart surgery show that mortality rates are now <5% in most of the well-established cardiac centers, where the most complex type of CHD surgeries had been performed.\(^9\) According to Stark et al., the overall mortality rate for all surgical procedures was 4.0% (with 95% confidence interval [CI]: 3.0–5.2). The mortality rate for TOF, atrio-VSD, VSD, and coarctation was 2.3%, 3.6%, 0.6%, and 1.1%, respectively. The mortality rates between surgeons varied from 1.6% to 6.9% within the limit of 95% CI.\(^1\)

According to Edward L. Hanan, there is a relation between hospital volume and surgeon volume, both of which are strongly linked with in-hospital mortality. These mortality differences also vary with high complex and low complex types of cardiac surgeries. A study shows that hospitals with annual pediatric cardiac surgery volumes of fewer than 100 had significantly higher mortality rates (8.26%) than hospitals with volumes of 100 or more (5.95%) and surgeons with annual volumes of fewer than 75 had significantly higher mortality rates (8.77%) than surgeons with annual volumes of 75 or more (5.90%).\(^2\)

### CONCLUSION

In view of the large burden of CHD in our country, congenital heart surgery is still in its emerging phase. We operate every type of CHD case, whether simple or complex, with the available resources and the results are comparable. There is a continuous requirement of well-established pediatric cardiac surgical units with trained ICU nursing staff so that maximum possible cases of CHD can be addressed.

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### Conflicts of interest

There are no conflicts of interest.

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