Deep Wound Infection in Pediatrics after Open Cardiac Surgery

Essay

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Waleed Abd-Allah Abd-Elrazzak Atiea

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List of Abbreviations

Abb.	Full term
ABC	*Aristotle Basic Complexity score*
ASA	*American Society of Anesthesiologists score*
CAS	*Comprehensive Aristotle Score*
CDC	*Centers for Disease Control and Prevention*
CDC/NHSN	*Centers for Disease Control and Prevention/National Healthcare Safety Network*
CHD	*Congenital Heart Disease*
CHS	*Congenital Heart Surgery*
CPB	*Cardio-Pulmonary Bypass*
CPBT	*Cardiopulmonary Bypass Time*
CRP	*C-Reactive Protein*
CT	*Computed Tomography*
CVC	*Central Venous Catheter*
DSC	*Delayed Sternal Closure*
DSWI	*Deep Sternal Wound Infection*
ECMO	*Extracorporeal Membrane Oxygenation*
Fig	*Figure*
HAI	*Healthcare-Associated Infection*
ICU	*Intensive Care Unit*
IL-2	*Interleukin-2*
IL-8	*Interleukin-8*
ITR	*Immature-to-Total neutrophil Ratio*
MD	*Medicinae Doctor*
MDWT	*Micro-Deformational Wound Therapy*
MRSA	*Methicillin-Resistant Staph Aureus*
MSDCPCHS	*Multi-Societal Database Committee for Pediatric and Congenital Heart Disease*

List of Abbreviations cont...

Abb.	Full term
MSSA	*Methicillin-Susceptible Staph Aureus*
NNIS	*National Nosocomial Infections Surveillance*
NPT	*Negative Pressure Therapy*
NPWT	*Negative Pressure Wound Therapy*
NTISS	*Neonatal Therapeutic Intensity Scoring System*
PCT	*Procalcitonin*
PhD	*Philosophiae Doctor*
PRISM	*Pediatric RISk of Mortality*
RACHS-1	*Risk Adjustment in Congenital Heart Surgery-1*
RBC	*Red Blood Corpuscles*
S. Aureus	*Staph Aureus*
SSI	*Surgical Site Infection*
STS–CHS	*Society of Thoracic Surgeons-Congenital Heart Surgery*
SWI	*Sternal Wound Infections*
TISS-28	*Revised Therapeutic Intensity Scoring System*
TISS-76	*Therapeutic Intensity Scoring System*
VAC	*Vacuum Assisted Closure*
WCL	*Wound Contact Layer*
WUWHS	*World Union of Wound Healing Societies*

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INTRODUCTION

Considering the rapid changes in physiologic, communicative and psychological development from birth through adolescence, it is important to define the subgroups within the paediatric population. The newborn period includes the day of birth to 30 days postnatal, and infancy is defined as 30 days to 2 years of life. Childhood starts at 2 years and extends until age 12. The adolescent period is from 12 to 21 years. [1]

Congenital heart disease (CHD) is the most frequent congenital abnormality with an estimated incidence of moderate-to severe CHD of 6 per 1000 live births. A substantial part of patients with moderate-to-severe CHD require surgical intervention, which is currently performed with low postoperative mortality. [2]

The field of cardiothoracic surgery entails not only massive surgical invasion of the heart and lungs, but also the unavoidable implantation of artificial materials and the adverse effects of the use of extra-corporeal circulation on the body's defense mechanisms, increasing the risk of postoperative infection. [3]

The mediastinum extends from the thoracic inlet to the diaphragm and lies between the right and left pleural spaces. [4] The mediastinum contains essential, vital structures and organs.

These include the thymus, trachea, bronchi, oesophagus, aorta and aortic arch, pericardium, heart, lymph nodes and nerve tissue. [5] Mediastinal structures are surrounded by loose connective tissue and fat. The mediastinum may be divided into superior and inferior parts, with inferior parts being subdivided into anterior, middle, and posterior compartments. [4]

Wound healing in children can be compromised by protein-calorie malnutrition, infection, hypotension requiring inotropic support, impaired perfusion, oedema and physiological instability that prevents safe redistribution of pressure. Distinct complexities exist in the neonatal and paediatric populations, such as immaturity, a high body surface to volume ratio, sensitivity to pain, increased potential for toxic percutaneous absorption and an immature immune system create additional intricacy in treating these age groups. [1]

The field of paediatric cardiac surgery is evolving rapidly, allowing for more complex operations to be undertaken in a younger population with more complex medical conditions. [6]

Postoperative infection is one of the most important and leading causes of increased morbidity, antibiotic usage, reoperations rate, and prolonged hospital and intensive care unit (ICU) stays, thus also augmenting treatment costs and increasing resource utilization. Postoperative infection is also a major contributor to increased mortality. [7]

In 2012, a recent prevalence study found that surgical site infection (SSIs) were the most common healthcare-associated infection (HAI), accounting for 31% of all HAIs among hospitalized patients [8] despite recent advances in surgical and intensive care therapies. [7] Surgical site infections are the second most common hospital-associated infection in the United States. [9]

While advances have been made in infection control practices, including improved sterilization methods, operating room ventilation, barriers, surgical technique, and availability of antimicrobial prophylaxis, SSIs remain an important cause of prolonged hospitalization, morbidity, and death. SSI is associated with a mortality rate of 3%, and 75% of SSI-associated deaths are directly attributable to the SSI. [8] Postoperative surgical site infection (SSI) adds a significant burden to the health system and suffering for patients and medical staff. [10] Surgical site infection (SSIs) also decrease patients' quality of life [11] and reduce patient satisfaction. [3]

Surgical site infection (SSI) is a serious complication requiring prolonged hospitalization, intravenous antibiotics, wound care and dressings resulting in increased cost and resistant bacteria. [10]

In pediatric cardiac surgery, Median sternotomy is the most frequently used incision for the correction of congenital anomalies. [1] Sternal wound infections (SWIs) are well

described complications of cardiac surgery and can occur in 3% to 8% of children. Furthermore, the mortality rate can increase 2-fold after SSIs. Also, SSIs are associated with an increased length of hospital stay, readmissions, and higher health care expenditures. [12]

Sternal wound infections (SWIs) are a costly complication for children after cardiac surgery, delaying recovery, increasing hospital stay, readmission rate morbidity, mortality, additional surgical procedures, and healthcare costs. [13] One pediatric center reported a $27,288 average increase in cost per surgery in patients that developed SSIs [14]; therefore, it is important to prevent such infections. [15]

Children undergoing cardiac surgery are at risk for sternal wound infections (SWIs) leading to increased morbidity and mortality. [16] The severity of sternal wound infections ranges from a superficial wound infection (which involves only skin or subcutaneous tissue) to fulminate mediastinitis with subsequent involvement of the sternum (sternal dehiscence and osteomyelitis) and organ tissues outside the incision. [17]

Postoperative mediastinitis also commonly called deep sternal wound infection (DSWI), is one of the most feared devastating complication of cardiac surgery [18] and remains a serious SSI that affects prognosis. [3] In pediatric patients mediastinitis usually occurs in the setting of cardiac surgery. [19] Acute and chronic forms of mediastinitis are recognized. [5]

Mediastinitis is a retrosternal wound infection frequently associated with a macroscopically sternal osteomyelitis. Mediastinitis is uncomfortable for patients, is poorly accepted by parents, leads to a prolonged hospital stay repeated surgery and prolonged antibiotic therapy. [20] Mediastinitis are costly for patients, providers, and health-care institutions. [16]

Despite widespread infection control practices, modern advancement in operative techniques, and routine antibiotic prophylaxis, the incidence of mediastinitis has remained stable over time. [21] Mediastinitis in children occur at approximately the same incidence as in adults. [22] affecting up to 2% of children undergoing median sternotomy [23] and the incidence appears to be higher in neonatal patients. [24]

In children, the mediastinitis risk factors include delayed sternal closure (DSC), nasal colonization with Staphylococcal species, need for re-exploration for bleeding, and others. [22]

Sternal wound infections (SWI) in delayed sternal closure (DSC) pediatric patients are a health-care burden after congenital heart surgery. A review of the Society of Thoracic Surgery Congenital Heart Surgery Database reported an SWI rate for DSC patients of 6.9%. There are no guidelines specific for prevention of Sternal wound infections (SWI) in pediatric DSC patients. [25]

Mediastinitis is always a secondary event, that is mainly due to intra-operative contamination. The origin of the germ is the patient, the surgical team or the operating room air. [20] Gram-positive organisms are most frequently found, [2] and Staphylococcus aureus is one of the main causes of mediastinitis, [17] isolated from mediastinal culture, and MRSA has become the predominant pathogen. [26] Gram-negative organisms are increasingly recognized, especially in neonates, and are related to delayed sternal closure. [2] Surgical infections with Candida species are rare in pediatric patients and carry a high morbidity and mortality. [27]

Mediastinitis characterized by clinical and culture evidence of deep sternal infection involving the pericardial space. [28] Mediastinitis is probably the most common cause for mediastinal fluid collection after cardiac surgery. [2] While surgical site infection in adult cardiac surgery has been well characterized and studied, in pediatric cardiac surgery, the prevention, and management is less well studied and significant practice variation exists. [14] Also the techniques used for management of surgical site infection in children are controversial. [29, 30] and not optimal in terms of mortality morbidity and the use of medical resources. [30] This is, in part, due to the large number of patients available for analysis in multicenter databases and the fact that most patients undergo the same operation (coronary artery bypass) allowing for a more consistent analysis of risk factors without confounding