Evaluation of the Prophylactic Antibiotic Policies of Cardiac Surgery in a University Teaching Hospital

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بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

" ولا تقولن لشيء إني فاعل ذلك غدا (٢٣) إلا أن يشاء ﷲ
واذكر ربك إذا نسيت وقل عسى أن يهدين ربي لأقرب من هذا
رشدا (٢٤) "

[الكهف: ٢٣، ٢٤]

صدق الله العظيم

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List of Abbreviations

ABD	Acid base difficile
ALT	Alanine transaminase
ANOVA	Analysis of variance
AR	Aortic Regurgitation
AS	Aortic Stenosis
ASD	Arterial septal defect
AST	Aspartate aminotransferase
BSI	Blood stream infection
CABG	Coronary Artery Bypass Graft
CoA	Coarctation of aorta
ICU	Intensive care unit
MANOVA	Multivariate Analysis of variance
MR	Mitral Regurgitation
MRSA	*Methicillin-resistant Staphylococcus aureus*
MS	Mitral Stenosis
NS	Not significant
PCO2	Partial pressure of carbon dioxide
PDA	Patent ductus arteriosus
PO2	Partial pressure of oxygen
q	Every
SSI	Surgical site infection
STS	Society of thoracic Surgeons
TOF	Tetralogy of Fallot
VSD	Ventricular septal defect

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Abstract

Abstract

Background: Antimicrobial prophylaxis in cardiac surgery has been demonstrated to lower the incidence of postoperative infection. Inappropriate antimicrobial prophylaxis, as inappropriate selection of the antimicrobial agent or dosing regimen, can increase the prevalence of antibiotic resistant strains, prolong hospital stay, cause postoperative infection, and negatively affect an institution's pharmacy budget for antibiotics.

Objective: To assess the current postoperative prophylactic antibiotic protocols applied in the cardiac surgeries department in Ain Shams University teaching hospitals with respect to others and to international guidelines for antimicrobial prophylaxis practice in cardiac surgery.

Methods: 320 pediatric and adult patients who were admitted for cardiac surgery to Ain Shams University teaching hospitals from September 2012 until March 2013. The antimicrobial prophylaxis indication, choice, duration, dose, dosing interval, and timing appropriateness were assessed against 3 international guidelines using a pre-tested, structured clinical data collection form. The study design was prospective observational. All study patients were monitored daily during their inpatient stay until discharge. Data regarding surgery duration, mechanical ventilation duration, intensive care unit stay, postoperative stay and total hospital stay were obtained.

Results: Adherence to all antimicrobial prophylaxis guidelines was not achieved for any study patients. A statistical significant difference for the mechanical ventilation duration, Intensive care unit stay, postoperative stay and total hospital stay were found concerning both the pediatrics and the adults between the infected and non-infected group.

Conclusion: Study findings indicate that adherence to international guidelines for antimicrobial prophylaxis is far from optimal in cardiothoracic department at Ain Shams University teaching hospitals, due to the inappropriate administration of many antibiotics. Developing local hospital guidelines, as well as giving the clinical pharmacist a central role in the administration, monitoring, and intervention of antimicrobial prophylaxis may improve the current practice.

Key Words: Prophylactic Antibiotic, Antibiotic Resistance, Nosocomial Infection, Clinical Pharmacy.

Review of Literature

Common Heart Diseases and their Surgical Management

Over the past century, cardiac surgery has undergone remarkable development and growth, most notably within the past 50 years, with the evolution of cardiopulmonary bypass capabilities **(Daly *et al.*, 2005)**.

Cardiopulmonary bypass was introduced in the 1950s to provide a bloodless field and quickly became the gold standard of providing extracorporeal circulation. In 1954, perfusion of oxygenated blood during a cardiac procedure through controlled cross circulation was supported**.** In l954 a ‘‘mechanical heart lung machine’’ was used to shunt blood around the heart and lungs and provide direct visualization and a bloodless field for cardiac procedures **(Gibbon *et al.*, 1954).**

Heart diseases are classified into adult heart diseases and pediatric heart diseases **(Bonow *et al.*, 2006)**.

Adult Heart Diseases

Cardiovascular disease can take many forms: coronary artery disease, valvular heart disease or rheumatic fever / rheumatic heart disease **(Veinot *et al.*, 2006)**.

1) Valvular Heart Diseases

Rheumatic heart disease

Before antibiotic medicines became widely used, rheumatic fever was the biggest cause of valve disease. Rheumatic fever is a complication of untreated streptococcal throat, which is caused by a group A β-hemolytic streptococcal infection of the respiratory tract in addition to other environmental and genetic factors. It leads to scarring of the heart's valves leading to narrowing of the valve and make it harder for the valve to open properly or to close completely **(Steer *et al.*, 2009).**

1. Mitral Valve Disease

i. Mitral Stenosis (MS)

It refers to narrowing of the mitral valve orifice**.** It is usually caused by rheumatic heart disease. Less common causes include infective endocarditis and systemic lupus erythematosus **(Bonow *et al.*, 2008).**

Surgical Management: It consists of mitral valvotomy (which can be either surgical or percutaneous) or mitral valve replacement. The surgical mitral valvotomy approach can be through a closed or open technique; the latter technique is rarely used, except in developing countries, and has largely been replaced by the percutaneous balloon commissurotomy **(Rahimtoola, 2010).**

Surgical valve repair may involve opening a narrowed valve by removing calcium deposits or reinforcing a valve that does not close properly. Moreover, with percutaneous balloon valvuloplasty / percutaneous mitral commissurotomy (PMC), a catheter is directed into the left atrium after transseptal puncture, and a balloon is directed across the valve and inflated in the orifice. This results in separation of the mitral leaflets **(Holmes *et al.*, 2011).**

With Surgical valvotomy/valve replacement, a defective valve is removed and a prosthetic valve is stitched in its place **(Vahanian *et al.*, 2012).**

There are two kinds of prosthetic valves used for valve replacement:

- ***Mechanical valves: -*** usually made from materials such as plastic, carbon, or metal. Mechanical valves are strong, and they last a long time. Because blood tends to stick to mechanical valves and create blood clots, patients with these valves need to take blood-thinning medicines (called anticoagulants) for the rest of their lives **(Rahimtoola *et al.*, 2010).**
- ***Biological valves :-***

  Xenograft → which are made from animal tissue like pig.

  Allograft or homograft → taken from the human tissue of a donated heart.

  Autograft → a patient's own tissue used for valve replacement.

Patients with biological valves usually do not need to take blood-thinning medicines. These valves are not as strong as mechanical valves and they may need to be replaced every 10 years **(Stassano *et al.*, 2009).**

ii. Mitral Regurgitation (MR)

It is leakage of blood from the left ventricle into the left atrium during systole**.** It is caused by structural or functional abnormalities of the mitral apparatus, adjacent myocardium, or both**.** The most common causes of mitral regurgitation are rheumatic heart disease, infective endocarditis, coronary artery disease, and cardiomyopathy **(Barbieri *et al.*, 2011).**

Surgical Management:

- Valve Repair through Valvuloplasty, which strengthens the leaflets to provide more support and to let the valve close tightly. This support comes from a ring-like device that surgeons attach around the outside of the valve opening**.**
- Also Valve Repair of structural support, which replaces or shortens the cords that give the valves support (these cords are called the chordae tendineae and the papillary muscles). When the cords are the right length, the valve can close properly.
- Valve replacement **(Clavel *et al.,* 2010)**.

iii. MITRAL VALVE PROLAPSE

It is the most common valvular abnormality, it usually has a benign course, but it occasionally leads to serious complications, including clinically significant mitral regurgitation, infective endocarditis, sudden cardiac death, and cerebrovascular ischemic events and it is managed through mitral valve repair or mitral valve replacement **(Izumo *et al.,* 2013).**

2. Aortic Valve Disease

i. Aortic Stenosis (AS)

It refers to obstruction of flow at the level of the aortic valve leads to restricted systolic opening of the valve leaflets**.** Rheumatic and congenital aortic stenosis account for the majority of cases. Valvular aortic stenosis results in chronic left ventricular pressure overloading. It is managed through percutaneous balloon valvuloplasty, which is used as a palliative measure or Aortic valve replacement **(Roberts *et al.,* 2012).**

ii. Aortic Regurgitation (AR)

It is defined by incompetence of the aortic valve, in which a portion of the left ventricular forward stroke volume returns to the chamber during diastole. It can occur because of leaflet pathology or aortic root disease and it is usually managed through aortic valve replacement **(Roberts *et al.,* 2012).**

3. Pulmonary Valve Stenosis

It is usually present at birth where the pulmonary valve or the pulmonary artery just below the valve is narrowed. It is most commonly caused by a defect

during fetal development and it is managed through percutaneous balloon valvuloplasty or surgical valvotomy **(Odenwald *et al.*, 2011).**

It refers to abnormal function of the tricuspid valve and it includes two types:-

i. **Tricuspid regurgitation**: - the valve is leaky or doesn't close tight enough, causing blood to leak backwards across the valve.
ii. **Tricuspid stenosis**: - the valve leaflets are stiff and do not open widely enough, causing a restriction in the forward flow of blood **(Roberts *et al.*, 2005).**

Tricuspid diseases are caused by rheumatic fever, infection, a dilated right ventricle and pulmonary hypertension and it is managed through valve repair or valve replacement **(Sharieff *et al.*, 2005).**

2) Coronary Artery Disease (Ischemic Heart Disease)

It is the narrowing or blockage of the coronary arteries, usually caused by atherosclerosis. The major risk factors are smoking, diabetes mellitus and Hypercholesterolemia together with the hypertension, Genetic and hereditary factors and stress **(Stone *et al.*, 2013).**

Atherosclerosis (hardening or clogging) of the arteries is the buildup of cholesterol and fatty deposits (called plaques) on the inner walls of the arteries which restrict blood flow to the heart muscle by physically clogging the artery or by causing abnormal artery tone and function **(Park *et al.*, 2009).**

Ischemia is a condition described as “cramping of the heart muscle “and it occurs when the narrowed coronary artery reaches a point where it cannot supply enough oxygen-rich blood to meet the heart’s needs. Without an adequate blood supply, the heart becomes starved of oxygen and the vital nutrients it needs to work properly. This can cause chest pain called angina which is the most common symptom of coronary artery disease that is manifested by a chest pain **(Mosca *et al.*, 2011).**

A collateral circulation is the development of new blood vessels that reroute blood flow around the blockage. If blood supply to a portion of the heart muscle is cut off entirely, or if the energy demands of the heart become much greater than its blood supply, a heart attack may occur **(Greenland *et al.*, 2010).**