CARDIAC ARREST DURING ANESTHESIA

Assay

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ABSTRACT

Cardiac arrest of patients during anesthesia has been the driving force behind the development of this specialty. Safer procedures, new anesthetics, and technical improvements such as monitoring devices and ventilators have successfully reduced intraoperative mortality. Nevertheless, modern technology itself creates specific risks; and causes, diagnosis, and management of anesthesia-related cardiac arrest differ considerably from situations encountered elsewhere

Keywords

Adverse events, anesthetic complication, anesthetic risk, cardiac arrest, resuscitation, advanced cardiac life support.

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LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

ACD-CPR	Active compression-decompression CPR
AHA	American Heart Association
ASA	American Society of Anesthesiology
ASA PS	American Society of Anesthesiology physical status
AV node	Atrio-ventricular node
AED	Automated external defibrillation
AIMS	Australian Incident Monitoring Scheme
BNP	B-type natriuretic peptide
BLS	Basic life support
CEMACH	Confidential Enquiry into Maternal and Child Health
CI	Confidence Interval
COPD	Chronic obstructive pulmonary disease
CAD	Coronary artery disease
CPR	Cardiopulmonary resuscitation
ECG	Electrocardiogram
ET tube	Endotracheal tube
FFP	Fresh frozen plasma
IAC-CPR	Interposed abdominal compression
ITD	Impedance threshold device
ICU	Intensive care unit
IL	Interlukin

LUCAS	Lund University cardiac arrest system
LDB	Load distributing band
LT	Laryngeal Tube
LMA	Laryngeal mask airway
MAP	Mean Arterial Pressure
MI	Myocardial infarction
MET	Medical emergency team
MIDCM	Minimally invasive direct cardiac massage
OR	Operating room
PEA	Pulseless electrical activity
PRBCs	Packed red blood cells
POCA	Pediatric Perioperative Cardiac Arrest
PMI	Perioperative myocardial infarction
PoAF	Postoperative atrial fibrillation
PACU	Postanesthesia care unit
PCA	Patient-controlled analgesia
PT	Prothrombin time
PTACD-CPR	Phased thoracic-abdominal compression-decompression-cardiopulmonary resuscitation
QA	Quality Assurance
rFVIIa	Recombinant activated factor VII
ROSC	Return Of Spontaneous Circulation

SA node	Sinoatrial node
VF	ventricular fibrillation
VT	ventricular tachycardia

INTRODUCTION

Cardiac arrest of patients during anesthesia has been the driving force behind the development of the specialty of anesthesia. Without the inherent risk of cardiac arrest, anesthesia might not have developed as an acknowledged medical specialty in its own right. Only a few years after the successful public introduction of ether and chloroform as anesthetics for painless surgery, John Snow published a review of 50 cases of fatal chloroform administration in mostly young and otherwise healthy individuals scheduled for trivial surgical interventions (1).

Initially, cardiac arrest seemed to only be related to the use of general anesthesia. But with the increased use of regional anesthesia, fatal outcome was also connected with physiological causes as a result of the loss of sympathetic reflexes, drug toxicity, convulsions, and early or delayed hypoxia(2).

During the last few years, several major studies of cardiac arrest associated with anesthesia have been published. They cover over 4 million anesthetic procedures for all age groups in different continents (3)(4)(5).

For many years, efforts to decrease fatal adverse events concentrated on the technical, pharmacological, equipment, and monitoring aspects of anesthetic care. Medication errors were the main cause of anesthesia-related cardiac arrests in most developed countries. More recently, organizational and human factors involved in anesthesia management including the presence, experience, and carefulness of hospital staff have been shown to influence mortality of patients exposed to anesthesia(6). The increasing demand of anesthetic support for unpleasant diagnostic and interventional procedures outside the operating room has created new hazards in a less controlled and monitored surrounding compared to the traditionally well-equipped and staffed operating room(7).

Insights into the incidence and circumstances of perioperative cardiac arrest are provided by analyses of multi-center registry data or single-institution patient outcome databases. The numerous reports detail a plethora of patient categories and procedures in geographically distinct location. However, there are major problems in comparing these reports, and gaining a true idea about the associated patient risk factors, surgical procedures, and other circumstances can be difficult. First, there is no uniformly accepted definition of the anesthesia-related cardiac arrest. Second, the time frames range from 'drug intake for premedication to 30 days after surgery' to during induction of anesthesia' or 'during the stay in the operating theatre. Third, there is a considerable heterogeneity in the patient collectives regarding not only the investigated age groups or patient comorbidities, but also the surgical procedures. Furthermore, some reports are based on voluntary reporting registries, others on single institution consecutive data sets, and both have their strengths and weaknesses (8).

In developed countries today, the incidence of anesthesia-related cardiac arrest in noncardiac surgery patients is reported to range from 0.2 to 1.1 per 10000 adults and from 1.4 to 2.9 per 10000 children(9). Cardiac arrest during neuraxial anesthesia is less frequent compared to general anesthesia (incidence 0.04-1.8 per 10000 anesthetics) but cases of cardiac arrest are reported with even the most modern and least cardio-depressant local anesthetics such as levobupivacaine(10).

Comparing the period from 1980 to 1990 with 1995-2005, the reported incidence related to anesthesia has declined from 1.3-6.0 per 10000 anesthetics to 0.2-1.1 per 10000 anesthetics, respectively. However, it remains controversial as to whether a true decline in cardiac arrest during anesthesia has occurred over time (11). A recent report impressively demonstrates the importance of definition and the need for separate analysis of high-risk subgroups. Possibly mere differences in included patient cohorts or used inclusion definitions are responsible for differences observed over time. On the contrary, the surgical population has dramatically changed over the past 50 years ;

today's patients are older, have more numerous and severe comorbidities, and surgical procedures have themselves become more complex (12).

Preioperative cardiac arrest, mostly multifactorial in origin, results from a coincidence of factors such as poor preoperative patient condition, inadequate risk estimation, inappropriate anesthesia management, and human error or misjudgment (11).

The American Society of Anesthesiology (ASA) physical status classification (ASA I to V) summarizes risk factors from coexisting diseases and risk-increasing patient factors (i.e., morbid obesity). There is a positive correlation between higher ASA classification and increased risk for cardiac arrest; 44-75% of all anesthesia-related cardiac arrests occur in patients with ASA classes of III or higher. A similar correlation is found in the pediatric population (13).

In common with the adult studies, the question is what to make of all these results. We assume that if we measure and analyze actual or potential adverse outcomes then we can improve the quality and standard of our service "If you cannot measure it you cannot manage it". This business dictum implies that you must be able to quantify and understand the issues, inputs and outputs of your business in order to ensure the efficient delivery of quality products or services. In the case of health care, and specifically anaesthesia, we must understand our business to effect meaningful change to improve our services (14).

In obstetric field anesthesia-related death is the seventh leading direct cause of maternal mortality in the United States and United Kingdom, and accounts for 1.6% of all pregnancy-related deaths in the United States .Since the 1980s, a significant reduction has been seen in anesthesia-related maternal deaths, with the success being attributed to increased use of regional anesthesia, the widely adopted policy of limiting oral intake during labor, and the effective measure of providing aspiration prophylaxis before operative delivery (15).

A maternal death is devastating to all involved; however, in obstetric patients (parturients), mortality is 200% (mother and baby) with significant medicolegal implications. There were no direct deaths attributed to regional anesthesia in this triennium (16). However, as the use of general anesthesia in obstetrics continues to decline, the anesthesia trainees' experience in basic airway management in obstetrics also continues to decline. Given the fact that 80% of anesthesia- related fatalities occur during emergency cesarean sections, the incidence of failed intubation is higher during emergencies that occur during nights and weekends (17).

Airway-related issues in obstetrics during induction and emergence continue to be problematic. Preoperative airway evaluation, risk assessment, having a preformulated strategy to deal with difficult or failed tracheal intubation, and acquisition of advanced airway skills are critical to avoid maternal morbidity and mortality from airway catastrophes (17).

"Anesthesia-related" cardiac arrest is preventable 53% of the time, and "anesthesia-related" mortality is preventable 22% of the time (18). Human error may be the most important factor in deaths attributable to anesthesia and manifests not as a fundamental ignorance but as a failure in the application of existing knowledge (19). Poor preoperative preparation and inadequate vigilance are frequently reported errors that could be avoided (9).

The importance of the 'human anesthesia environment' for patient safety has been demonstrated in a Dutch case-control study(6).Simple principles including direct availability of an additional anesthesiologist to help or troubleshoot when needed, the use of full-time instead of part-time anesthetic team members, and the presence of two persons from the anesthetic team during emergence from anesthesia have significantly reduced perioperative mortality.

Cardiac arrest during anesthesia occurs in an ideal setting for optimal quality resuscitation. Cardiac arrests are always observed, patients are monitored, intravenous accesses are established, and oxygen, emergency drugs, and a defibrillator are immediately available. However, as individual practitioners rarely encounter cardiac arrest, the speed with which the diagnosis is made and the consistency of appropriate management vary considerably (20).

Whenever a potentially reversible cause for cardiac arrest is presumed, aggressive and prolonged resuscitation efforts have to be considered. The use of mechanical chest compression devices or even extracorporeal support as bridge to correction might be an option in selected cases. Altogether, perioperative cardiac arrest is fortunately a rare event, and regarding anesthesia-related cardiac arrest, it is associated with a favorable outcome (some 80%) (20).

Resuscitation-related factors also have an effect on outcome. The rhythm during resuscitation and the duration of the resuscitation attempts have been related to the outcome of the patient. "No-flow" and "low-flow" states occur during the arrest and resuscitation process. A no-flow state occurs when a patient is in cardiac arrest before receiving resuscitation efforts. A low-flow state occurs when a patient is arrested and receiving resuscitation that is unable to provide adequate circulation. The longer the patient is in a "no-flow" state or a "low-flow" state, the worse the outcome is likely to be (21).

Anesthesiologists have struggled for years to reduce incidences of catastrophic procedural outcomes. Cardiac arrest during anesthesia has causes and unique features beyond the scope of current guidelines, and anesthesiologists have to develop and maintain awareness and competence to handle the situation (22).