Clinical paper

"Presumed cardiac" arrest in children and young adults: A misnomer?☆

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ARTICLE INFO

ABSTRACT

Aim: To use a novel methodology to assess the incidence and specific causes of Out-of-Hospital Cardiac Arrest (OHCA) within a young urban cohort.

Methods: All EMS attended OHCA patients in a large urban area, between 2009 and 2012, aged 2–45 years, treated or untreated, who died or survived, and that were designated as "no obvious cause" etiology by trained data abstractors were included. Using multisource (medical and coroner) records, an expert panel adjudicated the causes of the OHCAs as: *confirmed cardiac* causes, *confirmed non- cardiac* causes, and *other* causes.

Results: Of a total of 1993 cases EMS designated as "no obvious cause", only 29.9% (595/1993) were due to *confirmed cardiac* causes; the rest were due to *other* causes (non-cardiac etiologies): confirmed drug overdose (n = 624), trauma (n = 108), cancer (n = 69), complex chronic care (n = 65) and *non-cardiac acute illness* – mostly vascular, infectious, and metabolic (n = 376). The annual incidence rate of "no obvious cause" OHCAs after initial field classification was 12.97/100,000 pt. years (95% CI 12.40, 13.50), compared to 3.87/100,000 pt. years (95% CI 3.56, 4.18) for the *confirmed cardiac* OHCAs after adjudication. The predominant underlying etiologies of *confirmed cardiac* OHCAs were coronary heart disease and structural heart disease.

Conclusions: In young adults with OHCA, *confirmed cardiac* causes were responsible in a minority of cases, and they differed in presentation from those with *confirmed non- cardiac* causes. Establishing rigorous case ascertainment strategies with linkage to multiple data sources will facilitate a more reliable evaluation of the causes of these events.

1 Introduction

Out-of-hospital cardiac arrest (OHCA) in the young is a critical public health issue. The causes of OHCA in the young (age <35), are diverse and often have an underlying genetic cause [1]. Despite the fact that heritable cardiac syndromes can present as late as the 4th decade of life [2,3], few studies include patients beyond age 35 [4]. Moreover, the risk of OHCA due to cardiac cause increases dramatically after age 35; the annual OHCA incidence rate due to cardiac cause in those ages 36–49 was almost 10 times higher than in persons aged 1–35, with coronary artery disease (36%) and sudden unexplained deaths (31%) being the most common causes of death in autopsied cases [4]. A better understanding of the underlying causes of OHCA among this broader age group will help to improve future risk stratification tools.

Estimates of OHCA incidence in persons ages <35 vary widely from 1.34 to 8.04 per 100,000 persons annually [5–11], making study comparisons challenging and highlighting the lack of clarity with regard to the true scope of this phenomenon [12]. Much of the variation in incidence rates can be attributed to differing case ascertainment methods and how the underlying cause of death is determined [13]. Emergency Medical Services (EMS) studies [5,10] classify OHCAs as "no obvious cause" (i.e. "presumed cardiac"), and exclude cases with obvious, non- cardiac causes, such as suicide or homicide [14–16]. This approach results in an overestimation of cardiac OHCA incidence rates, by including cases that are not primarily cardiac (e.g. pulmonary embolism), or trauma or overdose that is not immediately obvious [17].

Another method uses death certificates or autopsy reports and links them with all available information including EMS records and in-hospital reports [6,10,18]. Yet not all OHCA cases are autopsied, and some OHCA patients survive after resuscitation. A comprehensive accounting of OHCA cases should include both persons who survive to hospital discharge and those who do not, as well as detailed case specific information.

The aim of this study was to use a novel methodology to assess the incidence and specific causes of OHCA within a young (age ≤45) urban cohort.

2 Methods

2.1 Design and setting

This observational cohort study used data collected using waiver of consent from the population-based Rescu Epistry cardiac arrest database; Rescu Epistry, is comprised of data points from the Resuscitation Outcomes Consortium (ROC) Epistry-Cardiac Arrest database and the Strategies for Post Arrest Resuscitation Care database; the methodologies of these two databases are described elsewhere [19,20]. The study was approved by the St. Michael's Hospital Research Ethics Board.

2.2 Study population

Rescu Epistry is a single web-based data management interface linking electronic data from EMS and Fire Services, monitors, defibrillators, laptops, and clinical data from hospitals. It enables the capture of consecutive cases for a given community and obtains all patients with OHCA for which there was a 911 response occurring in the City of Toronto and adjacent regions (Halton, Peel, Simcoe, Muskoka, York and Durham) serving a population of 6.6 million people. This group of end-users are collectively referred to as Toronto Regional RescuNET.

From the database, we identified all OHCA cases aged 2–45 years, attended by paramedics for an OHCA, treated or untreated, died or survived, during the calendar years 2009–2012. We included only OHCA cases that were designated "no obvious cause" etiology (e.g."presumed cardiac"), as per the standardized Utstein criteria by trained data abstractors [14–16].

The lower age cutoff was chosen to exclude deaths that may have been caused by Sudden Infant Death Syndrome. We chose the upper age cut-off to maximize capture rates for heritable cardiac syndromes and to reduce overlap with OHCA due to atherosclerotic coronary artery disease [21].

2.3 Key definitions

Out-of-Hospital Cardiac Arrest (OHCA): similar to Bardai et al [22], this was defined as occurring out-of-hospital, witnessed or unwitnessed, with abrupt loss of vital signs resulting in death (OHCA deaths), or if successfully resuscitated, survival to hospital discharge (OHCA survivors).

Presumed Cardiac as per the standardized Utstein criteria [14–16], an arrest of "no obvious cause" is presumed to be of cardiac etiology unless it is known or likely to have been caused by any other non-cardiac cause as best determined by rescuers. Data abstractors can also list contributing causes. When assigning cause, data abstractors have access to only EMS and in-hospital information and cannot review the coroner investigative statements, autopsy or toxicology reports.

Confirmed Cardiac Causes: were defined as underlying cardiac disease responsible for the OHCA event, such as coronary heart disease, structural diseases of the myocardium, or a normal heart on autopsy and no other identifiable cause of cardiac arrest (usually termed "primary arrhythmia syndrome").

Confirmed Non-Cardiac cases were defined as an acute illness causing OHCA, due to underlying non-cardiac disease, such as non-cardiac vascular disease or pneumonia.

Other causes were defined as those where the OHCA was an expected consequence of other conditions/events including drug overdoses, traumas, cancer or complex chronic care.

2.4 Data sources

Ambulance call and fire reports, which contain patient identifiers, past medical history, medications, narrative details about the circumstances of the event, call characteristics, prehospital interventions including the defibrillator monitor recording during the resuscitation, and outcomes.

In-hospital data was abstracted from emergency department (ED) reports, in-hospital medical notes, discharge summaries, consultations, clinical tests, and medical certificates of death.

The *coroner investigative statement (CIS)* contains personal information about the deceased as well as the circumstances, manner of death, and medical cause of death with contributory factors. A narrative summary includes medical history obtained from medical records and interviews with bystanders and/or family members/friends.

Autopsies are conducted when coroners are not otherwise able to determine the cause and manner of the death. All autopsies are conducted by a forensic pathologist and follow a standardized protocol. In circumstances where the death is suspected to be due to an underlying cardiac cause, the heart is sent to a specialized cardiovascular pathologist for further examination.

Toxicology testing includes screening for ethanol and drugs of abuse and for 300 prescription and over-the-counter drugs. Testing is performed in a sequential manner such that if a drug is detected at a level considered to be either toxicologically significant or fatal, testing stops. If an anatomic cause of death is found at autopsy, toxicology is not usually performed unless considered contributory.

2.5 Case identification and review process

Deceased subjects were matched to a CIS and autopsy/toxicology report if available; all resuscitated subjects were matched to their ED reports, in-hospital records, and discharge summaries. Cases were abstracted on standardized forms which contained all applicable information.

The primary author (KA) reviewed all available information for each case and determined which OHCAs were attributed to drug overdose, trauma and terminal disease. For the remaining OHCA cases, if there was complete agreement between the reviewer and the medical cause of death ascribed by the coroner, the adjudication process was considered complete.

In cases where there was (1) disagreement between the coroner and the primary reviewer (2) contributing factors, such as