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EDITORIAL

In-Hospital Cardiac Arrest

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ABSTRACT

A cardiac arrest is classified as 'in-hospital' (IHCA) if it occurs in a hospitalized patient who had a pulse at the time of admission. Unfortunately, the majority of patients resuscitated successfully from IHCA die before hospital discharge, and their prognosis has changed little over the past 30 years. Recent data indicate that survival to hospital discharge after in-hospital cardiac arrest is approximately 20%. A variety of factors have been proposed as determinants of poor outcomes associated with IHCA, which include first monitored rhythm, time to first shock, duration of cardiac arrest, hospital location of cardiac arrest and time of day of cardiac arrest occurrence. According to current guidelines for prevention of in-hospital cardiac arrest, hospitals should provide a system of care that includes staff education for rapid response, appropriate and regular patient vital sign monitoring, clear and uniform system of timely calling for assistance. Finally, after cardiac arrest has occurred, the quality of resuscitation and early defibrillation are crucial factors for improving survival.

KEY WORDS: *cardiac arrest; in-hospital cardiac arrest; cardiopulmonary resuscitation; cardiac defibrillation; ventricular fibrillation; ventricular tachycardia; advanced life support*

Abbreviations
AED = automated external defibrillator
ALS = advanced life support
CPR = cardiopulmonary resuscitation
DNAR = do not attempt resuscitation
ICU = intensive care unit
IHCA = in-hospital cardiac arrest
MET = medical emergency teams
NRCPR = National Registry of Cardiopulmonary Resuscitation
OHCA = out-of-hospital cardiac arrest
PEA = pulseless electrical activity
ROSC = return of spontaneous circulation
VF = ventricular fibrillation
VT = ventricular tachycardia

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INTRA-HOSPITAL CARDIAC ARREST

A cardiac arrest is classified as 'in-hospital' (IHCA) if it occurs in a hospitalized patient who had a pulse at the time of admission. Between 370,000 and 750,000 in-hospital resuscitation attempts are made in the United States each year. Only few studies have reported the incidence of IHCA. The incidence can be calculated either as the number of events per hospital beds per year or as the number of events per number of patient admissions. The American Heart Association (AHA) National Registry of Cardiopulmonary Resuscitation (NRCPR) have reported an incidence of 0.175 events/bed annually.[1] According to the second method the reported incidence of in-hospital cardiac arrest is variable, but is in the range of 1–5 per 1000 admissions.[1]

Unfortunately, the majority of patients resuscitated successfully from IHCA die before hospital discharge, and their prognosis has changed little over the past 30 years.[2,3] Survival from cardiac arrest can be expressed in relation to time as: 'immediate' ("return of spontaneous circulation", ROSC), 'short-term' (discharged alive from the hospital), and 'long-term' (6–12 months). Return of spontaneous circulation represents mainly a success of the cardiopulmonary resuscitation (CPR) manoeuvres. Recent data from the NRCPR indicate that survival to hospital discharge after in-hospital cardiac arrest is approximately 20%.[4]

PROGNOSTIC FACTORS

A variety of factors have been proposed as determinants of poor outcomes associated with IHCA.

FIRST MONITORED RHYTHM:

In the majority of studies, ventricular fibrillation (VF) / ventricular tachycardia (VT) is the first monitored rhythm in only 20–35% of IHCAs.[5-7] This contrasts with out-hospital cardiac arrest (OHCA), where the majority of cases which occur with a monitor in place are precipitated by VF/VT.[8] The lower prevalence of VF/VT rhythms in IHCA than in OHCA may be explained partially by differences in pathophysiology; IHCA is frequently precipitated by hypoxia or hypotension[9], which are more likely to cause non-shockable rhythms (pulseless electrical activity-PEA or asystole) than VF/VT. Conversely, VF/VT rhythms are more common when ischemia is the precipitating cause of cardiac arrest, as often occurs in OHCA.

There are two major reasons for the better outcome reported in VF/VT rhythms. First, VF/VT rhythms can be treated promptly and successfully with defibrillation. Second, since VF/VT rhythms deteriorate to asystole if not treated promptly, the presence of a VF/VT implies a recent onset of cardiac arrest.

EVENT INTERVALS (TIME TO FIRST SHOCK):

The value of early defibrillation of shockable rhythms in the out-of-hospital setting is beyond dispute. Evidence suggests that the same concept can be applied to IHCA. Herlitz et al.[10] showed that survival to discharge after IHCA was significantly higher when CPR was started within the first minute after collapse. In VF/VT IHCA, Peberdy et al[3] reported survival rates of 38% vs. 21% when the first shock was given within or after 3 min respectively.

EVENT DURATION:

Patients with a shorter duration of cardiac arrest have better outcomes. This is because shorter arrests are usually due to rapidly treatable causes, but also because longer resuscitation times are associated with generalized tissue hypoperfusion and hypoxic damage.

HOSPITAL LOCATION:

Despite the fact that patients admitted to intensive care units (ICU) are on average more seriously ill than patients in a general ward and can therefore be expected to show higher mortality rates after cardiac arrest, the majority of studies[11,12] report better outcomes for IHCA occurring in critical care areas than for those occurring in wards. Possible explanations for the apparent paradox associated with the ICU environment include: (a) monitored and witnessed status of virtually all cardiac arrests, (b) immediate availability of advanced life support (ALS), (c) younger age, and (d) better selection of patients to be resuscitated-effective use of a 'do not attempt resuscitation' (DNAR) policy.

TIME OF DAY:

Survival rate for in-hospital patients who had a cardiac arrest during the night was about one-half that during the day;[10] the incidence of unwitnessed arrest was significantly higher at night. The lower survival rates observed during night could be due to a less efficient response of the hospital emergency system. Another possible explanation is that futile resuscitation attempts are more likely to be made after hours when senior physicians and patient's relatives are absent.

HOW TO IMPROVE THE OUTCOME?

Outcome from IHCA is determined by pre-, intra-, and post-arrest factors. Early recognition of the deteriorating patient and prevention of cardiac arrest is the first link in the chain of survival.

In hospital cardiac arrest is often neither a sudden nor an unpredictable event. Evidence of deterioration during the 8 hours before the arrest has been reported in up to 84% of cases. These patients often have slow and progressive deterioration with the most common findings being respiratory problems, deterioration of mental status and hemodynamic instability that are unnoticed or are recognized but are treated poorly.[9,13,14] Many of these patients have unmonitored arrests, and the underlying cardiac arrest rhythm is usually non-shockable.

To assist in the early detection of critical illness, each patient should have a documented plan for vital signs monitoring that identifies which variables need to be measured and the frequency of measurement. Many hospitals now use early warning scores (EWS) or calling criteria to identify the need to escalate monitoring, treatment, or to call for expert help.[15,16]

The response to patients who are critically ill or who are at risk of becoming critically ill is usually provided by medical emergency teams (MET).[17] These teams replace or coexist with traditional cardiac arrest teams, which typically respond to patients already in cardiac arrest. Medical emergency teams usually comprise medical and nursing staff from intensive care and general medicine and respond to specific calling criteria (e.g. changes in blood pressure, respiratory rate or consciousness, a critical reduction in blood oxygen saturation). However, a recent meta-analysis showed that MET systems were associated with a reduction in rates of cardiopulmonary arrest outside the intensive care unit but are not associated with lower hospital mortality rates.[18]

Ideally, the sickest patients should be admitted to an area that can provide the greatest supervision and the highest level of organ support and nursing care. International organizations have offered definitions of levels of care and produced admission and discharge criteria for high dependency units

and ICUs.[19]

Early evaluation of patients during the course of their illness could also help to identify those patients for whom resuscitation would not be appropriate. It is a fact that the majority of in-hospital patients who undergo cardiac arrest are not resuscitated because for them the cardiac arrest is simply the final event of the dying process. Improved knowledge, training and 'do not attempt resuscitation' (DNAR) decision-making should improve patient care and prevent futile CPR attempts.[20]

According to current guidelines[21] for prevention of in-hospital cardiac arrest, hospitals should provide a system of care that includes: (a) staff education about the signs of patient deterioration, and the rationale for rapid response to illness, (b) appropriate and regular vital signs monitoring of patients, (c) clear guidance (e.g., via calling criteria or early warning scores) to assist staff in the early detection of patient deterioration, (d) a clear, uniform system of calling for assistance, and (e) an appropriate and timely clinical response to calls for assistance.

After cardiac arrest has occurred, the quality of resuscitation is crucial for improving survival. Current guidelines[21] emphasize the importance of minimizing interruptions to chest compressions and recommend a 30:2 rate between chest compressions and ventilations, with the aim of increasing their number delivered in each minute of CPR. However, despite its apparent simplicity, chest compression is rarely performed according to guideline recommendations. In IHCA CPR, approximately one third of the time compression rates are too low, a third of the compressions are too shallow, and a fifth of the duration of resuscitation comprises no flow time.[22,23] Excessive ventilation may also be deleterious to resuscitation outcome.

Another critical issue for survival after IHCA is time to defibrillation. Early defibrillation using automated external defibrillators (AEDs) might improve survival. Automated external defibrillators are easy to use and can be operated successfully by non-medical ward staff after minimal training. Despite the broad dissemination of CPR training, it has proven difficult to demonstrate improved outcomes following hospital staff training. Because skill retention is variable, rescuers should regularly attend refresher courses to practice their skills. Retraining at least every 2 years is strongly recommended.[24] Better resuscitation, faster defibrillation and continuous training of healthcare providers are all key components of the organization of an efficient emergency response and are likely to improve survival of IHCA.

The prognosis of patients admitted to the ICU after resuscitation from cardiac arrest is poor in comparison with other ICU patients.[25] The post-cardiac arrest syndrome is a complex combination of pathophysiological processes that include brain injury, myocardial dysfunction, and the systemic ischemia/reperfusion response. Interventions in the post-resuscitation period are likely to influence the final outcome significantly.

Despite the relative lack of firm evidence from randomized control studies regarding manoeuvres to improve outcome from IHCA, what remains most critical in this matter is the importance of being EARNEST: **E**arly detection, **A**utomatic defibrillation, **R**apid response teams, **N**onstop compression, avoidance of **E**xcessive zeal (in both ventilation and patient selection), and **S**upportive **T**herapy post-ROSC.[26]

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