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ORIGINAL RESEARCH ARTICLES

Characterization of in-hospital cardiac arrest in adult patients at a tertiary hospital in Kenya



Caractérisation de l'arrêt cardiaque à l'hôpital chez les patients adultes dans un hôpital tertiaire au Kenya

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Background: In-hospital cardiac arrest (IHCA) is defined as a cardiac arrest that occurs in a hospital and for which resuscitation is attempted. Despite the increased morbidity and mortality, IHCA incidence and outcomes remain largely unknown especially in sub-Saharan Africa. This study describes the baseline characteristics, pre-arrest physiological parameters and the rate of survival to hospital discharge of adult patients with an IHCA at a tertiary hospital in Kenya.

Methods: This was a retrospective chart review. Data on patient characteristics, pre-arrest physiological parameters and discharge condition were collected on all patients 18 years of age or older with an IHCA at the Aga Khan University Hospital, Nairobi, from January 2013 to December 2013.

Results: The main study population comprised 108 patients. The mean age was 59.3 ± 18.4 years and 63 (58.3%) patients were men. The initial rhythm post cardiac-arrest was pulseless electrical activity (41.7%) or asystole (35.2%) in the majority of cases. Hypertension (43.5%), septicaemia (40.7%), renal insufficiency (30.6%), diabetes mellitus (25.9%) and pneumonia (15.7%) were the leading pre-existing conditions in the patients. A Modified Early Warning Score (MEWS) of 5 or more was reached in 56 (67.5%, $n = 83$) patients before the cardiac arrest. The rate of survival to hospital discharge was 11.1%. All the patients who survived to hospital discharge had a good neurological outcome.

Conclusions: Early identification of warning signs that precede many in-hospital arrests may enable institution of treatment to prevent patient deterioration. Local hospitals should be encouraged to provide patients with resuscitation services and equipment in line with evidence-based programmes.

Contexte: L'arrêt cardiaque à l'hôpital (IHCA, In-hospital cardiac arrest) se définit par un arrêt cardiaque ayant lieu dans un hôpital et pour lequel on tente une réanimation. Malgré sa morbidité et sa mortalité croissantes, l'incidence de l'IHCA et ses résultats restent très méconnus, en particulier en Afrique sub-saharienne. Cette étude décrit les caractéristiques fondamentales, les paramètres physiologiques précédant l'arrêt et le taux de survie à la sortie de l'hôpital des patients adultes ayant subi un IHCA dans un hôpital tertiaire au Kenya.

Méthodes: Il a été procédé à un examen rétrospectif des dossiers. Les données sur les caractéristiques des patients, les paramètres physiologiques précédant l'arrêt et l'état à la sortie ont été recueillies pour tous les patients de plus de 18 ans ayant subi un IHCA à l'Hôpital Universitaire Aga Khan de Nairobi, de janvier 2013 à décembre 2013.

Résultat: La population de l'étude principale était de 108 patients. L'âge moyen était de $59,3 \pm 18,4$ ans et 63 (58,3%) patients étaient des hommes. Dans la majorité des cas, le rythme initial suivant l'arrêt cardiaque était une activité électrique sans poulx (41,7%) ou une asystole (35,2%). Les affections préexistantes les plus courantes chez les patients étaient l'hypertension (43,5%), la septicémie (40,7%), l'insuffisance rénale (30,6%), le diabète sucré (25,9%) et la pneumonie (15,7%). Un Score d'alerte précoce modifié (MEWS, Modified Early Warning Score) de 5 ou plus a été atteint chez 56 (67,5%, $n = 83$) patients avant l'arrêt cardiaque. Le taux de survie à la sortie de l'hôpital était de 11,1%. Tous les patients qui ont survécu à la sortie de l'hôpital présentaient de bons résultats neurologiques.

Conclusions: L'identification précoce des signes d'alerte précédant bon nombre d'arrêts cardiaques à l'hôpital peut permettre l'instauration d'un traitement visant à prévenir la dégradation de l'état de patient. Les hôpitaux locaux devraient être encouragés à fournir aux patients des services et des équipements de réanimation conformément aux programmes fondés sur des faits probants.

African relevance

- The article demonstrates the possibility of developing hospital resuscitation teams in health facilities in Africa.

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- Development of systems to identify early warning signs that precede many in-hospital arrests in Africa may enable introduction of treatment to prevent patient deterioration.
- There are gaps in current local morbidity and mortality data highlighting a need for research into the causes of in-hospital cardiac arrests.

Introduction

Cardiac arrest is defined as the lack of a palpable central pulse, apnoea, and unresponsiveness.¹ In-hospital cardiac arrest

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(IHCA) is defined as a cardiac arrest that occurs in a hospital (whether the patient is admitted or not) and for which resuscitation is attempted with chest compressions, defibrillation, or both.² Despite the increased morbidity and mortality, IHCA incidence and outcomes remain largely unknown especially in sub-Saharan Africa.

Majority of the studies have focused on out-of-hospital cardiac arrest (OHCA) with a limited number of studies reporting on the incidence, patient characteristics and outcomes after IHCA. Single-institution studies have reported hospital-wide incidence rates of adult IHCA ranging from 3.8 to 13.1 per 1000 admissions.^{3,4} These large variations are primarily due to the absence of standardized data sets containing uniform definitions and reliable data abstraction across hospitals. In an effort to solve this problem, the American Heart Association (AHA) recently published recommendations aimed at measuring and optimizing outcomes after in-hospital cardiac arrest (IHCA).²

Survival rates among patients with OHCA have increased in the last decade due to improvements in resuscitation care.⁵⁻⁸ It is commonly assumed that advances in OHCA care are directly applicable to the epidemiology and treatment of IHCA. Recent data from the Get with the Guidelines (GWTG)-Resuscitation registry based in the United States showed a rate of survival to hospital discharge for IHCA of 17.0%.⁹ Whether similar rates are observable in other regions remains largely unknown due to the different causes and burden of chronic illnesses that contribute to IHCA epidemiology, team configuration, and access to resources, especially in sub-Saharan Africa.

Kenya is located on the equator in the eastern part of Africa. It has a population of over 38 million people; Nairobi, the capital, has a population of more than three million people.¹⁰ The leading causes of death and disability in Kenya are shown in Table 1.¹¹

The Aga Khan University Hospital, Nairobi (AKUH, N), is a regional tertiary referral university hospital that provides secondary and tertiary level health care services in Nairobi. It has over 300 beds with a 24-h Emergency Centre (EC), 11-bed High Dependency Unit (HDU) and a 20-bed Intensive Care Unit (ICU). The Code Blue Team is the dedicated hospital emergency response team constituted of nurses and doctors from the EC and ICU. The team handles all in-hospital cardiac arrests. It is activated by a single four-digit number from any

telephone extension in the hospital, 24 h a day, seven days a week, in the event of a cardiac arrest within the hospital premises. All team members are trained in basic and advanced life support according to the American Heart Association guidelines. During the resuscitation, a pre-designated member of the Code Blue Team records all the events of the resuscitation on a specially designed resuscitation form.

This study aimed to: (i) describe the baseline characteristics and pre-arrest physiological parameters of adult patients with an IHCA at a tertiary hospital in Kenya; and (ii) determine their rate of survival to hospital discharge using the recently published recommendations from the AHA. The hope is that an improved understanding of the scope of this problem will help guide future research and implementation of strategies that will benefit healthcare delivery that pertains to IHCA.

Methods

This was a retrospective chart review. Resuscitation forms from January 1, 2013, through December 31, 2013 were used to identify all patients 18 years of age or older with an IHCA at the Aga Khan University Hospital, Nairobi (Fig. 1). Only the index pulseless cardiac arrest for each admission was included in the study.

The study sample was comprised of 108 patients. The study was approved by the Aga Khan University Faculty of Health Sciences East Africa research ethics committee (2014/REC-24).

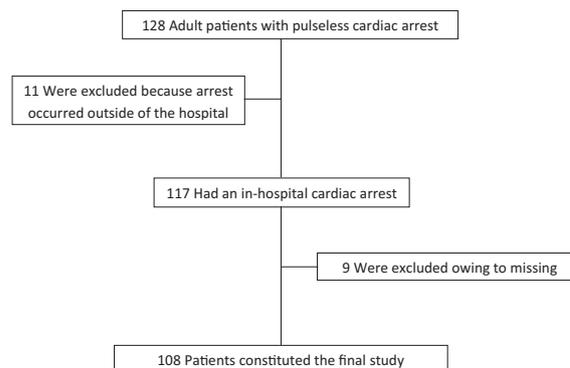


Figure 1 Study cohort.

Table 1 Leading causes of deaths and disability in Kenya.¹¹

Causes of death			Causes of DALYs ^a		
Rank	Disease or injury	% total deaths	Rank	Disease or injury	% total DALY's
1	HIV/AIDS	29.3	1	HIV/AIDS	24.7
2	Conditions arising during perinatal period	9.0	2	Conditions arising during perinatal period	10.7
3	Lower respiratory infections	8.1	3	Malaria	7.2
4	Tuberculosis	6.3	4	Lower respiratory infections	7.1
5	Diarrhoeal diseases	6.0	5	Diarrhoeal diseases	6.0
6	Malaria	5.8	6	Tuberculosis	4.8
7	Cerebrovascular disease	3.3	7	Road traffic accidents	2.0
8	Ischaemic heart disease	2.8	8	Congenital anomalies	1.7
9	Road traffic accidents	1.9	9	Violence	1.6
10	Violence	1.6	10	Unipolar depressive disorder	1.5

^a DALYs = Disability Adjusted Life Years – Time lost due to incapacity arising from ill health.

Table 2 Modified Early Warning Score.^{a,13}

Individual component scores							
Parameter	3	2	1	0	1	2	3
Systolic blood pressure (mmHg)	≤70	71–80	81–100	101–199		≥200	
Heart rate (bpm)		≤40	41–50	51–100	101–110	111–129	≥130
Respiratory rate (bpm)		<9		9–14	15–20	21–29	≥30
Temperature (°C)		<35	35–38.4			≥38.5	
AVPU score				Alert	Reacting to Voice	Reacting to Pain	Unresponsive

^a Modified Early Warning Score (MEWS) is calculated as the sum of the individual component scores.

Study data were filled in directly from the resuscitation forms and the patients' records onto the data sheets. Data collected on each patient included: age and sex; date and time of cardiac arrest; location of cardiac arrest; time to Code Blue Team arrival; first documented pulseless rhythm; duration of resuscitation; return of spontaneous circulation (ROSC) (defined as >20 min of sustained ROSC); pre-existing conditions at time of cardiac arrest; discharge condition and cerebral-performance category (CPC) scores at admission and at discharge.¹² A CPC score of 1 denotes mild or no neurologic disability, 2: moderate neurologic disability, 3: severe neurologic disability, 4: coma or vegetative state, and 5 brain death.

Data were also collected on the patients' physiologic parameters including heart rate, systolic blood pressure, respiratory rate, temperature and AVPU score (A for 'alert', V for 'reacting to vocal stimuli', P for 'reacting to pain', U for 'Unconscious') during the 4 h before the cardiac arrest. Only the last four measurements taken during this period were collected. The measurements were used to calculate a Modified Early Warning Score (MEWS) (Table 2).¹³ MEWS is a tool that has been validated for bedside evaluation to determine the severity of illness of a patient based on five physiological parameters: systolic blood pressure, pulse rate, respiratory rate, temperature and AVPU score. A score of five or more has statistically been linked to increased likelihood of death or admission to an intensive care unit.¹⁴

All statistical analyses were conducted using Microsoft Office Excel 2014 software. For continuous variables, the mean and the standard deviation of the mean (SD) was calculated. Frequencies in percent were determined for all categorical variables.

Results

Patient characteristics

Table 3 summarizes the characteristics of IHCA among the study population.

Ninety-three (86.1%) patients had only one arrest during the same admission; however, 14 (12.9%) had two arrests, and one patient (1%) had three arrests.

Physiological parameters before the cardiac arrest

Physiological parameters taken during the 4 h before the cardiac arrest were available for 101 (93.5%, $n = 108$) patients. Each complete set of physiological data collected during the 4 h before the cardiac arrest was used to calculate a MEWS;

77% of patients had complete data sets. A MEWS of 5 or more was reached in 56 (67.5%, $n = 83$) patients during the four hours before the cardiac arrest. Fifty-four (65.1%, $n = 83$) patients had more than one MEWS calculated during the 4 h before the cardiac arrest. Thirty-three (61.1%, $n = 54$)

Table 3 Baseline characteristics of patients with an in-hospital cardiac arrest.

Characteristic ($n = 108$)	
Demographics	No. (%)
Age (years)	59.3 ± 18.4
Male sex	63 (58.3)
Female sex	45 (41.7)
<i>Cardiac arrest</i>	
Initial cardiac-arrest rhythm	No. (%)
Pulseless electrical activity (PEA)	45 (41.7)
Asystole	38 (35.2)
Unknown rhythm by documentation	11 (10.2)
Pulseless ventricular tachycardia (VT)	8 (7.4)
Ventricular fibrillation (VF)	6 (5.6)
<i>Hospital location of arrest</i>	
Intensive care unit (ICU)	43 (39.8)
High dependency unit (HDU)	23 (21.3)
Coronary care unit (CCU)	14 (13.0)
General in-patient area (wards)	14 (13.0)
Emergency centre (EC)	4 (3.7)
Renal unit	4 (3.7)
Catheterization lab	3 (2.8)
Operating room (theatres)	2 (1.9)
Out-patient clinic	1 (0.9)
Arrest at night (11 p.m. to 7 a.m.)	33 (30.6)
Arrest on weekend	40 (37)
Average Code Blue Team response time (seconds) ^a	164 ± 135
Pre-existing conditions	No. (%)
Hypertension	47 (43.5)
Septicaemia	44 (40.7)
Renal insufficiency	33 (30.6)
Diabetes mellitus	28 (25.9)
Pneumonia	17 (15.7)
HIV/AIDS	15 (13.9)
Metastatic cancer	15 (13.9)
Previous heart failure	12 (11.1)
Myocardial infarction, current admission	10 (9.3)
Previous myocardial infarction	9 (8.3)
Major Trauma	9 (8.3)
Acute stroke	5 (4.6)
Hepatic insufficiency	4 (3.7)
Heart failure, current admission	2 (1.9)

^a This is the average response time to all areas except the Emergency Centre and the Intensive Care Unit.

Table 4 Outcomes of in-hospital cardiac arrest by first documented pulseless rhythm.^{a,b}

	VF ^c or Pulseless VT ^c n = 14	Asystole n = 38	PEA ^c n = 45	Unknown rhythm ^d n = 11
ROSC ^c > 20 min	6 (42.9)	10 (26.3)	19 (42.2)	4 (36.3)
Survival to discharge	1 (7.1)	3 (7.9)	6 (13.3)	2 (18.2)
Neurological outcome				
Good ^c	1 (7.1)	3 (7.9)	6 (13.3)	2 (18.2)
Poor	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

^a First documented pulseless rhythm was defined as the first electrocardiographic rhythm documented at the time of the cardiac arrest.

^b Values are number (%) of patients.

^c VF: ventricular fibrillation; VT: ventricular tachycardia; PEA: pulseless electrical activity; ROSC: return of spontaneous circulation.

^d Unknown rhythm by documentation.

^e Good neurological outcome was defined as cerebral performance category (CPC) 1 or 2 or no change from baseline CPC.

patients demonstrated a deterioration in their MEWS at one point during the 4 h before the cardiac arrest.

Survival to hospital discharge

The rate of survival to hospital discharge was 11.1% (12 of 108 patients). Table 4 summarizes outcomes for IHCA patients as a function of the first pulseless rhythm obtained at the time of the cardiac arrest.

Discussion

This study is the first comprehensive standardized characterization of IHCA in Kenya. These results will help inform the development and advancement of local systems for IHCA care.

Patient characteristics

The mean age of the patients was 59.3 ± 18.4 years. This may be related to the latest WHO data, which indicates that the current total life expectancy in Kenya is 59.7 years.¹⁵ The initial rhythm at the time of the cardiac arrest was PEA or asystole in majority of the patients. Similar studies on IHCA have demonstrated similar findings^{9,16,17} which contrast studies on OHCA, which typically report a higher prevalence of VF/VT rhythms.¹⁸ The differences in pathophysiology partially explains the lower prevalence of VF/VT rhythms in IHCA in comparison to OHCA: hypoxia or hypotension which frequently precipitate IHCA,^{17,19} are more likely to cause PEA or asystole than VF/VT. Conversely, when ischemia is the precipitating cause of cardiac arrest, as often occurs in OHCA, VF/VT rhythms are more common. The list of pre-existing conditions of patients who had an IHCA demonstrates the rising burden of non-communicable diseases (NCDs) in Kenya. NCDs, including cardiovascular diseases and metastatic cancer, pose a growing health challenge for Kenya and other sub-Saharan Africa countries which are still grappling with high burdens of communicable diseases and HIV/AIDS; a rise in road traffic injuries further compounds the situation.²⁰ Though pre-arrest variables such as sepsis, renal failure, metastatic cancer and stroke are associated with worse prognosis after IHCA, they cannot completely explain the cardiac arrest outcomes.^{21–23}

Physiological parameters before the cardiac arrest

A MEWS of five or more is linked to increased likelihood of death or admission to an ICU.¹⁴ This previously reported finding was clearly demonstrated in this study as well; a majority of the patients in the study who eventually had an IHCA had a MEWS of five or more at one point during the 4 h before the cardiac arrest. Patient deterioration was also noted during the 4 h before the arrest in up to 61.1% of cases. Greater emphasis should be placed on the need to regularly calculate the MEWS for all patients admitted in the hospital to identify those patients with an increased likelihood of death. Interventions by trained in-hospital staff should be instituted immediately clinical deterioration is detected to try and prevent IHCA.

Survival to hospital discharge

The rate of survival to hospital discharge was lower than those observed in similar studies from North America (11% vs. 17%).⁹ Differences in the causes and burden of comorbidities in the two populations that contribute to IHCA epidemiology may partially explain this finding. More research is needed to determine the specific factors that are responsible for the differences in survival after cardiac arrest between the two populations. All the survivors-to-hospital discharge had a good neurological outcome – defined as cerebral performance category (CPC) of 1 or 2 or no change from baseline CPC. This finding is in keeping with the majority of papers that also report relatively good functional outcomes in survivors from IHCA.^{9,17,24} Therapeutic hypothermia, though recommended for comatose adult patients with ROSC after IHCA of any initial rhythm,²⁵ was not instituted due to lack of resources but this did not seem to influence our findings.

Limitations

Being a retrospective chart review, the study was subject to limitations and biases, including missing data; collection of nonrandomized data; and as this was one hospital, the population may not be representative of the whole country. Assessment of the quality of resuscitation was not part of the scope of this study.

Conclusions

This is the first study to characterize in-hospital cardiac arrest in Kenya. It provides important information on patients with IHCA and may have implications for the development of local systems to advance IHCA care. Early identification of warning signs that precede many in-hospital arrests may enable institution of treatment to prevent patient deterioration. Local hospitals should be encouraged to provide patients with resuscitation services and equipment in line with evidence-based programmes. Resuscitation outcomes should subsequently be collected, regularly reviewed, and published to provide more useful information for improving outcomes after in-hospital cardiac arrest.

Conflict of interest

The authors declare no conflict of interest.

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