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Incidence of in-hospital cardiac arrest in Poland

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Abstract

Background: In-hospital cardiac arrest with its poor prognosis is a challenging problem in hospitals. The aim of this study was to evaluate in Polish hospitals the frequency of in-hospital cardiac arrests with the subsequent mortality, with special emphasis on the type of unit at which the event occurred, and the patient's demographic data, such as age and sex.

Methods: The study was a retrospective analysis of data for 2012 registered in the Polish General Hospital Morbidity Study. This research covered all Polish hospitals, excluding only government and psychiatric hospitals. The study inclusion criterion was the incidence of cardiac arrest in any hospital ward, recorded by the respective ICD-10 diagnosis code.

Results: Of the 7,775,553 patients hospitalized, the diagnosis of cardiac arrest was reported in a total of 22,602 patients, which included 22,317 adults (98.7% of all patients) and 285 children (1.3%). Overall mortality after cardiac arrest among adults was 74.2%, and in children 46.7%.

In both absolute numbers and as percentages of all documented cases, cardiac arrests occurred most often at the departments of intensive care, internal medicine, cardiology and emergency medicine. The accompanying mortality was lower than average at the departments of intensive care, cardiology, cardiology high dependency unit and emergency medicine.

The median age of patients with cardiac arrest who died in the hospital was higher than the median age of those who survived (72 vs. 64; $P < 0.05$). Although cardiac arrests were reported more often among men than women (58.2% vs. 41.8%; $P < 0.001$), the hospital mortality was higher among women (79.2% vs. 71.6%; $P < 0.001$).

Conclusion: The frequency of in-hospital cardiac arrests in Polish hospitals and the subsequent mortality is not substantially different from that observed in other countries. However, our study, based on ICD-10 diagnosis codes, gives only limited information about the patients and circumstances of this event. An in-depth analysis of the causes, prognoses, and outcome of in-hospital cardiac arrests could be facilitated by the creation of a national registry.

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Key words: in-hospital cardiac arrest, cardiopulmonary resuscitation, CPR, mortality rate

Cardiac arrest (CA) is the major cause of death in Europe and worldwide [1]. The estimated annual incidence of in- and out-of-hospital CA in the United States is about 200,000 and 300,000 cases, respectively, with the mortality above 80% [2]. The CA incidence rates estimated for Europe are comparable [3]. The majority of on-going studies are focused on out-of-hospital cardiac arrest (OHCA). Their findings can be only partially related to in-patients due to differences in characteristics of the in-hospital population, different mechanisms of cardiac arrest and disparate structures of emergency management. At present, there are a few reports concerning in-hospital CA available in Polish and worldwide literature. Determination of CA incidence is essential for assessment of the quality of treatment, identification of

the departments in which CA cases occur most frequently, introduction of an adequate policy of personnel training and the implementation of medical emergency teams (MET) systems and rapid response systems.

Monitoring of in-hospital CA is associated with numerous difficulties [2] e.g. a lack of uniform CA definitions, inclusion into statistics, patients provided with long-term care and patients with do-not-resuscitate (DNR) orders.

One of the measures to monitor resuscitation procedures is data collected by the MET which often leads to overestimates (inclusion of patients who did not develop CA despite emergency calls) or underestimates (in cases with CA development at Emergency Departments, operating suites, cardiology wards or Intensive Care Units (ICUs). Another option of monitoring is a compilation of procedures codes carried out in a given hospital or diagnosis codes, e.g. ICD-10 (the International Statistical Classification of Diseases and Related Health Problems, the 10th revision).

The aim of the present study was to assess the incidence of in-hospital CA and the resultant mortality in Polish hospitals based on a retrospective analysis of the 2012 data using ICD-10 diagnosis codes, in particular the departments where such incidents occurred, as well as age and gender of patients.

METHODS

A prospective CA study involving a large population of patients is difficult to design; therefore, we decided to carry out a retrospective study based on the data available in the Polish Study of General Hospital Morbidity. The study involves all Polish hospitals, except for hospitals of the Ministry of Defence, the Ministry of Internal Affairs as well as specialist psychiatric hospitals and is supervised by the National Institute of Public Health — the Department of Hygiene, responsible for data analysis and archiving. We based our analysis on data gathered from individual report cards (Mz/SZp-11), which had been filled out at each department during hospitalisation of a particular patient. Individual report cards contain demographic characteristics of the patient, type of ward during hospitalisation, length of stay, important procedures on the ward and ICD-10 diagnosis codes of the main admission diagnosis and the other comorbidities. CA cases according to the ICD-10 are reported using one of the four codes, i.e. I46 (cardiac arrest without extension), I46.0 (cardiac arrest with successful resuscitation), I46.1 (sudden cardiac death) or I46.9 (cardiac arrest, unspecified).

The inclusion criterion was one of the above codes corresponding to CA reported during hospitalisation or amongst the causes of death. Our assumption was that any report of the CA code on the card meant the occurrence of CA during hospitalisation on the ward and the institution of the cardiopulmonary resuscitation (CPR) procedure. The following variables from the database were considered in the analysis: median age, gender, type of hospital ward where CA occurred and in-hospital mortality.

Normally distributed data were presented as a mean and standard deviation while those with non-normal distributions as a median and interquartile range. Significant differences between non-normal medians in both groups were determined using the Mann-Whitney U test; moreover, the significance of differences in more than two groups was assessed using the Kruskal-Wallis ANOVA and the test of rank multiple comparisons. The significance of differences among the percentage values was evaluated using the test of differences between two indices of structure.

Statistical calculations were based on STATISTICA 10.0 (StatSoft Inc., Tulsa, USA). Comparisons between two non-measurable variables were assessed using the χ^2 test. $P < 0.05$ was considered statistically significant.

RESULTS

Of 7,775,553 patients hospitalised in 2012 in Poland, 25,242 incidents of CA were recorded in 22,602 patients. This group constituted 0.3% of the total population of hospitalised patients. Of the total number of 22,602 patients with at least 1 incident of CA, this diagnosis was established in 22,317 adult patients (98.7%) and 285 children (individuals below the age of 18 years, 1.3%). The overall mortality following CA was 74.2% in adults and 46.7% in children. Further evaluation included only adults.

During hospitalisation, the CA code could have been reported at each hospital ward. In almost 90% of patients CA was observed one time during hospitalisation; in over 10% of individuals the diagnosis was established more than once.

Table 1. Frequency of documented individual codes denoting cardiac arrest (CA) with resultant in-hospital mortality

Code	n	%	Description	Mortality (%)	
I46.0	11003	44.1	Cardiac arrest with successful resuscitation	54.0	$P < 0.001$
I46.9	10907	43.8	Cardiac arrest, unspecified	91.7	
I46	2041	8.2	Cardiac arrest without extension		
I46.1	979	3.9	Sudden cardiac death		

n — number of ICD-10 codes recorded in the study population; % — frequency of use of a particular code compared to all ICD-10 codes of CA

Table 2. Number and percentage of patients with documented cardiac arrest (CA) treated in different types of departments (units), median age and in-hospital mortality rate

Hospital ward/unit	Number of patients	Age (median; lower-upper quartile)	Number of CA (percentage of patients treated at hospital ward)	Percentage of the total number of CA	Percentage of in-hospital mortality in patients with CA
Intensive Care Unit	23215	66.0 (57.0–77.0)	9340 (40.2)	37.8	69.2
Internal Medicine	885609	77.0 (65.0–84.0)	7201 (0.8)	29.2	84.8
Cardiology	382391	71.0 (60.0–81.0)	2646 (0.7)	10.7	57.8
Emergency Department	701916	67.0 (57.0–79.0)	1690 (0.2)	6.8	71.9
General Surgery	729741	75.0 (62.0–84.0)	1036 (0.1)	4.2	88.9
Neurology	231587	78.0 (66.0–85.0)	585 (0.3)	2.4	94.0
Cardiology High Dependency Unit	24718	67.0 (59.0–79.0)	281 (1.1)	1.1	53.7
Nephrology	55793	73.0 (61.0–83.0)	235 (0.4)	1.0	90.2
Palliative Medicine	12999	74.0 (61.0–82.5)	204 (1.6)	0.8	99.5
Pulmonology	95498	73.5 (63.0–81.0)	148 (0.2)	0.6	85.8
Orthopaedic Surgery	343328	84.0 (74.0–88.0)	135 (0.4)	0.5	85.2
Gastroenterology	61114	70.0 (57.0–83.0)	115 (0.2)	0.5	91.3
Geriatrics	15393	84.0 (76.5–87.5)	92 (0.6)	0.4	95.7
Remaining	3563302	–	1534	4	–
Total	7775553	72.0 (60.0–81.0)	25242 (0.3)	100	74.2

Table 3. Relationship between in-hospital mortality and median age amongst patients who developed CA

Details	n	Median age	*P*-value
Total	22317	72	
No death	5277	64	$P < 0.05$
Death	17325	74	

Table 4. Number of patients after CA with in-hospital mortality rate in individual age groups

Age groups (years)	Number of patients with CA code (% of all CA codes)	In-hospital mortality (%)	
18–64	9 052 (36.3)	63.5	$P < 0.001$
≥ 65	15 878 (63.7)	81.3	

The individual codes of CA were used with various frequency (Table 1); I46.0 (cardiac arrest with successful resuscitation) and I46.9 (cardiac arrest, unspecified) were most commonly applied (in over 87% of cases). The mortality rate when I46.0 diagnosis codes were used was lower than that in the remaining codes of diagnoses.

The demographic characteristics of patients with CA with the types of hospital ward are presented in Table 2. The lowest median of age was found in ICUs, emergency departments and cardiology high dependency units. The highest median of age was noted in the geriatric and orthopaedic hospital wards. The highest incidence of CA was recorded in patients treated in ICUs. The lowest in-hospital mortality amongst patients with CA was recorded in cardiology high dependency units and cardiology wards (Table 2).

The median age of patients with documented CA who died in hospitals was significantly higher compared to the median age in survivors (Table 3).

When divided into two age groups, i.e. above and below 65 years of age, the incidence of CA and the mortality rate were higher in the former (Table 4).

Table 5. Incidence of CA and in-hospital mortality according to gender

Gender	CA cases n (%)		In-hospital mortality n (%)	
Male	14 510 (58.2)	$P < 0.001$	10 400 (71.6)	$P < 0.001$
Female	10 418 (41.8)		8 257 (79.2)	

The incidence of CA was higher in male than in female patients. By contrast, the in-hospital morality rate was higher amongst females compared to males (Table 5).

DISCUSSION

The present study is the first attempt to analyse in detail the incidence of in-hospital CA in Polish hospitals in which we determined its frequency, hospital location and related mortality on a national level.

According to European and American reports, the incidence of in-hospital cardiac arrests in which CPR was carried out is 0.1–0.5% of all hospitalisations [4, 5], which is

comparable to that observed in Poland (0.29%). Moreover, the in-hospital mortality rate following CA was reported at the level of 77.7% in the United States, 81.6% in Great Britain and 70% in Sweden [5–7]. Our findings regarding in-hospital mortality (about 74%) are similar to the data from other countries. The study involving patients > 65 years of age and covering the period of 1992–2005 has demonstrated that mortality rate after in-hospital CA remained at the constant level of approximately 80% during this period [8]. A similar study involving over 84 thousand cases during the period 2000–2009, reported that the mortality rates had decreased from 87% to 78% [9]. One study with almost 15 thousand cases of in-hospital CA has revealed that 8% of the study population developed more than one CA incident during the same hospitalisation [10] which was in line with our results (10%).

Our data do not allow one to assess reliably the efficacy of CPR. However, taking into consideration only the diagnosis codes, it can be assumed that the CPR was at least temporarily successful (Table 1; diagnosis code I46.0 — CA with successful resuscitation) in at least 44% of cases while the mortality rate in this group was substantially lower. Our results provide evidence that the survival chances after effective resuscitation are higher compared to the general population with CA (54% vs. 74.2%, respectively). The above observations have been confirmed by other studies, in which the efficacy of resuscitation after in-hospital CA ranged from 52% to 62% while the resultant in-hospital mortality ranged from 64% to 89%. The evaluation of resuscitation efficacy using the CA codes other than I46.0 is not possible based on the data collected in our study. However, in-hospital mortality above 90% observed in the study group may indicate the low efficacy of the undertaken CRP (Table 1).

Our data do not provide information about the frequency of withdrawing of CPR in cases of in-hospital CA. The mortality close to 100% observed in palliative and geriatric departments is worth noticing. The above observation may arouse doubts whether the documented CA did not result from the natural process of dying ending with the administration of CPR. It seems that the decision to undertake/ /withdraw CPR is likely to be affected by the lack of legal regulations regarding DNR orders. The changes in this field should allow one to reduce the incidence of unsuccessful and unnecessary CPR in terminally ill patients [11, 12].

The study data do not allow one to identify CA cases in operating suites or recovery rooms. CA at the surgical ward could have occurred at the ward itself, the operating suite or the recovery room. Considering the significantly higher average mortality rates amongst surgical patients who developed CA, accurate identification of the setting would be essential in order to determine CA causes and circumstances.

Lower mortality rates after CA observed in cardiology wards and ICUs, as compared to other hospital locations, despite the case-mix of patients being under life-threatening conditions was similar to the findings of others [13, 14]. A quick diagnosis of CA, the immediate administration of advanced CPR, the lower ages of patients, and the monitoring of vital signs on the development of CA are likely to be responsible for better outcomes. According to some studies, up to 45% of all cases of in-hospital cardiac arrest occur in ICUs [15]; the percentage in Polish ICUs is found to be comparable.

In contrast, according to some other studies, e.g. a long-term Finnish retrospective study only 2.9% of patients hospitalised in ICUs develop CA [16]. The discrepancies incline to consider whether the documented cases of CA in ICUs actually occurred there; it is possible that CA could have developed before the patient's admission to the ICU. Similar situations may concern emergency departments, where the diagnosis of CA may mean admission after out-of-hospital CA.

The high mortality rate after CA commonly observed among patients of internal medicine and related wards prompts one to determine the risk of its occurrence in this group of patients. According to some studies, early identification of a life-threatening condition using the early warning system (EWS) enables one to reduce the incidence of in-hospital CA [17]. On the other hand, the early assessment of patient clinical status and concomitant prognosis would prevent futile resuscitation [12].

The relationship between the patient`s age and post-CA prognosis observed in our study is similar to the findings reported in other studies [15, 18]. It is noteworthy that the authors analysing the circumstances affecting post-CA prognosis have also emphasized the significant role of some other factors, i.e. a patient`s clinical status, accompanying diseases and the mechanism of CA [19].

The higher incidence rates of in-hospital CA observed in Poland amongst men were in line with the results of a similar study carried out in Great Britain [5]. Otherwise, as for higher mortality rates following CA observed by us in female patients, no reports confirming our observations have been found. The opposite results were reported in a single-centre Swedish study involving 557 cases of in-hospital CA. However, after adjustment for confounders, female patients were associated only with non-significant improvement of survival [20]. In one study, higher mortality in women was observed in cases of out-of-hospital CA [21].

The strength of this study is the use of a large database, which in 2012 included data from 97% of all Polish hospitals (with the exclusions mentioned earlier). On the other hand, a major limitation of both the analysed database and this study is the lack of information regarding the causes and mechanisms of CA. Diagnostic codes (ICD-10) and codes

defining the cause of death documented in statistical cards, do not enable one to, determine the appropriate cause of cardiac arrest. Moreover, it cannot be excluded that in some cases I46 codes of cardiac arrest were omitted and replaced with other ICD-10 codes that defined the underlying disease. The scale of a potential error resulting from such an omission is unknown. Summing up, the collected data do not allow for in-depth analysis of CA in terms of its causes, the patient's condition immediately before the incident, the mechanism of CA and the management introduced (especially information regarding initiation or refraining from CPR). To obtain these type of data national CA registries are used in many countries. For instance, in Great Britain, the in-hospital CA data are collected and analysed within the National Cardiac Arrest Audit (NCAA). The objective of this institution is preparation of recommendations aiming the reduction of risk of CA and improvement of its prognosis. In Sweden, such data have been collected since 2005; in 2010 75% of Swedish hospitals were involved in providing detailed information on six thousand in-hospital CA cases [7]. In the United States, where there is no central registry, analyses of in-hospital SCA are based on the data of the American Heart Association, which includes multi-centre studies in this field [4]. The creation of central registries results, in many places, in the introduction of a standardised model of prognosis for survival after in-hospital cardiac arrest. The model is based on a group of identified, independent prognostic factors for survival, such as age, the place of CA occurrence, its mechanism, as well as a patient's clinical status in the period preceding the development of CA. The comparisons of CPR success rates among individual hospitals based on the defined standardised model of CA survival prognosis enables the objective evaluation of therapeutic management and improved survival, which is essential for monitoring the quality of treatment [22]. In Poland, the need for monitoring the quality of treatment in the field of anaesthesia and intensive care is also currently highlighted [23, 24]. The creation of a registry for in- and out-of-hospital CA would become a part of this trend. Indeed, certain initiatives regarding CA, e.g. the Polish Registry for Therapeutic Hypothermia, have already been created [25].

CONCLUSIONS

1. Analysis of the available data regarding in-hospital CA demonstrates that both its incidence in Polish hospitals and resultant mortality are comparable to the data reported in other countries.
2. At present, there is no effective system of data collection in Poland that could enable in-depth analysis of the causes leading to in-hospital CA and the efficacy of its management. The creation of a central CA registry could facilitate early identification patients at risk. The data from such a registry could be useful in introducing regulations concerning decisions to avoid futile therapy.

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