

Epidemiology of out-of-hospital cardiac arrest in the Bielsko-Biala district: a 12-month analysis

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Abstract

Background: Out-of-hospital cardiac arrest (OHCA) is the sudden, unexpected loss of heart function, which occurs out of specialist healthcare facilities and inevitably leads to death if uninterrupted by effective cardiopulmonary resuscitation (CPR).

Aim: To evaluate the circumstances and basic epidemiological indices of OHCA in the population of adult inhabitants of Bielsko-Biala district within 12 months.

Methods: On the basis of standard ambulance dispatch cards of the Emergency Medical Services (EMS) teams, a retrospective analysis was made of 272 OHCA cases covering the period from 01.01.2013 to 31.12.2013. We assessed the basic demographic data of the victims, circumstances of the occurrence of OHCA, information on the potential cause and mechanism of the OHCA, and data related to the actions undertaken by witnesses and EMS teams.

Results: The overall OHCA incidence was 170/100,000 (243/100,000 in men; 99/100,000 in women). It increased with subjects' age ($p < 0.01$). The most frequent place of OHCA was the victim's home (82%). OHCA occurred in the presence of witnesses in 60% of cases. CPR was undertaken by a witness in 56% cases. Median CPR duration undertaken by a witness was 10 (IQR 8–14) min. Median time from notification receipt by the EMS to the team arrival was 9 (7–11) min. On the scene, defibrillation rhythm was recognised in 39% of cases. Sixty-seven patients were declared deceased after the arrival of the EMS teams. In the remaining 205 cases, CPR was undertaken, which was ineffective for 141 persons. Median CPR duration undertaken by the EMS team was 30 (20–40) min. The overall prehospital case fatality ratio was 76.5% (75.3% for men; 79.3% for women).

Conclusions: OHCA incidence in the Bielsko-Biala population in 2013 was high, increased with age, and was twice as high for men than women. OHCA occurred most often at home, in the presence of a witness; however, CPR was not always undertaken promptly at the scene. CPR was effective for approximately 30% of the victims. The prehospital mortality was high with no differences between genders.

Key words: out-of-hospital cardiac arrest, incidence, mortality, cardiopulmonary resuscitation

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INTRODUCTION

Sudden cardiac arrest (SCA) is the unexpected loss of heart function, which inevitably leads to death if it is uninterrupted by effective cardiopulmonary resuscitation (CPR) [1]. Depending on the place of the incident, SCA can be divided into an out-of-hospital (out-of-hospital cardiac arrest [OHCA]) or in-hospital form (in-hospital cardiac arrest [IHCA]). They are

classified as different clinical conditions with diverse aetiology, epidemiology, proceedings, and prognosis [1].

Based on European data, the annual incidence of OHCA is on average 40 cases per 100,000 adults [2], which according to the population of Poland, gives an estimated amount of more than 15,200 victims per year. Although the most frequent reason for OHCA is ischaemic heart disease,

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a significance in prognosis is assigned to other potentially reversible causes (4H&4T, i.e. hypoxia, hypovolaemia, hypo-/hyperkalaemia/metabolic disturbances, hypothermia, thromboembolism, pericardial tamponade, toxic disturbances, tension pneumothorax) [1].

Despite the progress in diagnostics and therapy, OHCA has a very high case fatality ratio [1]. Adding a number of CPR failures at the place of the incident to the ratio during hospitalisation, only one per 10–15 patients has a chance of surviving an SCA [3]. Mortality depends on the circumstances of the incident, numerous demographic and clinical factors, and the reversibility and mechanisms of SCA [3]. The scope of actions undertaken after identifying SCA is also of great importance. Although higher medical standards allow for a more detailed analysis of IHCA, little is known about the circumstances of OHCA, especially in larger territorial units and over a longer time period. Therefore, we sought to determine the circumstances and epidemiology of OHCA in the population of adult inhabitants of Bielsko-Biala district within 12 months.

METHODS

Ambulance dispatch cards used by teams of the Emergency Medical Services (EMS) in Bielsko-Biala in 2013 ($n = 23,400$) were investigated in detail. All consecutive cards referred to SCA were subjected to assessment ($n = 276$). The cards concerning persons < 18 years of age were excluded ($n = 4$). Having taken the above criteria into account, 272 cards were finally analysed (Fig. 1) (190 [70%] cases in men, 82 [30%] cases in women). In this time period, the EMS in Bielsko-Biala district covered 173,699 inhabitants, including 81,991 men and 91,708 women, in an area of 125 km² [4].

A detailed analysis was given to the basic demographic data (age, gender) of the patients, the circumstances of OHCA incidents (month, day of week, time of day, hour, place), information about the possible reason and mechanism of the OHCA (first identified heart rhythm, previous medical history), and data related to the action undertaken by witnesses (presence of witnesses at the place of the incident, CPR undertaken by witnesses, the fact of administering automated external defibrillator [AED]) and by the EMS teams (time interval from the notification until arrival to the place of incident, actions undertaken, duration of CPR, CPR result).

Statistical analysis

The statistical analysis was based on the procedures available in the licensed MedCalc (v14) software. The quantitative variables are presented as median and interquartile range (IQR, i.e. 25–75%). The qualitative variables are presented as absolute value and percentage. The differences between groups and trends for the qualitative variables were evaluated with the χ^2 test. Odds ratios (OR) with 95% confidence intervals (CI) were calculated where appropriate. U Mann-Whitney

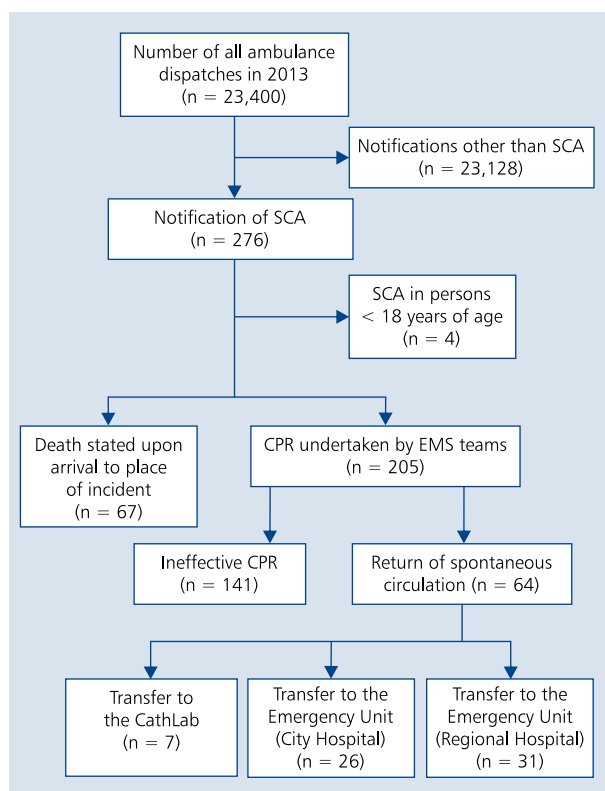


Figure 1. Patients' flow chart; CPR — cardiopulmonary resuscitation; EMS — Emergency Medical Services; SCA — sudden cardiac arrest

test was used for quantitative data. A significance level of $p < 0.05$ was assumed.

The incidence and mortality indices were estimated for the whole group as well as for sub-groups defined by gender and age categories. The calculations were based on the data available in the Statistical Yearbook for 2013 [4].

RESULTS

The overall OHCA incidence was 170/100,000 and was over twice as high for men (243/100,000) as it was for women (99/100,000) ($p < 0.01$). It increased with age ($p < 0.01$) (Fig. 2). Out of 272 analysed emergency calls, 67 persons (45 men, 22 women) were declared dead on the arrival of the EMS teams and CPR was not undertaken. Thus, excluding these cases, the incidence was 128/100,000 (186/100,000 for men and 73/100,000 for women).

In the remaining 205 cases, CPR was undertaken, which was unsuccessful in 141 subjects (97 men, 44 women) ($p = 0.6$). In the whole investigated group, including persons recognised deceased at the scene, the death rate amounted to 130/100,000 of inhabitants of the Bielsko-Biala district (182/100,000 for men and 80/100,000 for women).

The overall prehospital case fatality ratio reached 76.5%, including 75.3% for men and 79.3% for women ($p = 0.6$).

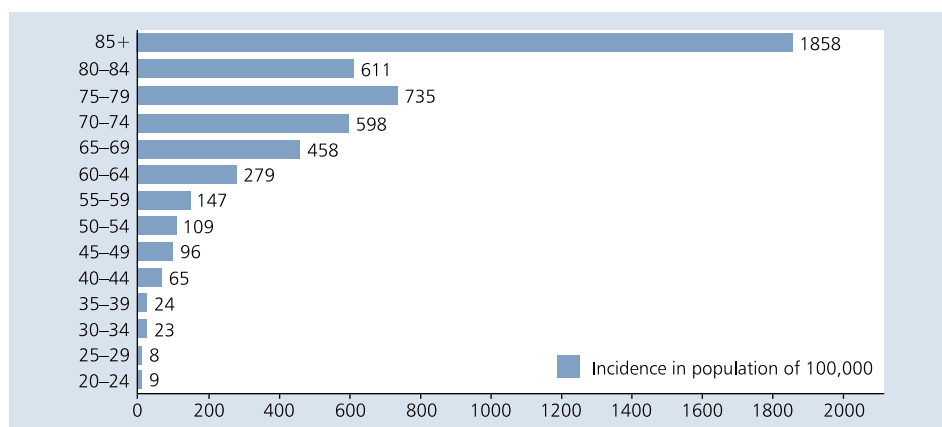


Figure 2. Out-of-hospital cardiac arrest incidence in Bielsko-Biala population in 2013 in age group categories

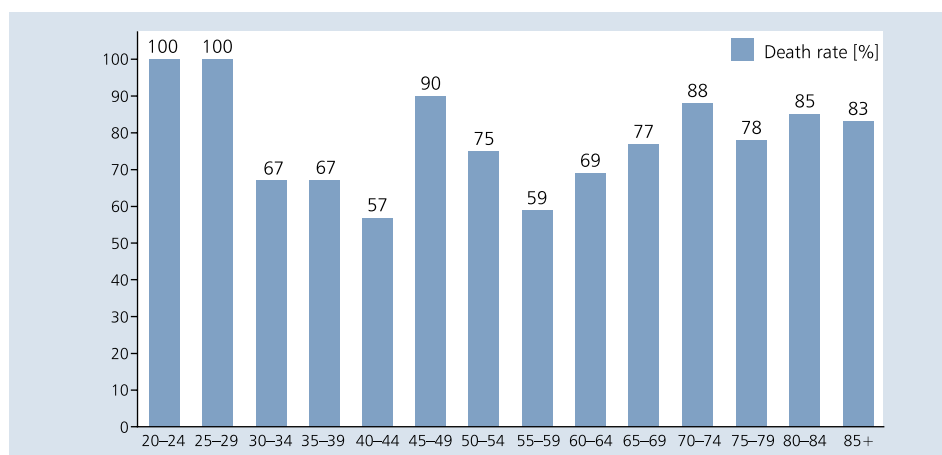


Figure 3. Prehospital mortality due to out-of-hospital cardiac arrest in Bielsko-Biala population in 2013 in age group categories

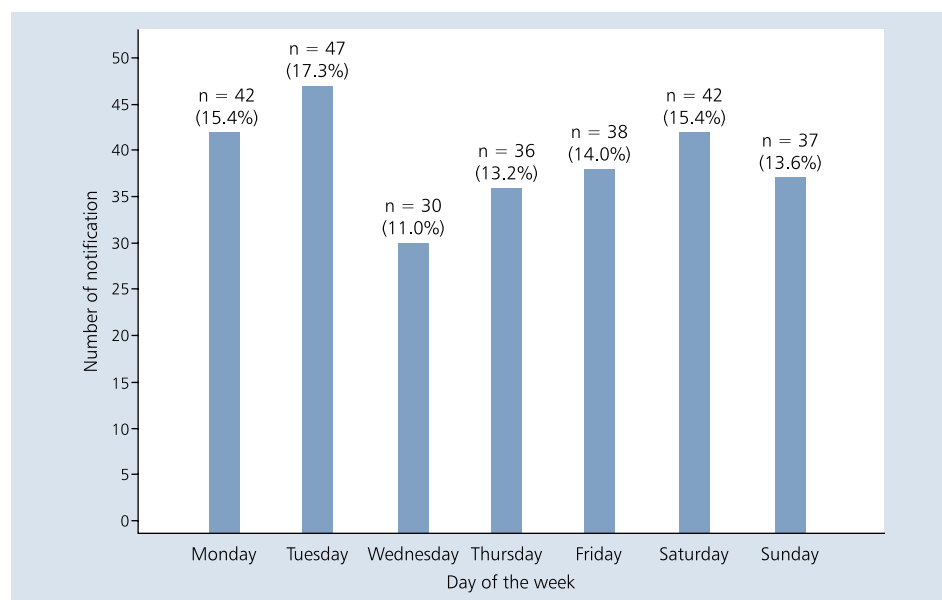


Figure 4. Number of notification calls to out-of-hospital cardiac arrest in subsequent days of the week

Sixty-four patients were successfully transferred to hospital (47 men, 17 women) (Fig. 1). The mortality differed between subsequent age categories, which is depicted in Figure 3. There were no statistically significant differences in the above-mentioned indices of mortality between time periods during day, week, or year ($p > 0.05$ for all).

Median patient's age was 71 (60–80) years. The number of notifications did not vary between particular weekdays ($p = 0.6$) (Fig. 4). However, there were significant differences between months ($p < 0.01$) (Table 1), but the tendency in particular quarters of the year was less variable ($p = 0.05$) (Fig. 5). Based on six-hour time intervals, the smallest number of notifications was noted between 00:01 am and 06:00 am (16%; $p = 0.01$) (Fig. 6).

OHCA occurred at the patient's home ($n = 223, 82\%$), in the street/public place ($n = 35, 12.9\%$), or at work/school ($n = 14, 5.2\%$). OHCA occurred in the presence of witnesses in 164 (60%) cases. The people who reported the incident were mostly members of the family ($n = 210, 77\%$). A non-related witness of the incident was noted less frequently ($n = 47, 18.3\%$). CPR was undertaken by witnesses in 152 cases before the arrival of the EMS team, and most often consisted of chest compressions (147 cases), a defibrillation attempt was undertaken in one case (of 10 possible), and artificial respiration in 30 cases. Median duration of CPR performed by the witnesses was 10 (8–14) min.

Median time from the receipt of the notification by the dispatcher until the arrival of the EMS was 9 (7–11) min. First recorded rhythms were: ventricular tachycardia/ventricular fibrillation (VT/VF; $n = 106, 39\%$), asystole ($n = 132, 48.5\%$) and pulseless electrical activity ($n = 34, 12.5\%$), respectively. The defibrillation rhythm was statistically significantly more frequent if it occurred in a public place (OR = 2.5; 95%

CI 1.3–4.6; $p < 0.01$), was witnessed (OR = 3.2; 95% CI 1.9–5.6; $p < 0.01$), or CPR was undertaken by the witness (OR = 7.8; 95% CI 4.3–14.1; $p < 0.01$), especially with chest compression (OR = 6.3; 95% CI 3.6–11.2; $p < 0.01$). Median CPR duration undertaken by the EMS team was 30 (20–40) min. OHCA origin was assessed in 59 (22%) cases. In 13 (5%) cases, a possible injury was registered as the basis of the OHCA. Nineteen (7%) persons had seizures, and two of them were clearly under the influence of alcohol.

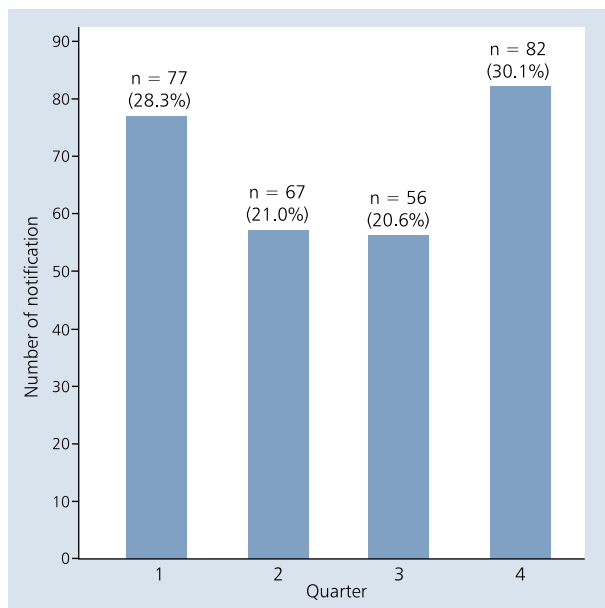


Figure 5. Number of notification calls to out-of-hospital cardiac arrest in subsequent quarters of 2013

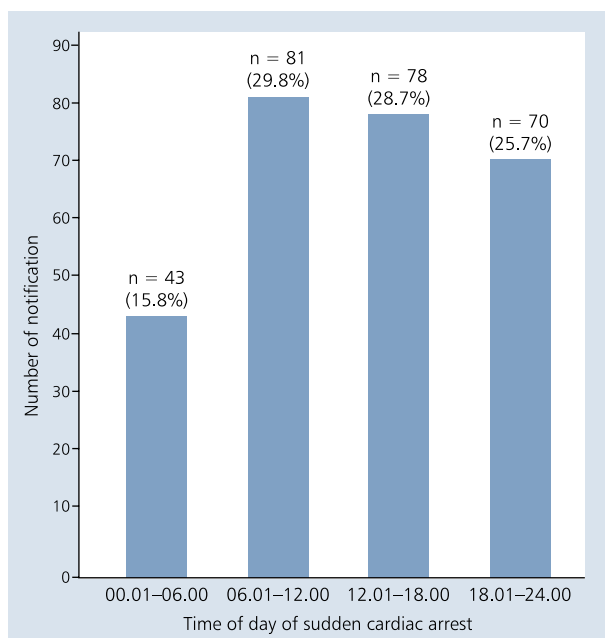


Figure 6. Number of notification calls to out-of-hospital cardiac arrest in six-hour time periods within 24 hours

Table 1. The number of notification calls to out-of-hospital cardiac arrest incidents in subsequent months in 2013

Month	Number of notifications	Percentage of notifications
January	24	8.8%
February	19	7.0%
March	34	12.5%
April	15	5.5%
May	6	2.2%
June	36	13.2%
July	36	13.2%
August	9	3.3%
September	9	3.3%
October	26	9.6%
November	16	5.9%
December	42	15.4%

DISCUSSION

The purpose of this study was to outline the data related to OHCA in the Bielsko-Biala district during a 12-month observation.

OHCA incidence was 170/100,000 inhabitants, and excluding patients where CPR was not undertaken: 128/100,000. Comparing the data with literature, a significant discrepancy can be noted, especially with the countries of Western Europe where the numbers are two or three times lower [2]. On the basis of international data, the standard OHCA incidence rate ranges from 34/100,000 (Denmark) [5], through 51/100,000 (Finland) [6], 52/100,000 (Sweden) [7], and 88/100,000 (Ireland), [8] to 206/100,000 (Austria) [9]. These detectable differences can be explained by two major facts: on the one hand, it is related to the characteristics of patients and circumstances of the incident, and on the other hand, to the system of reporting results. It has been proven that the highest incidence occurs in the population with a higher cardiovascular risk, among older people, and people with more limited access to medical procedures [2]. Also, in respect of OHCA reporting requirements, numerous studies still apply rates that are unadjusted to the age or gender of the population, and the reporting according to Utstein criteria is suboptimal in many aspects [10]. This inconsistency, described in our study, needs to be additionally emphasised between incidences for women and men [8, 11] — the rates are twice as low for women. It has been confirmed that women who suffered from OHCA are usually older and burdened with several comorbidities. Also in women, cardiac arrest occurs less often in the presence of a witness or in public places, CPR is undertaken by a witness less frequently, and a defibrillation rhythm occurs less frequently [12]. What is interesting is that despite so many differences, the in-hospital survival and neurological outcome are usually similar [12, 13].

The basic subjects' characteristics in our study do not differ significantly from other literature reports since OHCA, as a rule, affects most men of about 70–75 years of age [6–9, 11, 14–20]. Moreover, the described circumstances of OHCA are consistent: cardiac arrest usually occurs at home (60–80%) in the presence of witnesses (up to 90%) and with other mechanisms than VT/VF (up to 90%) [8, 11, 14–16, 18–21]. CPR is undertaken by approximately half of the witnesses. An extreme exception is described by the data from Beijing (China), where CPR was undertaken in only 25% of OHCA incidents, and only 11.4% by a witness of the incident [22]. The low rate of CPR attempts undertaken by witnesses was also described in a few European studies [8, 20, 21], including Polish ones [14, 15]. This is especially important because early undertaking of basic lifesaving activities by witnesses and then advanced lifesaving actions by EMS teams are basic links in the chain of survival and, at the same time, important factors that increase the chance for the procedures undertaken in OHCA to be successful [1]. In the case of VT/VF, the most

important fact which determines survival is early administration of defibrillation. Therefore, AED devices are installed in public places more and more often. They should be easily accessible and simple to manage by incident witnesses. In this study it was reachable in 10 cases, but AED was used once only. This result reveals insufficient progress, contrary to what has been observed in Western European Countries and the United States of America for over 10 years [23]. Paradoxically, no direct relation has been documented between the location of AED and the place of occurrence of OHCA [23]. Of note, rescue breathing was also applied infrequently. This observation requires additional reflection. Although current literature data highlights the fact that there is clear progress in theoretical knowledge and practical skills regarding witnessed OHCA [24], implementation of active assisted ventilation during CPR may not always be beneficial compared to chest compression only [25]. So, it is still under debate whether it is necessary to improve teaching policy with more attention given to rescue breathing [26].

There are interesting observations which state that OHCA occurrence may vary with time of day, day of the week, and month of the year [11, 14, 18]. The differences may be related to the chronobiology of the reasons for OHCA (mainly cardiologic background) and weather conditions [27]. Circadian patterns in OHCA and its outcomes may depend on acute changes in some biological triggers, including blood pressure and heart rate, vascular tone, blood pressure, heart rate variability, blood viscosity, and platelet aggregation [18, 27]. Seasonal variations may in turn depend on relative changes in the climate and weather (temperature, humidity), which are occasionally strengthened by important behavioural changes, including stress before and after holidays or seasonal migrations [27, 28].

Irrespective of the circumstances of cardiac arrest, the more time passes from the loss of consciousness to the commencement of adequate intensive treatment, the lower are the patient's chances of survival. Therefore, an equally important parameter that influences CPR efficiency is the arrival time of an EMS team. In our study, the arrival time was 9 min. This result is comparable to international data [7, 9, 14, 18–20, 29].

The CPR success among inhabitants of Bielsko-Biala reached 31% of cases, and the overall prehospital case fatality ratio was 76.5%. The indices come close to the abovementioned literature, including large registries [8, 9, 11, 14–18, 20, 29]. Although the 'gold standard' in the evaluation of effectiveness of therapy after an OHCA incident is the death rate from the moment of undertaking CPR until successful discharge from hospital, the scope of our project does not allow for its evaluation.

Our study also has some limitations in concluding. Apart from the previously mentioned lack of possibility to examine in-hospital treatment and outcome, there are also limited observation time and lack of territorial diversity. However, the

population of Bielsko-Biala district is relatively heterogeneous, which is not limited to a city- or a village area, which, paradoxically, gives a better insight into the OHCA circumstances. Moreover, the lack of information about the possible reasons for the cardiac arrest makes a more detailed analysis of the problem impossible, except for the typical epidemiological description of the incident. That is why the standard dispatch cards should be modified with easy-to-use (e.g. by putting a tick in the box) items covering major issues from the anamnesis (chronic conditions, recent injury or surgery) and the most frequently taken medications. Lastly, the study is of observational nature and, as such, it is exposed to systematic errors.

CONCLUSIONS

1. Out-of-hospital cardiac arrest incidence rate in the population of Bielsko-Biala in 2013 was 170/100,000 inhabitants, it increased with age, and was twice as high for men as for women.
2. Out-of-hospital cardiac arrest most frequently occurred at home in the presence of the family. However, CPR was not always undertaken by the witnesses of the incident.
3. Cardiopulmonary resuscitation was effective in about 30% of patients, without differences between men and women.
4. The prehospital mortality was high but did not differ between men and women.

Conflict of interest: none declared

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Epidemiologia pozaszpitalnego zatrzymania krążenia w powiecie bielskim: analiza 12-miesięczna

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Streszczenie

Wstęp: Pozaszpitalne nagłe zatrzymanie krążenia (OHCA) jest stanem ustania mechanicznej czynności serca, który prowadzi nieuchronnie do zgonu, jeżeli nie zostanie przerwany poprzez skuteczne zabiegi resuscytacyjne. Zapadalność na OHCA wynosi 40–200 przypadków na 100 000 ludności i rośnie wraz z wiekiem. Rokowanie w OHCA pozostaje niepomyślne, niezależnie od przyczyny i mechanizmu zatrzymania krążenia, z śmiertelnością sięgającą 70%.

Cel: Celem pracy była ocena okoliczności i podstawowych parametrów epidemiologicznych związanych z OHCA w populacji dorosłych mieszkańców powiatu bielskiego w obserwacji 12-miesięcznej.

Metody: Na podstawie standardowych kart wyjazdowych zespołów Państwowego Ratownictwa Medycznego (PRM) dokonano retrospektywnej analizy 272 przypadków OHCA na terenie powiatu bielskiego, które miały miejsce w terminie od 01.01.2013 r. do 31.12.2013 r. Szczegółowej ocenie poddano podstawowe dane demograficzne pacjentów (wiek, płeć), okoliczności wystąpienia OHCA (miesiąc, dzień tygodnia, pora dnia, godzina, miejsce), informacje o potencjalnej przyczynie i mechanizmie OHCA (pierwszy oceniony rytm serca, potencjalny wywiad chorobowy), a także dane związane z działaniami podjętymi przez świadków (obecność świadków w miejscu zdarzenia, podjęcie resuscytacji krążeniowo-oddechowej przez świadków zdarzenia, fakt wykonania defibrylacji) oraz członków zespołu PRM (czas od otrzymania zgłoszenia do przybycia na miejsce zdarzenia, podjęte działania na miejscu zdarzenia, czas trwania resuscytacji krążeniowo-oddechowej i jej wynik).

Wyniki: W 2013 r. w powiecie bielskim zarejestrowano 23 400 zgłoszeń do zespołów PRM, z czego 272 (1,16%) dotyczyło OHCA (190 [70%] u mężczyzn; 82 [30%] u kobiet). Współczynnik zapadalności na OHCA wynosił 170/100 000 ludności i był ponad 2-krotnie większy u mężczyzn (243/100 000) niż u kobiet (99/100 000) ($p < 0,01$). Mediana wieku poszkodowanych wynosiła 71 (IQR 60–80) lat. Zapadalność wzrastała z wiekiem badanych ($p < 0,01$). Liczba zgłoszeń nie różniła się między poszczególnymi dniami tygodnia ($p = 0,6$), stwierdzono natomiast znaczące różnice w odniesieniu do poszczególnych miesięcy

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($p < 0,01$). Bazując na 6-godzinnych przedziałach czasowych, najmniej zgłoszeń w ciągu doby przyjęto pomiędzy godziną 00:01 a 06:00 (16%) ($p = 0,01$). Najczęstszym miejscem wystąpienia OHCA był dom poszkodowanych ($n = 223$; 82%). Osobami zgłaszającymi zdarzenie zwykle byli członkowie rodziny ($n = 210$; 77%). OHCA wystąpiło w obecności świadków w 164 (60%) przypadkach. Resuscytacja krążeniowo-oddechowa została podjęta przez świadka w 152 (56%) przypadkach, a mediana czasu jej trwania wynosiła 10 (IQR 8–14) minut. Mediana czasu od przyjęcia zgłoszenia przez dyspozytora do przyjazdu zespołu PRM wynosiła 9 (IQR 7–11) minut. Po przybyciu na miejsce zdarzenia przez zespół PRM w 106 (39%) przypadkach stwierdzono rytm defibrylacyjny. Częściej stwierdzano go w sytuacji, gdy wystąpił w miejscu publicznym (OR = 2,5; 95% CI 1,3–4,6; $p < 0,01$), w obecności świadków zdarzenia (OR = 3,2; 95% CI 1,9–5,6; $p < 0,01$), gdy podjęli oni akcję resuscytacyjną (OR = 7,8; 95% CI 4,3–14,1; $p < 0,01$), a zwłaszcza masaż serca (OR = 6,3; 95% CI 3,6–11,2; $p < 0,01$). Z 272 analizowanych wezwań w 67 przypadkach (45 mężczyzn, 22 kobiety) stwierdzono zgon po przybyciu zespołu PRM. W pozostałych 205 przypadkach podjęto resuscytację krążeniowo-oddechową, która była nieskuteczna u 141 osób (97 mężczyzn, 44 kobiety). W przypadku podjęcia resuscytacji krążeniowo-oddechowej mediana czasu jej przeprowadzania przez zespół PRM wynosiła 30 (IQR 20–40) minut. Wskaźnik śmiertelności do momentu przekazania do szpitala w całej grupie był równy 76,5% (75,3% u mężczyzn i 79,3% u kobiet). Nie odnotowano znamienych różnic w parametrach śmiertelności w odniesieniu do pory dnia, dnia tygodnia czy miesiąca.

Wnioski: Współczynnik zapadalności na OHCA w populacji bielskiej w 2013 r. wynosił 170/100 000 ludności, wzrastał z wiekiem poszkodowanych i był 2-krotnie większy u mężczyzn niż u kobiet. OHCA miało miejsce najczęściej w domu rodzinnym, w obecności rodziny, jednak resuscytacja krążeniowo-oddechowa nie zawsze była podejmowana przez świadków zdarzenia. Była ona skuteczna u ok. 30% poszkodowanych, bez różnic między kobietami i mężczyznami. Śmiertelność chorych po OHCA do momentu przekazania do szpitala w badanej grupie była wysoka, ale nie różniła się pomiędzy kobietami i mężczyznami.

Słowa kluczowe: pozaszpitalne zatrzymanie krążenia, zapadalność, śmiertelność, resuscytacja krążeniowo-oddechowa

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