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The role of Rapid Response Teams during in-hospital sudden cardiac arrest – a retrospective cohort study

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Resources - **H**
Software - **I**
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Validation - **K**
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ABSTRACT

INTRODUCTION: Sudden Cardiac Arrest (SCA) is a condition in which it is crucial to quickly start resuscitation measures. In hospitals, Advanced Life Support (ALS) is the responsibility of medical personnel, usually operating as a Medical Emergency Team (MET) or Critical Care Response Team (CCRT). During medical duty, a Rapid Response Team (RRT) is selected from the Hospital Emergency Department (ER) or the Anesthesiology and Intensive Care Unit (ICU). The aim of the study was to determine the effect of RRT activities on the outcome of resuscitation during in-hospital SCA and to identify factors of increased risk of such an event.

MATERIALS AND METHODS: The analysis included 87 SCA and resuscitation protocols prepared in a voivodeship (state) hospital in central Poland in 2023. Attention was paid, among other things, to the mechanism and cause of SCA, the medical actions taken by the RRT and the time it took the RRT to reach the patient. Variables were assessed in terms of short-term survival. Basic data were calculated using descriptive statistics and variable correlations. The significance level was set at p=0.05.

RESULTS: The analysis included 87 calls for in-hospital cardiac arrest, of which 56 (64.37%) were men and 27 (31.03%) were women (4 cases did not specify sex). Most interventions concerned the general surgery (n=26; 29.89%), cardiology (n=20; 22.99%) and orthopedics departments (n=11; 12.64%). In the vast majority of cases (n=56; 64.37%), SCA occurred in the presence of medical staff from a given hospital department, who notified the RRT. The team arrived at the call site in an average of 3.30 minutes. The predominant procedure (n=80; 91.95%) implemented by RRT was rescue pharmacotherapy, indirect cardiac massage (n=70; 80.46%), ventilation (n=69; 79.31%), and device-assisted airway management (n=66; 75.86%). The implementation of respiratory therapy by RRT proved to be significant in achieving ROSC (p=0.003). In most patients, asystole or PEA was observed as the mechanism of SCA (n=76; 87.36%). Before the arrival of the Emergency Medical Team, defibrillation was performed in 7 (8.05%) cases, and after arrival in 11 (12.64%) cases. Spontaneous circulation return was achieved in 42 patients (48.28%).

CONCLUSIONS: Rapid Response Teams play an important role in providing medical assistance to patients who experience a sudden deterioration in their condition or cardiac arrest during hospitalization, especially in the surgical, cardiology and orthopedic departments. Emergency medical services arrive at the scene of the call quickly, most often implementing pharmacotherapy, chest compressions, ventilation and instrument-based airway opening management. Despite these efforts, more than half of the patients did not survive SCA.

KEY WORDS: Rapid Response Teams, sudden cardiac arrest, critical care, anesthesiology, intensive care.

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INTRODUCTION

Rapid Response Teams (RRTs) constitute the basic structure protecting sudden health threats occurring in medical facilities. They most often include staff on medical duty in the Hospital Emergency Department (ED) or the Anesthesiology and Intensive Care Unit (ICU). These are the people responsible for assessing the patient's condition and implementing emergency intensive care [1,2]. Recognizing symptoms that signal possible cardiac arrest is extremely important. The detection of new disorders in circulatory or respiratory system functioning should arouse the vigilance of on-duty medics in order to take preventive measures. The annual incidence of IHCA in Europe ranges from 1.5 to 2.8 per 1000 hospitalizations [3]. Numerous healthcare facilities around the world, aiming at improving the hospitalized patients care, introduce the so-called Early Response Teams (ERTs), which are sometimes also part of resuscitation teams [1,4].

The 1990s are considered to be the beginning of ERT operation, as they appeared in North American countries and Australia, from where they later reached Western Europe. Medical teams base their actions on early diagnosis of the patient's condition and the introduction of appropriate therapy [1]. In Poland, these teams were implemented based on the project of the Center for Monitoring Quality in Healthcare in 2016, and 25 hospitals participated in it. Data collected from 2160 documents analyzed by Krittayaphong R, Saengsung P et al. show that in cardiac arrests with shockable rhythms, early electrical shock is the most effective [5]. These assumptions were also confirmed by a retrospective study conducted in one Austrian hospital. Based on 500 cardiac arrests that occurred in a medical facility and were not monitored, the use of an external defibrillator resulted in a higher patient survival rate [6]. Rapid Response Teams are adapted to various in-hospital care systems. They operate within the structures of Rapid Response Systems (RRS), Critical Care Response Team (CCRT), and Medical Emergency Team (MET). The task assigned to them is based on the quick interpretation of the patient's condition and the initiation of targeted treatment. Studies and opinions regarding the operation of resuscitation teams in hospitals agree on the need for their standardization, which requires a thorough assessment of the already operating teams. In Finland, attention was drawn to the urgent need to develop resuscitation skills of anesthesiology department personnel [7]. Rapid Response Teams are one of the most important elements of action during in-hospital sudden cardiac arrest. A quick response and implementation of resuscitation activities not only increases patient survival but also reduces the duration of subsequent hospitalizations [8].

A condition such as Sudden Cardiac Arrest (SCA) requires high-quality resuscitation procedures from both witnesses to the event and the RRT arriving at the site. In order to improve the performance of their tasks, the staff can use the Guidelines of the European Resuscitation Council (ERC) and the International Liaison Committee on Resuscitation (ILCOR) [3,10], which are based on current medical knowledge. The algorithms described in the ERC outline the course of action not only for medical personnel, but also for witnesses to the incident (Basic Life Support – BLS).

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Performing cardiopulmonary resuscitation (CPR) including the use of an Automated External Defibrillator (AED). Quick defibrillation increases patient survival rates and supports subsequent actions by medics who implement advanced life support (ALS). The use of manual defibrillation, device-based airway protection, and pharmacotherapy all contribute to supporting the patient. Nevertheless, the guidelines also draw attention to the patient's vital signs and possible reversible causes of SCA. Over the last years, the use of Point-of-Care Ultrasonography (POCUS) has been emphasized to rule out conditions such as tension pneumothorax and cardiac tamponade. The ability to efficiently perform and interpret the results allows medics to implement important procedures that can influence the return of spontaneous circulation (ROSC). In hospital settings, there is also an increased possibility of access to extracorporeal CPR techniques using an ECMO device (eCPR) [9].

The authors attempted to analyze the original documentation of the tertiary referral hospital where the RRT operates. The effect of RRT activities on the resuscitation outcome during in-hospital SCA was determined and factors of increased risk of such an event were identified.

MATERIALS AND METHODS

After obtaining the consent of the hospital management and the Research Ethics Committee of the University of Siedlce (No. 87/2024 of October 4, 2024), a retrospective study was conducted. The research tool involved the in-hospital resuscitation protocols from 2023. The study consisted of 4 stages.

Materials

The study was performed using data contained in 95 SCA and resuscitation protocols of the Rapid Response Teams from the Anaesthesiology and Intensive Care Unit of the Hospital in Siedlce. The protocols were hand-filled documents from interventions undertaken from the beginning of January to the end of December 2023. Due to missing and illegible data, 8 forms were rejected, including 87 cases in the study. The form included, among others: information about the department where the cardiac arrest occurred, the time when the Emergency Medical Services were called, the presence of witnesses at the scene, the cause of the cardiac arrest, the activities performed by witnesses and members of the resuscitation team, and the effect of CPR (Figure 1).

Oddział ...
Imię i nazwisko pacjenta ...
Data urodzenia / Pesel ... Nr historii choroby ...
Rozpoznanie ...
Płeć ☐ M ☐ K

ZDARZENIE

Wewnątrzszpitalne
☐ SOR
☐ Oddział ...
☐ Sala Operacyjna
☐ OIT
☐ Inne: ...

☐ Zewnątrzszpitalne
☐ Karetka
☐ Miejsce zamieszkania
☐ Miejsce publiczne
☐
Inne ...

Czas	GG	MM
Zdarzenia		
Przybycia		
Pierwszej analizy rytmu		
Zakończenia		

Świadkowie ☐ NIE ☐ TAK ...
Monitorowanie NZK ☐ NIE ☐ TAK
Mechanizm NZK / Początkowy rytm
☐ VF ☐ VT ☐ Asystolia ☐ Bradykardia
☐ PEA ☐ Inny ...

Przyczyna:
☐ Kardiologiczna
☐ Neurologiczna
☐ Hipoksja
☐ Hipowolemia
☐ Zaburzenia elektrolitowe
☐ Hipotermia
☐ Odma prężna
☐ Tamponada osierdzia
☐ Zator tętnicy płucnej
☐ Inna ...

Efekt resuscytacji
☐ Zgon
☐ ROSC

Czas RKO ...

Dalsze losy
☐ pozostał w oddziale
☐ przeniesiony do ...

Stan w momencie przybycia ZR
Przytomny ☐ TAK. ☐ NIE
GCS ...
Oddech ☐ TAK ☐ NIE
Krążenie ☐ TAK ☐ NIE

Czynności wykonane do przybycia ZR
☐ brak działań
☐ monitorowanie
☐ masaż pośredni serca
☐ bezprzyrządowy
☐ przyrządowy ...
☐ przyrządowe udrożenie d. o.
☐ wentylacja
☐ workiem
☐ respiratorem
☐ defibrylacja
☐ przez świadków
☐ wszczepiony ICD
☐ Kaniulacja żyły
☐ Leki ...
☐ Inne ...

Podjęte czynności przez ZR
☐ NIE
☐ oznaki śmierci
☐ DNAR
☐ Oznaki zachowanego krążenia
☐ TAK
☐ monitorowanie
☐ masaż pośredni serca
☐ bezprzyrządowy
☐ przyrządowy
☐ przyrządowe udrożenie d. o.
☐ wentylacja
☐ workiem
☐ respiratorem
☐ defibrylacja
☐ Kaniulacja żyły
☐ Leki
☐ Inne

Uwagi:

Figure 1. SCA and resuscitation protocol.

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TOWARZYSTWO POMOCY DORAŹNEJ

Methodology

Stage 1 - In the first stage of the study, the form of calling the Rapid Response Team in the studied hospital, as well as the original resuscitation protocol form, were identified. Due to the difficulty in reading the documentation in some cases, only those cards that contained the necessary legible data were included in the study. The in-hospital procedure recommends that the department's staff shall notify the Emergency Medical Services (RRT) about the patient's deteriorating condition and cardiac arrest by contacting the internal number set as 555. Messages are passed on to the operating theater nurse anesthesiologist, who passes them on to the doctor in the anesthesiology department. The Rapid Response Team only visits hospitalized patients.

Stage 2 - The second stage of the study involved categorizing the equipment used by RRT. The called team equipped with a resuscitation box containing medications from the "resuscitation tray" and a self-inflating bag immediately goes to the department from which help was called.

Stage 3 - In the third stage, the persons included in the RRT were identified, which included the nurse/anesthesiologist from the operating theater and the doctor from the anesthesiology department who were on duty on a given day. Shift-based duty ensures 24-hour staffing, every day of the year.

Stage 4 - The fourth stage of the study involved the analysis of data contained in the SCA and resuscitation protocols. The following information was used: patient's sex, place of the event, date of the event, time of SCA occurrence, presence of witnesses, resuscitation activities performed by witnesses, cause of SCA, its mechanism, monitoring of cardiac arrest, actions taken by the RRT, CPR effect, CPR duration, and further hospitalization of the patient.

Statistical analysis - Statistical analysis was performed using Microsoft Excel 365 and IBM SPSS Statistics version 29. Basic data was calculated using descriptive statistics and the normality of distribution test, Spearman's rho test and Student's T-test for independent samples. The significance level was set at p=0.05.

RESULTS

Characteristics of the study group

The study group consisted of patients from 14 departments and units of the voivodeship (state) hospital, described in the SCA and resuscitation protocols from 2023. The data contained in 87 protocols was verified for completeness and readability of the data and then interpreted. The patients were men in 56 (64.37%) cases, and women in 27 (31.03%). Four cases did not define sex in the medical records.

RRT interventions on a daily and annual basis

Most of the interventions (n=48; 55.17%) were performed by the RRT on duty between 7:00 a.m. and 7:00 p.m. Less than half of them (n=39; 44.83%) were performed during the night shift, which took place between 7:00 p.m. and 7:00 a.m., showing no significant correlation with the number of cases per shift (p=0.172; Chi^2). The exact hourly breakdown is shown in Figure 2.

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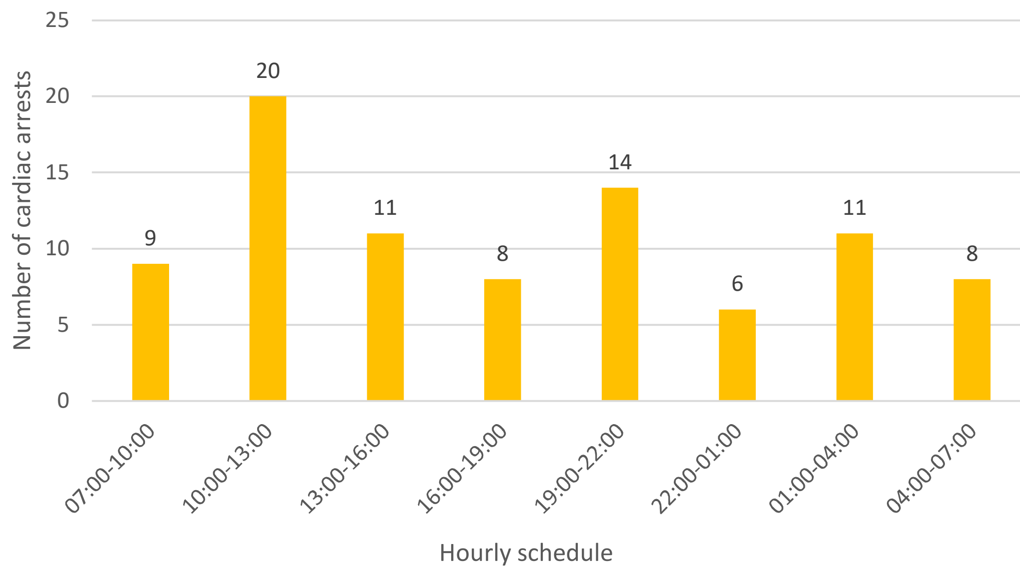

Figure 2. Hourly schedule of RRT interventions.

The Rapid Response Team was called most frequently in November (n=13), January (n=10) and October (n=10). The least frequent months in which it was called were: April (n=4), June (n=4) and July (n=5). In the remaining months, the number of interventions ranged between 6 and 8 cases (Figure 3).

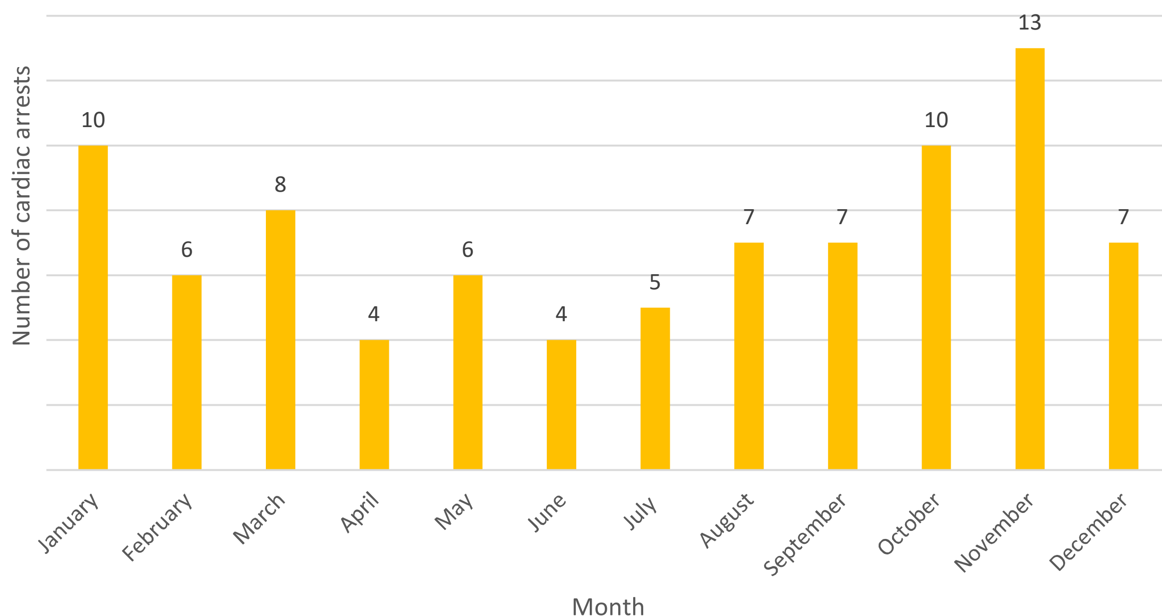

Figure 3. Year-round distribution of RRT interventions.

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Location of the Event

The data contained in the SCA and resuscitation protocols were analyzed according to the location where the cardiac arrest occurred. Most interventions took place in the general surgery department (n=26; 29.89%). Slightly fewer interventions were observed in the cardiology department (n=20; 22.99%) and in the orthopedics department (n=11; 12.64%). The fewest interventions, only 1 (1.15%) each, were observed in the neonatology, pediatrics, clinical oncology departments, dialysis center and operating theater, as presented in detail in Figure 4. A significant correlation (p=0.000) was found in the occurrence of SCA depending on the type of department.

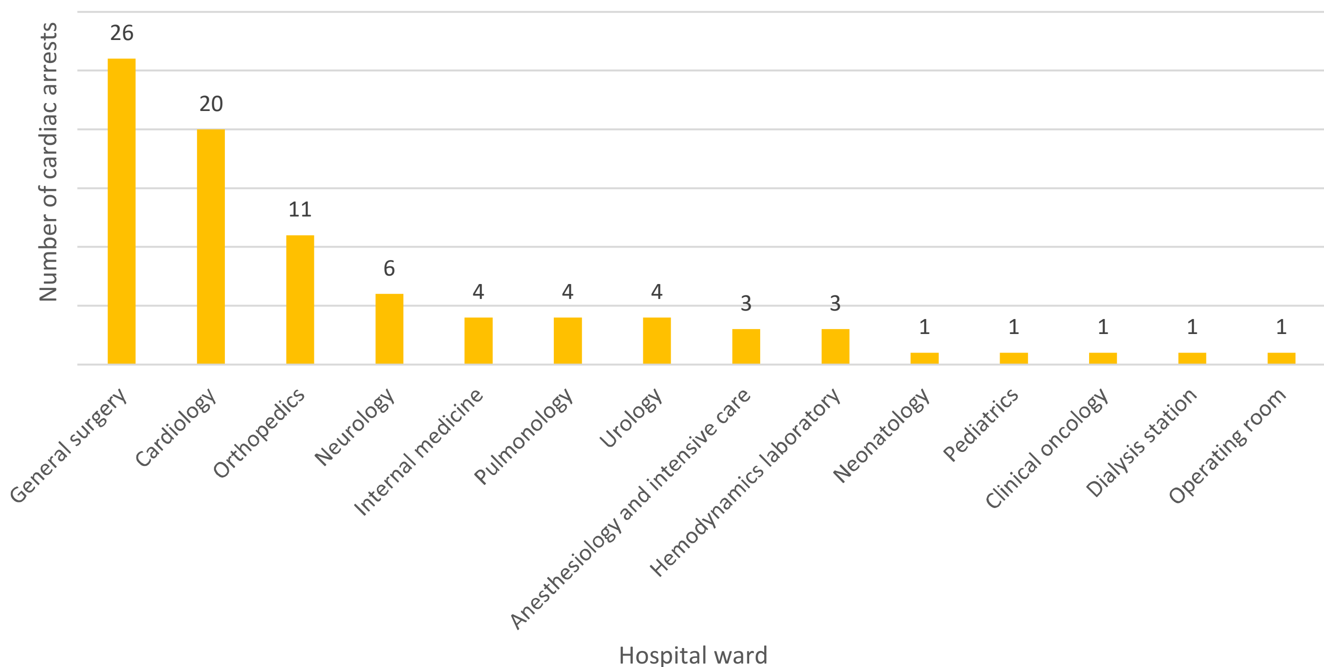

Figure 4. Number of interventions in individual hospital wards.

Presence of witnesses during the event

Even in medical facilities, there may be no medical personnel present during cardiac arrest, as observed in 7 (8.05%) events. However, medical staff was present with the patient in the vast majority of cases (n=56; 64.37%).

Activities performed before RRT arrival

SCA and resuscitation reports also include information about activities performed by witnesses to the event. The vast majority of hospital staff provided patient monitoring after calling the Rapid Response Team, which occurred in 87.36% of cases (n=76). In a slightly smaller number of patients (n=64; 73.56%), the personnel recognized SCA and initiated chest compressions defined in the protocol as "indirect cardiac massage". In the vast majority of cases, it was performed using the device-free method (75.86%), and mechanical compression support devices were used in 4.60% of patients.

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A similar number of patients (n=60; 68.97%) were ventilated before RRT arrival. Hospital staff used a self-inflating bag much more often than a ventilator (72.41% vs. 13.79%). Few patients had airways secured with a device (n=18; 20.69%). No statistical significance was found (p=0.489) using the Spearman's Rho test, in terms of the relationship between the airway opening and the return of spontaneous circulation. SCA was monitored in 52 patients (59.77%), and only 14 patients (16.09%) were not under cardiac monitoring. Defibrillation was used in 7 cases. Statistical analysis showed no statistically significant correlation between defibrillating the patient before the arrival of the Rapid Response Team and increasing the chances of ROSC (p=0.190). The quantitative values of procedures performed by medical personnel before the arrival of the RRT are shown in Figure 5.

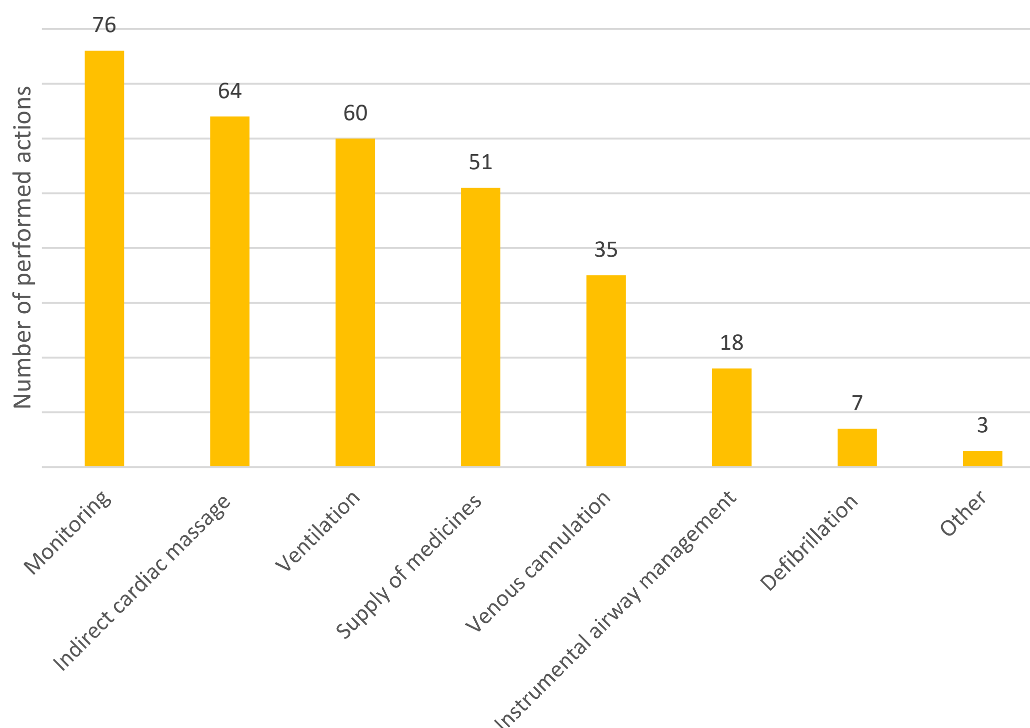

Figure 5. Activities performed before RRT arrival.

Activities performed by the Rapid Response Team

In 70 patients (80.46%), the intervention started with chest compressions. Mechanical chest compression was implemented in 28.74% of patients. Patient ventilation was taken over or implemented by the RRT in 69 patients (79.31%). In these cases, a ventilator was used in almost half of the patients (43.68%), and a significant correlation (p=0.003) was observed between ventilator use by RRT and ROSC. A significant number of patients (n=66; 75.86%) had their airways secured with a device. In the vast majority of cardiac arrests, RRT members also initiated rescue pharmacotherapy. Drug administration was observed in 80 cases (91.95%). Other activities performed by RRT are shown in Figure 6.

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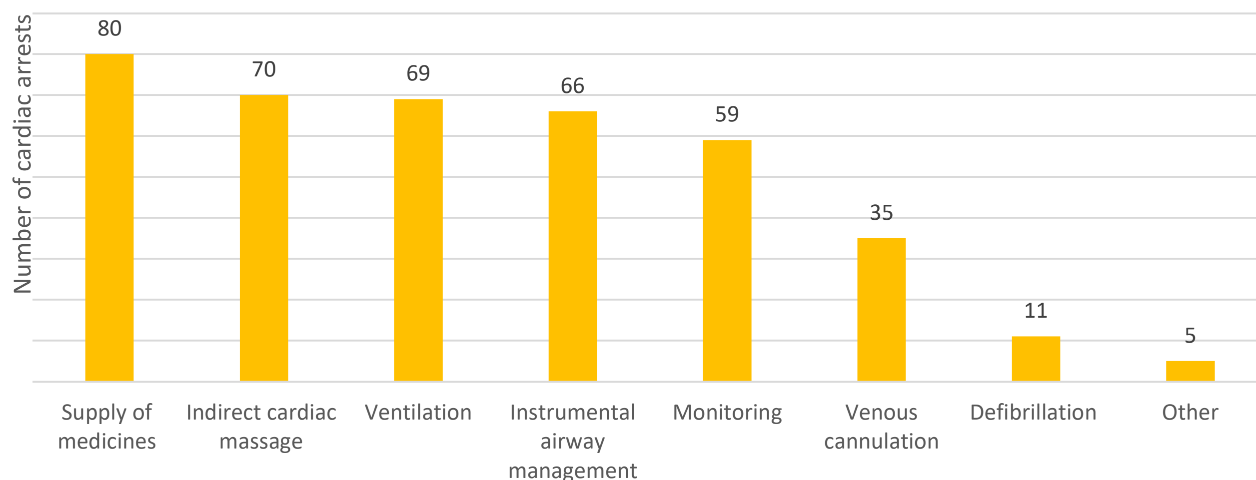

Figure 6. Activities performed by RRT.

The cardiac arrest mechanism

Cardiac arrest most often occurred due to non-defibrillation mechanisms. Asystole or Pulseless Electrical Activity (PEA) occurred in 76 patients (87.36%). Ventricular Fibrillation (VF) and pulseless Ventricular Tachycardia (pVT) occurred 11 times (12.64%). Additionally, bradycardia was observed in two patients.

Causes of SCA and resuscitation outcome

The medical doctor in charge of the RRT diagnosed "cardiological problems" as the cause of SCA in 39 cases (44.83%). In 20 patients, the problem leading to cardiac arrest was hypoxia, accounting for as many as 22.99% of cases. In selected cases, the staff identified several causes of SCA simultaneously. Figure 7 shows other causes of cardiac arrest that occurred much less frequently. ROSC was observed in 42 patients (48.28%).

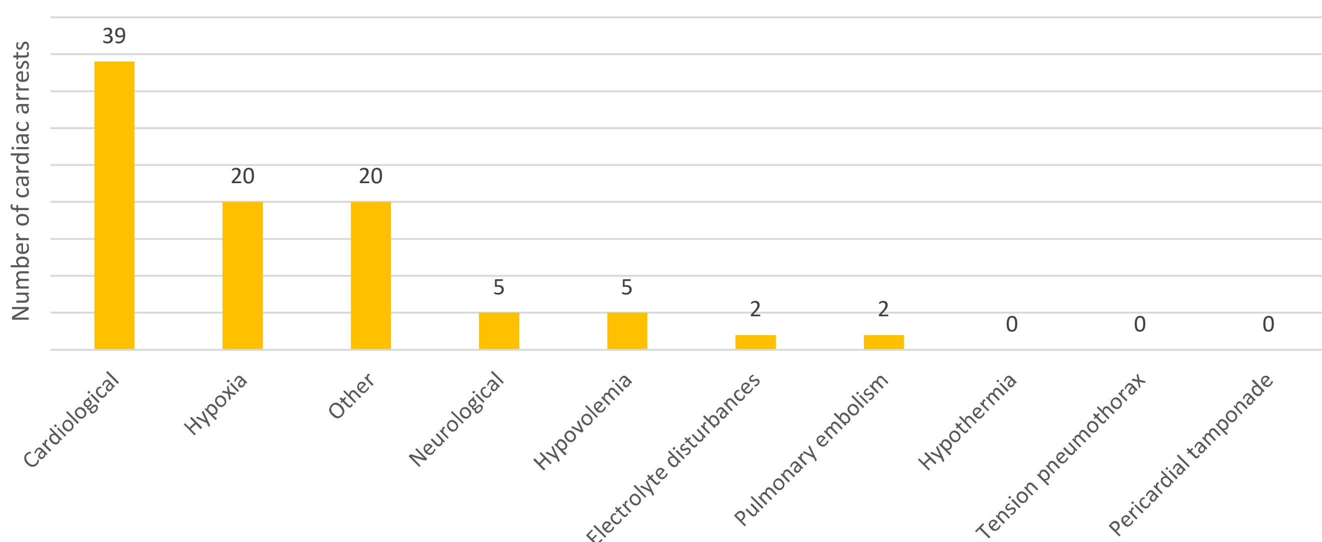

Figure 7. Causes of cardiac arrest.

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Duration of CPR

The average time spent performing resuscitation by the RRT was 31.14 minutes. The shortest resuscitation procedures took 2 minutes, and the longest 234 minutes. The resuscitation trend is shown in Figure 8.

Figure 8. The time of conducting resuscitation activities by the RRT.

RRT arrival time

On average, the Rapid Response Team arrived at the scene in 3.30 minutes. In 15 cases (17.24%), it was already on site when cardiac arrest occurred. The longest time needed to reach the patient was 25 minutes (Figure 9). When performing the Spearman's rho test, no statistically significant correlation was observed between the time of RRT reaching the patient and achieving ROSC (p=0.378).

Figure 9. Time of RRT arrival at the incident site.

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DISCUSSION

Rapid Response Teams constitute an important element of medical facilities' operations [11]. Thanks to their actions, it is possible to quickly and efficiently assess the patient's condition and initiate resuscitation procedures. During the study, a number of parameters were assessed, indicating the frequency and location of in-hospital SCA and medical activities performed before and after the RRT arrival at the call site.

The authors performed a series of analyses of variable dependencies. Life-saving procedures such as early defibrillation, airway management with devices, artificial ventilation, pharmacotherapy, and good-quality chest compressions may have a significant effect on the cardiopulmonary resuscitation outcome. The study showed that only achieving ROSC was significantly correlated (p=0.003) with the implemented respiratory therapy. A similar relationship was observed in a study by Malinverni S. et al., in which the researchers also indicated that using ventilator therapy in advanced life support increases the chance of ROSC [20]. Ventilation with a self-inflating bag and airway management with devices did not significantly affect resuscitation success, which was also confirmed by other researchers' studies [13-17].

The relationship between defibrillation of the patient before the arrival of the RRT and the return of spontaneous circulation was also not significant (p=0.190). Witnesses to cardiac arrest performed defibrillation only in 7 cases, which may also be evidenced by the statistically low survival rate of in-hospital SCA. The European Resuscitation Council guidelines recommend performing defibrillation as soon as possible, in order to increase the chances of ROSC [3]. In a study conducted by Awada E. et al., it was noted that early defibrillation increases the patient's chances of survival by 19% [18]. Similar conclusions were drawn in the study by Krittayaphong R et al., where the researchers observed that prompt defibrillation in hospitalized patients increased their chance of ROSC [5]. It should therefore be concluded that too small study sample does not show the actual effectiveness of defibrillation in a hospital department. Additionally, the time of RRT arrival was analyzed, in correlation with the spontaneous circulation return. However, there was no significant correlation between these factors (p=0.378). However, in the study by Leong CK et al., opposite conclusions were described [19].

The most common disorders leading to cardiac arrest described by the RRT physician were cardiological causes. A high risk of SCA and SCI interventions was demonstrated in the surgical department. The relatively high effectiveness of RRT intervention (ROSC was achieved in 48.28% of patients) results from numerous factors that are difficult to interpret unambiguously. The activities of the RRT of the studied hospital were based on advanced procedures implemented by the medical staff, as well as the short time in which they were initiated. On average, the RRT reported to patients within 3.30 minutes of calling. Quick and effective actions will certainly increase the survival rate of patients who have suffered cardiac arrest.

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The study demonstrated the need for further research on in-hospital SCA and the evaluation of actions implemented by local RRTs. The authors draw attention to the need to standardize medical documentation, the readability of which will certainly be improved by the digital version. Consideration should be given to implementing a separate form in the hospital's central documentation, relating to the resuscitation protocol conducted both by the staff of a given department (SCA witnesses) and the resuscitation team called to the scene.

Limitations of the study - the limited number of SCAs and resuscitation protocols resulted from the documentation kept by the RRT in the studied hospital. The appearance and elements included in the protocols were created by the indicated medical entity. These cards were filled out by hand by RRT members, which in some cases made it difficult to read the content of the document. The protocols were archived only in paper form, without maintaining a collective database, which significantly hindered their verification. In some cases, the documentation was incomplete, which forced exclusion from the study. Furthermore, the lack of patient data correlation with the central system prevented insight into the patient's further hospital stay and the indication of long-term survival.

CONCLUSIONS

A significant proportion of the Rapid Response Team calls concerned cardiac arrest in men. The team was most often called in during the winter, and in the morning and evening hours. In most cases, hospital staff were at the site of the cardiac arrest. The most common mechanism of SCA was asystole and PEA, and the cause determined by the physician was cardiac problems and hypoxia. On average, RRT arrived at the scene 3.30 minutes after the call to the internal emergency number. After noticing SCA, medical personnel performed monitoring, chest compressions, and ventilation in most cases. RRT's use of a respirator was crucial in achieving ROSC. In addition, RRTs usually implemented rescue pharmacotherapy and used devices to open the airways. RRT performed resuscitation activities for an average of 31.14 minutes. The number of cases achieving ROSC was comparable to the number of patients who died. It is recommended to standardize the documentation kept by the Rapid Response Team, as well as take measures to improve the level of training and equipment of the staff of surgical and cardiology departments, due to the high risk of SCA.

SUPPLEMENTARY INFORMATION

Funding: *No fund was received related to this study.*
Institutional Review Statement: *The study was conducted according to the guidelines of the Declaration of Helsinki.*
Informed Consent Statement: *Informed consent was obtained from all subjects involved in the study.*
Data Availability Statement: *The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.*
Conflicts of Interest: *The authors declare no conflicts of interest.*

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