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Clinical paper

Time delays to reach dispatch centres in different regions in Europe. Are we losing the window of opportunity? — The EUROCALL study☆

Nikolaos Nikolaou[a,*], Maaret Castrén[b], Koenraad G. Monsieurs[c], Diana Cimpoesu[d], Marios Georgiou[e], Violetta Raffay[f,g], Rudolph Koster[h], Silvija Hunyadi-Antičević[i], Anatolij Truhlář[j,k], Leo Bossaert[l], The EUROCALL investigators[1]

[a] *Konstantopouleio General Hospital, Athens, Greece*
[b] *Dept. of Emergency Medicine and Services, Helsinki University Hospital and Helsinki University, Helsinki, Finland*
[c] *Antwerp University Hospital and University of Antwerp, Antwerp, Belgium*
[d] *Universitatea de Medicină şi Farmacie "Gr. T. Popa" Iaşi, Romania*
[e] *American Medical Center, University of Nicosia, Cyprus*
[f] *Municipal Institute for Emergency Medicine, Novi Sad, Serbia*
[g] *Serbian Resuscitation Council, Novi Sad, Serbia*
[h] *Academic Medical Centre, Amsterdam, The Netherlands*
[i] *Center for Emergency Medicine, Clinical Hospital Center Zagreb, Zagreb, Croatia*
[j] *Emergency Medical Services of the Hradec Králové Region, Hradec Králové, Czechia*
[k] *Department of Anaesthesiology and Intensive Care Medicine, University Hospital Hradec Kralove, Czechia*
[l] *University of Antwerp, Antwerp, Belgium*

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ABSTRACT

Aim: In out of hospital cardiac arrest (OHCA) the start of Cardiopulmonary Resuscitation (CPR) by a single rescuer may be delayed considerably if the total time (TT) to connect the telephone call to the Emergency Medical Communication Centre (EMCC) is prolonged. EUROCALL investigated the TT-EMCC and its components using different calling procedures.
Methods: This prospective, multicentre, randomised study was performed in April 2013. Telephone calls were randomly allocated to time of call, and to those connecting directly to the EMCC (1-step procedure) and those diverted before connecting to the EMCC (2-step procedure).
Results: Twenty-one EMCCs from 11 countries participated in the study. Time to first ringtone was similar between 1-step 3.7 s (IQR 1.0–5.2) and 2-step calls 4.0 s (IQR 2.4–5.2). For the 1878 1-step calls, the median TT-EMCC was 11.7 s (IQR 8.7–18.5). For the 1550 2-step calls, the median time from first ringtone to first call-taker was 7 s (IQR 4.6–11.9) and from first call-taker to EMCC was 18.7 s (IQR 13.4–29.9). Median TT-EMCC was 33.2 s (IQR 24.7–46.1) and was significantly longer than the TT-EMCC observed with the 1-step procedure ($P < 0.0001$). Significant differences existed among participating regions between and within different countries both for 1-step and 2-step procedures.
Conclusion: TT-EMCC was significantly shorter in a 1-step procedure compared to a 2-step procedure. Regional differences existed between countries but also within countries. This may be relevant in cases of OHCA and other situations where patient outcome is critically time-dependent.

Introduction

Sudden cardiac arrest is a leading cause of death in Europe. Each year Emergency Medical Services (EMS) respond to between 24 and 186 out-of-hospital cardiac arrest OHCA per 100 000 inhabitants.[1–3] The chain of survival describes the critical steps in the treatment of a cardiac arrest.[4] The first step, early recognition and calling for an ambulance, is critical to initiate the activation

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* Corresponding author.
E-mail address: nikosinikolaou@gmail.com (N. Nikolaou).

[1] See Appendix A for the details of EUROCALL investigators.

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of local and dispatched rescuers. If the dispatcher does not recognize a call regarding a cardiac arrest, three months survival is only 5% whereas if it is recognized as such, 3 months survival is 14%.[5] Early bystander Cardiopulmonary Resuscitation (CPR) is a critical second step: patients receiving bystander CPR within 2 min after the collapse have an odds ratio for survival to one month of 8.3 as compared to 2.9 if CPR was started later.[6]

The next step is equally important, as for every minute of delay from collapse to defibrillation, chances for survival decrease by 10%.[7–10]

In case of OHCA the current CPR guidelines recommend for a single rescuer to first call the Emergency Medical Communication Centre (EMCC) and to start CPR immediately thereafter.[11] In case of a single rescuer, therefore, the start of CPR may be delayed considerably if the total time to connect to the dispatcher at the EMCC (TT-EMCC) is prolonged.[12]

The Council of the European Union (EU) introduced the uniform emergency telephone number 112 in 1991 in order to make emergency care more accessible for all citizens.[13] The operational conditions of emergency calls differs between European countries. In some countries 112 is the national number for all emergencies. Other countries have separate national emergency numbers for police, fire and/or ambulance services and there the number 112 is available as a secondary emergency number but its use for alerting EMS is variable. In these countries a call to 112 is either diverted to the corresponding national telephone number or to the final call-taker with responsibility for EMS response vehicle dispatch.[14]

TT-EMCC is measured in many systems of care, but its components are rarely reported. The aim of the EUROCALL study was to investigate these components of TT-EMCC in several regions in Europe, also taking into consideration the differences in handling a call between countries and regions.

TT-EMCC was investigated in calls that connected directly to the EMCC (1-step procedure), either using the uniform European 112 emergency number or using a local number, and in calls that did not connect directly but were diverted to the EMCC (2-step procedure).

We also investigated differences in TT-EMCC using a landline versus a mobile phone and in relation to the day and time of the call.

Methods

Setting and study question

EUROCALL was a prospective, one month, multicentre randomised study that was conducted from April 1 to April 30, 2013. The European Resuscitation Council (ERC) supported the study.

EMCCs were recruited after an open invitation to the national representatives of countries in the General Assembly of the ERC. EMCCs from 11 countries participated.

The main goal of the study was to measure the components of the time delay to reach the dispatcher at the EMCC that sends an EMS response team to a medical emergency. These time intervals were studied in calls that reached the EMCC directly (1-step procedure, either using the uniform European emergency number 112 or using the local number) and in calls where a call-taker from 112 or from the local number was reached first, and was connected to the EMCC after triage (2-step procedure). The components of the TT-EMCC were: (1) time from dialling to first ringtone and (2) time from first ringtone to call taken by EMCC. This second interval may consist of 1 or 2 intervals: time from first ringtone to first call-taker and time from first call-taker to call taken by EMCC (Fig. 1).

Study design

Planned study calls were distributed over a period of 30 days with six calls over each 24 h for a total of 180 calls to each EMCC. Using a pilot sample of 42 calls per region performed within a week in Athens (Greece), Nicosia (Cyprus), Iasi (Romania) and Novi Sad (Serbia), we calculated that 180 calls to each EMCC were required to measure TT-EMCC with a precision of 10 s. The diurnal variation of the number of research calls was estimated using a sample of 4246 consecutive calls conducted in a week in Novi Sad (Serbia), showing that the ratio between day calls and night calls (between midnight and 6 AM) was about 5:1. Therefore, each day was divided in four 6-h periods (0–6 h, 6–12 h, 12–18 h and 18–24 h) with one call to be performed between midnight and 6 AM and five calls distributed at random over the three other 6-h periods. The time and process (1 vs. 2 step and mobile vs. landline) to perform a call were determined using a random number generator (using the "RANDBETWEEN" function of Microsoft Excel 2008 for Mac version 12.3.6). Each call could be performed at any moment within a prescribed 1-h interval and the exact time had to be recorded. If a call was missed, it could be conducted on the same day and time during another study week. An abandoned call was defined as a call that ended before a conversation occurred.

In regions where both possibilities were available, the calls were stratified for 1-step calls or 2-step calls. The calls were also randomised to be performed with a landline telephone or with a mobile phone.

An online timer was used to measure the successive time intervals and to store these measurements on a computer file (http://online-stopwatch.chronme.com/). Only when an internet connection was not available when a call was to be performed, the stopwatch of a mobile phone/smartphone was used as an alternative.

Before the start of the study all participating EMCCs were informed about the project. For each participating EMCC, the telephone calls were made by the local investigator who was responsible for data collection and quality, and also for ensuring approval from local authorities. One co-investigator could assist each local investigator. If, at any time during a 2-step research call, a dispatcher questioned the reason for the call, the investigators immediately disclosed that this was a test call on behalf of the EUROCALL study and connection to the dispatcher at the EMCC was requested. After reaching the EMCC and the time measurement of that call was completed, the true nature of the call was revealed by the caller, in order to avoid actual activation of the EMS.

Written approval for participation in the study was obtained from the appropriate authorities for each participating EMCC. As no patients and no interventions were involved, ethical approval was waived in all regions except in Finland–Turku (ETMK:45/1802/2013, 19-3-2013) and in Poland (Cracow, Poznan, Rzeszow and Wroclaw) (KBET/32/B/2013, 28-2-2013).

Statistical analysis

Continuous variables are summarised as median (interquartile range IQR). Categorical data are expressed as percentages. Missing data were excluded from the analysis.

The TT-EMCC and its various components did not have a normal distribution as they were skewed to the left; therefore distribution-free statistics were used. For continuous variables between-group differences for two groups the Mann–Whitney U test was used. Differences in case of more than two groups were tested using Kruskal–Wallis (KW) Analysis of Variance (H statistics). Between-group differences for categorical data were tested using the Chi-square test. P-values <0.05 were considered statistically significant.

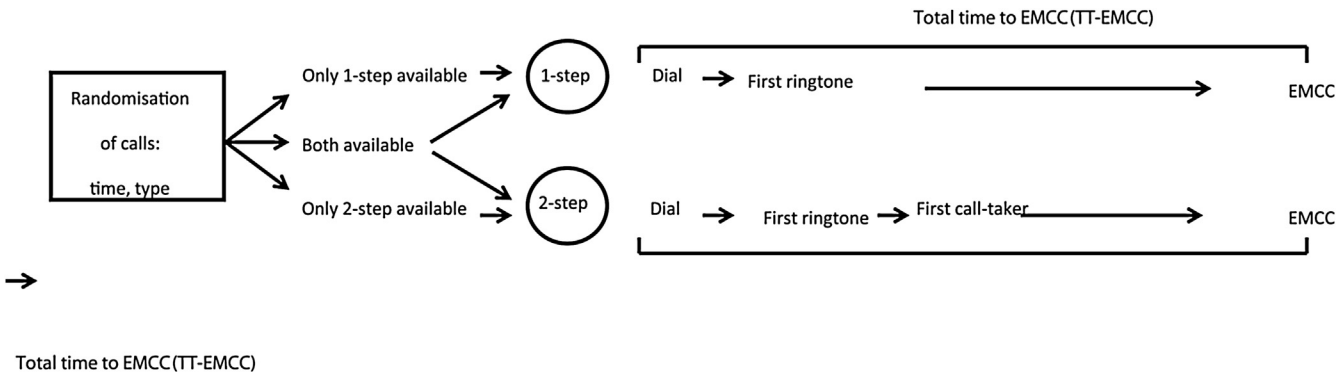

Fig. 1. Time intervals measured in the EUROCALL study.

Results

Participating EMCC

Twenty-one EMCCs from 11 countries participated in the study. Characteristics of each EMCC during the study period are shown in Table 1.

In seven regions all study calls were connected directly to the EMCC (1-step procedure) (Table 2), of which two regions used 112 and the other five a national number. In four regions, only a 2-step procedure was available (112 first and then forwarded to the EMCC). In the remaining ten regions, both a 1-step and a 2-step procedure were in use.

Adherence to study protocol

A total of 3613 out of 3780 (95.6%) scheduled calls were performed according to the protocol, 167 calls (4.4%) were not performed and 5 calls were abandoned. There was no significant difference in the number of missed calls during the night vs. during the day (5.4% vs. 3.9%, P = 0.09), between landlines vs. mobile phones (4.2% vs. 4.1%, P = 0.92) or using 1-step vs. 2-step procedure (4.3% vs. 4%, P = 0.86).

Of all calls, 5.5% were not performed on the pre-specified date (1.7% were performed on the same day of another week, 3.8% on a different day) and 4.5% were performed on a different time of day than pre-specified. The median time deviation from the anticipated time was 16.9 min (IQR 4.5–54 min).

Data of 185 calls (5.1%) were incomplete (in 180 calls in Styria the time interval between dialling and first ringtone was not available and also in 5 abandoned calls in Bergen, time from 112 or EMCC was not captured) and could not be used to calculate TT-EMCC. In total 3428 calls were analysed. The measured times are shown in Table 2. In total 1878 calls were performed using a 1-step procedure and 1550 using a 2-step procedure.

Time to reach the EMCC

The TT-EMCC for all countries is shown in Fig. 2. In 67% of study calls, the TT-EMCC was reached in less than 30 s and in 93% in 60 s or less.

For 1-step calls (n = 1878), the median time to first ringtone was 3.7 s (IQR 1.0–5.2) and the median time from first ringtone to response by the call-taker was 6.4 s (IQR 2.9–13.5). This resulted in a median TT-EMCC of 11.7 s (IQR 8.7–18.5).

For 2-step calls (n = 1550), the median time to first ringtone was 4.0 s (IQR 2.4–5.2), the median time from first ringtone to first call-taker was 7 s (IQR 4.6–11.9) and the median time from first call-taker to EMCC was 18.7 s (IQR 13.4–29.9). This resulted in a median TT-EMCC for 2-step calls of 33.2 s (IQR 24.7–46.1). The difference of the TT-EMCC between 1-step and 2-step systems was statistically significant (P < 0.0001).

In 17 calls (0.5%) no telephone connection could be established at the first attempt and the investigator had to hang up and try again after the end of the first call. In one occasion a third attempt was necessary. These calls had a very long time interval to contact the EMCC, median 45.9 s (IQR 38.6–114.1). In another five cases the call was abandoned by the caller after a median of 108 s (IQR 20.7–132.1).

In three Polish regions (Cracow, Poznan, Wroclaw) all 540 calls (15.8% of total calls in study) were immediately followed by an automated message (zero time to ringtone interval). For the other regions time to first ringtone was <5 s in 1896 calls (55.3%), between 5 and 10 s in 917 calls (26.8%), >10 s in 75 (2.2%) calls and >20 s in 7 cases (0.2%). Overall time to first ringtone accounted for 22.9% of TT-EMCC (95% CI 22.2–23.4).

Variability in TT-EMCC

1-step procedure vs. 2-step procedure.

The TT-EMCC for all countries is shown in Fig. 2. For the 1878 calls with a 1-step procedure the median TT-EMCC was 11.7 s (8.7–18.5) vs. 33.2 s (24.7–46.2) for the 1550 calls using a 2-step procedure (P < 0.0001) (Fig. 2). In 88.6% of the calls using a 1-step procedure the EMCC was reached within 30 s but in only 40.6% with a 2-step procedure (P < 0.0001).

In countries and regions where both a 1-step and 2-step procedure was available and the calls were randomised the median time was shorter using the 1-step [n = 838, median: 12 s (IQR 9–17)] compared to using the 2-step procedure with 38.5 s (n = 893, IQR 28.3–55, P < 0.0001).

The number of calls with TT-EMCC <30 s was also significantly higher with the 1-step procedure than with the 2-step procedure (94% vs. 29%, P < 0.0001).

Landline vs. mobile call

Overall 3101 calls could accommodate both options and were randomised to use a fixed landline or a mobile telephone. Median time to first ringtone was marginally shorter using a landline both for 1-step (2.7 vs. 3.8 s, P < 0.0001) and 2-step (3.8 vs. 4.2 s, P < 0.009). This ended up to median times shorter by 1 s for 1-step calls (11.4 vs. 12.4, P < 0.003) but not in 2-step calls (33.1 vs. 33.4, P = 0.33). Overall, TT-EMCC was 22 s (IQR 11–36.5) for landlines and 23.6 s (IQR 11.9–37.1) for mobile calls. In the 2-step procedure, there was no difference between time from first ringtone to first call-taker (6.9 s for landline and 7.0 s for a mobile call) and for time between first call-taker and EMCC call-taker (28.7 s for landline and 28.6 s for a mobile call).

Table 1
Location (countries/regions) of the participating EMCCs with population served and number of real calls during study time and per year.

Country	EMCC region	Calling procedure	Population served	Number of real calls during study period	Real calls/1000 inhabitants/month
Austria	Styria	1-step	905 500	11 752	13
	Tyrol	1-step	720 000	44 485	62
Croatia	Zagreb	1-step	1 002 494	13 099	13.1
		2-step	1 107 623	9116	8.2
	Primorsko Goranska County, Rijeka	1-step	296 195	4760	16.1
	Split-Dalmatian County, Split	2-step	179 000	4412	24.6
	County Zadarska, Zadar	1-step	200 000	3680	18.4
		2-step	n/a	9093	n/a
	Koprivnica	2-step	120 000	2240	18.7
	Brodsko-Posavska County, Slavonski Brod	1-step	180 000	6256	34.8
Cyprus	Nicosia	2-step	300 000	1200	4
Czech Republic	Central Bohemian	1-step	2 005 867	15 229	7.6
	Region, Kladno	2-step	n/a	33 713	n/a
	Hradec	1-step	552 946	7040	12.7
	Kralove	2-step	n/a	8428	n/a
Finland	Turku	1-step	468 936	19 763	42
Greece	Attiki, Athens	1-step	3 972 984	135 000	34
Norway	Hordaland, Bergen	1-step	426 011	3973	9.3
Poland	Lesser Poland, Cracow	1-step	1 191 000	14 000	11.8
		2-step	1 973 439	58 961	29.9
	Greater Poland, Poznań	1-step	900 000	7142	7.9
		2-step	3 500 000	109 209	31.2
	Subcarpathian,	1-step	350 328	1931	5.5
	Rzeszow	2-step	346 793	8694	25.1
	Lower Silesian, Wroclaw	1-step	1 095 607	40 841	37.2
Romania	Iasi	2-step	772 348	16 294	21.1
Serbia	Novi Sad, Sremski Karlovci	1-step	369 075	15 523	42.1
Sweden	Stockholm	1-step	2 135 865	67 827	31.8

(In six locations the population served in the 2-step procedure could not be defined accurately: Rijeka, Zadar, Slavonski Brod, Kladno, Hradec Kralove and Bergen. For Rijeka, Slavonski Brod and Bergen there was no information regarding the 2-step procedure).

Table 2
Time intervals to reach EMCC.

Country	EMCC location (s)	Calling procedure	Total study calls	Time from dial to first ringtone	Time from first ringtone to first call-taker	Time from first call-taker to EMCC	Total time to reach EMCC (TT-EMCC)
Austria	Styria, Tyrol	1-step	355[a]	3.1 (1.8–4.4)	n/a	5 (3–8)	8.2 (6–10.7)
Croatia	Koprivnica, Rijeka, Split,	1-step	317	4.1 (3.1–5.1)	n/a	7 (4.5–10.7)	11.1 (8.7 –15.6)
	Slavonski Brod, Zadar, Zagreb	2-step	699	4.1 (3–5.1)	5.5 (3.8–7.8)	16.3 (12.6–21.4)	26.9 (21–33.5)
Cyprus	Nicosia	2-step	179	4.8 (3.5–5.6)	14.9 (13–17.6)	14.2 (11.6–17.9)	34.7 (31.5–40.8)
Czech Republic	Hradec Kralove, Kladno	1-step	173	4.1 (3.2–5.4)	n/a	3.7 (2.8–6.7)	8.4 (6.1–12)
		2-step	187	4.8 (3.5–5.9)	5.1 (4.5–6.2)	47.1 (38.1 55.7)	55.5 (48.4–66.6)
Finland	Turku	1-step	180	6.8 (5.1–7.2)	n/a	5.4 (3.7–6.7)	11.6 (9.9–13.6)
Greece	Athens	1-step	178	1.2 (0.6–3.4)	n/a	26.6 (22.8–35.6)	28.9 (24.7–37.1)
Norway	Bergen	1-step	90	4 (3.7–6.4)	n/a	6.4 (5.2–7)	10.6 (9.5–13)
		2-step	90[b]	4 (3.8–6.7)	7.4 (6–11.4)	12.5 (10.7–14.7)	24.3 (22–29.1)
Poland	Cracow, Poznan,	1-step	438	0 (0–0)	n/a	13.9 (10.8–21.6)	16.5 (11.3–23.6)
	Rzeszow, Wroclaw	2-step	282	0 (0–4.5)	13.7 (9.7–17.6)	26.1 (20.7–42.9)	44.7 (34.9–60.4)
Romania	Iasi	2-step	118	3.8 (2.6–5.2)	4.7 (3–8.4)	18.7 (12.8–27)	30 (22.7–38.7)
Serbia	Novi Sad	1-step	180	4.9 (4.1–5.8)	n/a	4 (3–5.8)	9.2 (7.8–11.4)
Sweden	Stockholm	1-step	147	3.3 (3–3.8)	n/a	5.6 (4.4–10.3)	9.9 (8–13.8)
Total calls done		1-step	2058[a]	3.7 (1–5.2)	n/a	6.4 (2.9–13.5)	11.7 (8.7–18.5)
		2-step	1555	4.0 (2.4–5.2)	7 (4.6–11.9)	18.7 (13.4–29.9)	33.2 (24.7–46.1)
		All calls	3613	3.9 (1.8–5.2)	n/a	n/a	21 (10.7–35)

Times are expressed in seconds: median (IQR 25th–75th percentile).
[a] Total time to reach EMCC (TT-EMCC) was not calculated for 180 patients because time to first ringtone was missing.
[b] In 5 calls TT-EMCC was not calculated because time from 112 to EMCC was not captured.

Variability according to days of week

TT-EMCC between weekends and weekdays was not significantly different. For 1-step calls this was 11.6 s (IQR 8.7–18.1) vs. 11.7 s (IQR 8.8–20.2), P = 0.17, respectively and for 2-step calls taking 33.4 s (IQR 24.7–46.8) vs. 31.9 s (IQR 24.6–44.3), P = 0.24, respectively.

Day calls vs. night calls

For calls performed at night (midnight to 6 AM) and performed at daytime, TT-EMCC was not significantly different. This was true for 1-step calls taking 12.1 s (IQR 9.4–17.4) vs. 11.7 s (IQR 8.6–18.7) (P = 0.67), and 2-step calls taking 35.4 s (IQR 26.7–45.8) vs. 33.3 s (IQR 25–46.8) (P = 0.43).

Discussion

Participating EMCC

The EUROCALL study indicates that when making an emergency call to the EMCC considerable time may elapse before a medical dispatcher answers the call. Time to contact the EMCC was almost twice as long when calls were performed using a 2-step procedure

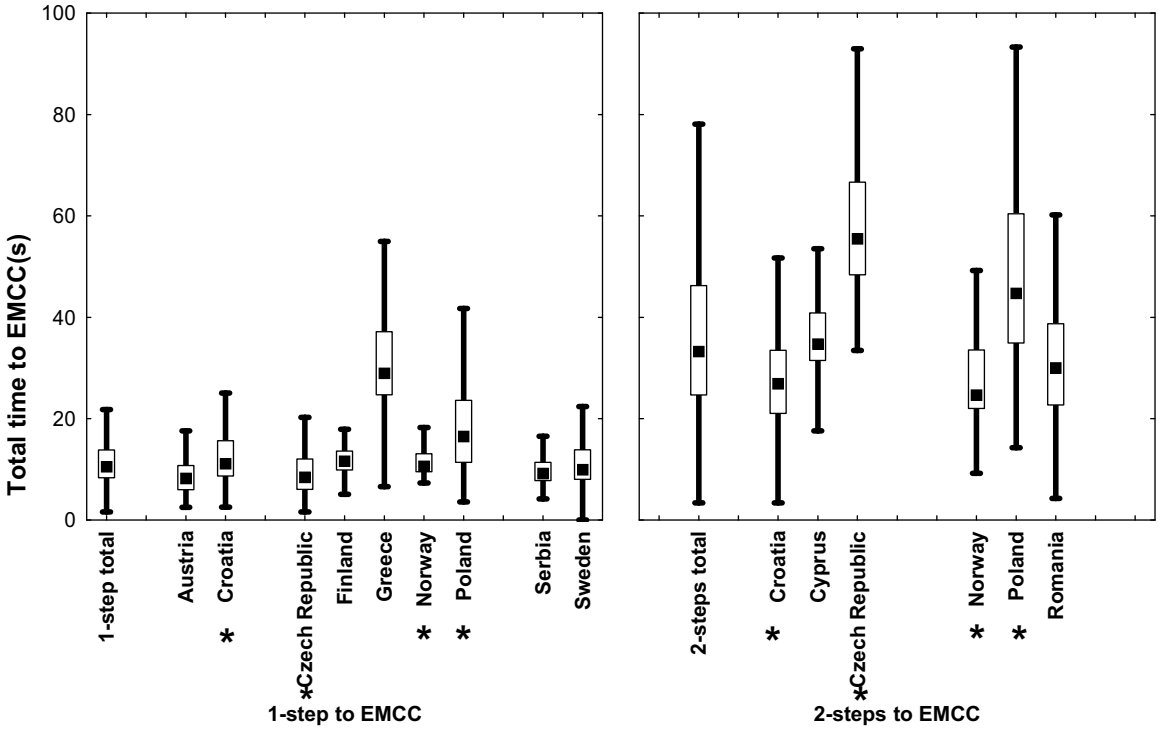

Fig. 2. TT-EMCC for all countries using 1-step or 2-step procedure. *Countries where calls were performed using both 1-step and 2-step procedures.

compared to calls with a 1-step procedure. In 33% of calls more than 30 s was needed to reach the EMCC. Although the optimal time delay to reach the EMCC in case of OHCA is unknown, survival decreases by 10% per minute delay from patient collapse to start of CPR.[5] It is known that TT-EMCC adds to other delays such as a median of 75 (47–121) s until the medical dispatcher recognises the cardiac arrest, 176 (141–242) s until the first dispatcher-assisted chest compression are delivered and 338 (261–422) s until arrival of the EMS.[11] If a single rescuer first calls the EMCC, the initial window of opportunity of CPR of the initial 2–3 min after patient collapse may be lost, when bystander CPR and defibrillation are most effective.[9] Therefore, in OHCA it is appropriate for lay rescuers to seek on-site help from other bystanders so that one rescuer can start CPR while someone else can contact the EMCC. If there is no second rescuer, starting CPR while trying to contact the EMS using a mobile phone with active speaker function is recommended.[10]

1-step vs. 2-step procedure.

"112" offers an important advantage as people in distress may call any time and any day in all member states of the European Union to get immediate assistance for a variety of emergencies. In some European countries, the number 112 is the national emergency number and connects directly to the EMCC (1-step). In other countries a call to 112 is first switched to the national emergency centre operated by different organisations and then to the EMCC (2-step). Only 29% of calls that used the 2-step procedure reached the EMCC within 30 s, and the difference in median time to EMCC was more than 26 s. These time delays are very relevant in OHCA.

Apparently, the major advantage of 112, i.e. the use of a single number for all emergencies, may become a disadvantage if a 2-step procedure is used in case of a very urgent situation due to the delays inherent to the additional time for triaging a call and then switching the call from 'all emergencies' to medical dispatch. The 112-system is still underutilised in many European areas but its importance as a uniform European system for all emergencies is crucial. Therefore every effort should be made in order to establish protocols that will reduce the observed delays in case of OHCA and other life-threatening situations.

Significant differences in TT-EMCC were observed among participating centres. Within country differences were also noted between 1-step and 2-step calls. The observed differences in TT-EMCC using 1 vs. 2 steps ranged from 13.7 s (Bergen–Norway) to 47.1 s (Czech Republic) but higher values were also present. The observed time differences ranged from a few seconds to more than a minute. It is unclear what caused these differences: short-term variation of call volume may play a role, but also technical or organisational differences. These differences should be investigated further. EUROCALL findings confirm the importance of local organisation when handling time delays to contact medical dispatch. This may be achieved through local directives for lay rescuers but also through operational efforts to improve the local system of responding to an emergency calls.

A '911' performance report from the EMCC in New York USA (a 2-step system) indicated an average TT-EMCC of 01:09 min for life threatening medical emergencies and 01:17 min for non life-threatening medical emergencies. The time from call to first response by 911 was 3 s in both situations.[15] In the UK, Ambulance Quality Indicators require life-threatening emergencies to be treated on-site within 8 min. More than 95% of emergency calls have to be answered within 15 s. Each call centre has to achieve its performance goals and make every effort to improve.[16]

A ringback tone is an audible confirmation for the caller that the telephone at destination is ringing. In our study this time interval was zero in a few regions but exceeded 5 s in about a quarter of calls. When making a call, a delay up to a few seconds may be perceived as normal. However, if the time to the ringback tone is longer than a few seconds it may become frustrating to the caller. The caller may feel unsure: stay online or disconnect and make a new call. Disconnecting should be discouraged because the caller may find

himself again at the bottom of the waiting list.[17] Therefore, this information should be provided to participants of CPR courses and lay promotion campaigns should be informed accordingly.

Limitations

The participating EMCCs were recruited on a voluntary basis. Therefore, this study is not a comprehensive representation of the situation in each country and all over Europe. Our findings may underestimate the delays in other parts of Europe: regions that may anticipate poor performance may have excluded themselves from the study. Most of the participating regions are small to intermediately sized areas and large densely populated European countries are under-represented.

This study investigated technological delays and call reconnection in a 2-step procedure. These delays may be influenced by human factors affecting emergency number dialling. Real-life calls may be performed under pressure, therefore more abandoned or even mistaken calls are anticipated in an emergency situation that we only simulated.

After contacting the emergency call-taker the EUROCALL investigators disclosed the investigative nature of the call as soon as the emergency call-taker asked about the reason of the call. In real-life emergency call-takers may have asked for more detailed information regarding the incident.

Conclusion

The TT-EMCC was significantly shorter in a 1-step procedure as compared to a 2-step procedure. We found wide regional differences between countries but also within countries. This may be relevant in cardiac arrest and other situations where patient outcome is critically time-dependent. Between the use of mobile phone or landlines there was no significant difference in TT-EMCC. Appropriate authorities should make every effort possible to shorten the time to reach medical dispatch.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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Appendix A. The EUROCALL investigators (NC = National Coordinator)

Austria: M Glanzer, B Senarclens (Styria) and M Baubin, J Baubin, G Wehinger (Tyrol).

Croatia: B Radulović, N Mandić, J Hamzić (Zagreb); S Hunyadi-Antičević (NC), A Protić, A Tancabel (Rijeka); R Majhen-Ujević, Z Aman (Split); J Patrk (Zadar), N Teufel, D Curman (Koprivnica); I Hadžibegović, O Čančarević (Slavonski Brod).

Cyprus: M Georgiou (Nicosia).

Czech Republic: J Bradna (Kladno); A Truhlář (NC), T Ježek (Hradec Králové).

Finland: T Iirola, P Kamsula (Turku).

Greece: A Rompola, A Anadiotis (Athens).

Norway: L Myrmel, G Brattebo (Bergen).

Poland: P Krawczyk (NC), G Kołodziej, P Bogacki (Cracow); M Jurczak, P Rusek (Poznan); A Kawalec, K Kawalec, M Kawalec (Rzeszow); A Kościński, W Dzido (Wroclaw).

Romania: D Cimpoesu (Iasi).

Serbia: V Raffay, R Joksic (Novi Sad).

Sweden: K Bohm (Stockholm).

The EUROCALL steering committee

Nikolaos Nikolaou (principal investigator), Leo Bossaert, Maaret Castren, Rudolph Koster, Freddy Lippert, Koenraad G. Monsieurs.

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