Resuscitation 105 (2016) 182–187

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

# A text message alert system for trained volunteers improves out-of-hospital cardiac arrest survival☆

Ruud W.M. Pijls[a,*], Patty J. Nelemans[b], Braim M. Rahel[c], Anton P.M. Gorgels[a]

[a] Department of Cardiology, CAPHRI School for Public Health and Primary Care, Maastricht University Medical Centre+, P. Debyelaan 25, 6202 AZ Maastricht, Netherlands
[b] Department of Epidemiology, CAPHRI School for Public Health and Primary Care, Maastricht University Medical Centre+, P.O. Box 616, 6200 MD Maastricht, Netherlands
[c] VieCuri Medical Centre for Northern Limburg, Tegelseweg 210, 5912 BL Venlo, Netherlands

ARTICLE INFO

*Article history:*
Received 13 March 2016
Received in revised form 12 May 2016
Accepted 8 June 2016

*Keywords:*
Survival
OHCA
Community responder

ABSTRACT

*Aims:* The survival rate of sudden out-of-hospital cardiac arrests (OHCAs) increases by early notification of Emergency Medical Systems (EMS) and early application of basic life support (BLS) techniques and defibrillation. A Text Message (TM) alert system for trained volunteers in the community was implemented in the Netherlands to reduce response times. The aim of this study was to assess if this system improves survival after OHCA.

*Methods and Results:* From April 2012 to April 2014 data on all 1546 emergency calls for OHCA in the Dutch province of Limburg were collected according to the Utstein template. On site resuscitation attempts for presumed cardiac arrest were made in 833 cases, of which the TM-alert system was activated in 422 cases. Two cardiopulmonary resuscitation (CPR) scenarios were compared: 1. TM-alert system was activated but no responders attended ($n = 131$), and 2. TM-alert system was activated with attendance of ≥1 responder(s) ($n = 291$). Survival to hospital discharge was 16.0% in scenario 1 and 27.1% in scenario 2 corresponding with OR = 1.95 (95% CI 1.15–3.33; $P = .014$). After adjustment for potential confounders the odds ratio increased (OR = 2.82; 95% CI 1.52–5.24; $P = .001$). Of the 100 survivors, 92% were discharged from the hospital to their home with no or limited neurological sequelae.

*Conclusion:* The TM-alert system is effective in increasing survival to hospital discharge in OHCA victims and the degree of disability or dependence after survival is low.



## Introduction

Sudden out-of-hospital circulatory arrest (OHCA) is an important public health problem,[1,2] largely caused by cardiac disease.[3] Survival rates are low[4–6] (<10%) and increase by early notification of Emergency Medical Systems (EMS) and early application of basic life support and defibrillation.[6]

In 50–70% of victims, their cardiac arrest occurs at home[1] and improving outcomes after OHCA requires new strategies. To counteract delayed ambulance arrival times, first responder systems were implemented in several countries.[7,8] In a number of regions in the Netherlands, a novel system was introduced where citizen volunteers trained in resuscitation and the use of an Automatic External Defibrillator (AED) are notified by the EMS dispatch centre, using a text message (TM) notification, to go to an OHCA victim in their zip code based vicinity.

The aim of this study, executed in the Dutch province of Limburg, has been to assess the ability of this TM-alert system to improve outcomes after OHCA.

## Methods

### *Setting*

A prospective registry included all OHCAs in the Dutch province of Limburg for which EMS were called between April 2012 and April 2014. Variables were gathered according to the Utstein recommendations and definitions[9–11] for assessing the contribution to survival of the TM-alert system. The study region consists of 1.12 million inhabitants living in an area of approximately 2153 km$^2$

☆ A Spanish translated version of the summary of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2016.06.006.

* Corresponding author at: Department of Cardiology, Maastricht University Medical Centre+, P. Debyelaan 25, 6202 AZ Maastricht, Netherlands.
*E-mail address:* ruud.pijls@mumc.nl (R.W.M. Pijls).

http://dx.doi.org/10.1016/j.resuscitation.2016.06.006

(831mi$^2$). Approval for the study was obtained from the medical ethics committee of the Maastricht University Medical Centre (project number 114029).

### *Resuscitation volunteer network in the study region*

If EMS are called for (suspected) OHCA, the professional procedure throughout the Netherlands consists of dispatching two ambulances to the scene. Each vehicle is manned by 1 paramedic and a driver with CPR skills and equipped for providing advanced life support. First responders (policemen) are notified only if they are already in close range of the circulatory arrest case. To reduce the delay in response time to start BLS, a network of BLS/AED trained volunteers was developed. This network consists of TM-volunteers and AEDs placed in residential areas. TM-volunteers are notified by the dispatch centre, using the zip code derived location of the victim and the TM-volunteers. In a suspected OHCA, the dispatch centralist activates the system simultaneously with the two ambulances. Zip code identified TM-volunteers within a radius of 1 km (0.62 mi) of the victim receive a TM, directing them to the scene to either start BLS (1/3 of notifications) or to get a nearest network AED first (2/3). During the study period the network comprised 17 of the 24 Dutch dispatch centres and 61.000 TM-volunteers, including two dispatch centres and >9000 volunteers (8.3/1000 inhabitants) in Limburg.

Notification of TM-volunteers does not result in a predictable response, because this depends on the number of TM-volunteers in the specific zip code area and their availability. The dispatcher is not aware of actual attendance of volunteers.

To analyse the effect of attending TM-volunteers, two different resuscitation scenarios were compared. In scenario 1 the TM-alert system was activated but no TM-volunteers responded to the notification. This unwanted situation will improve with further implementation of the system, but for the purpose of our study these cases were considered as the reference group because survival of the OHCA victims depended on standard care. In scenario 2 the TM-alert system was activated and at least one TM-volunteer responded to the notification.

The primary outcome measure was the proportion of OHCA victims who survived to hospital discharge. Secondary outcome measures were proportion with return of spontaneous circulation (ROSC) at departure from site of the OHCA and at hospital arrival, proportion with discharge to rehabilitation centre and nursing/caring home and Modified Rankin score[12] (mRS) at discharge.

### *Data collection*

Data were retrieved from the following sources: 1. the dispatch centres from Limburg North and South, 2. their respective emergency medical services, 3. notified volunteers, 4. TM-alert database (HartslagNu®), 5. the six hospitals in Limburg, and 6. AED providers.

On a daily basis, all emergency calls in the dispatch centre system were screened for suspected OHCAs. Data collected consisted of notification time, ambulance departure time and arrival time at the location, departure time to and arrival time at the hospital, patient's condition and treatment. Information was also obtained from the paramedics notes on the resuscitation scenario. The TM-alert system organisation provided information about the activation of the TM-alert system, such as the time the TM was sent, the number of notified TM-volunteers and AEDs, and type of notification (start BLS or first get an AED).

All notified TM-volunteers received a questionnaire gathering information about their attendance and if applicable about details of the CPR scenario. Information included the presence of a witness and the start of CPR by the witness or by a bystander. Importantly, a witness was defined as the one who saw, heard or monitored the arrest whereas the term bystander was reserved for those who did not witness the event but arrived the scene as well (e.g. a neighbour alarmed by the witness). Also recorded was if and how many TM-volunteers reached the scene. From the six hospitals receiving the victims, information was gathered about the post resuscitation treatment, outcome and discharge date, and if applicable, the medical history before OHCA. To acquire information about the quality of survival, discharge to the patients home, to a rehabilitation centre or to a nursing/caring facility was used as an indicator for cerebral outcome. Additionally, in one hospital (Maastricht) the Modified Rankin Scale[12] was used to determine the degree of disability at hospital discharge. The scores were derived from chart review. AED recordings were retrieved from the TM-alert system organisation or from private AED providers.

### *Statistical analysis*

Patients with OHCA were categorised into two groups according to the corresponding CPR scenario. The distribution of age, gender, witnessed OHCA and other potential determinants of survival at hospital discharge were compared between the two CPR scenarios. Categorical variables were described as absolute numbers and percentages, and continuous variables as means with standard deviation or medians with interquartile range. The Chi square test was used to test for statistically significant differences between proportions. The *t*-test for independent samples or the Mann Whitney *U*-test was used for continuous variables.

To assess whether mobilisation of TM-volunteers improved probability of survival, odds ratios as a measure of relative risk with 95% confidence interval (95% CI) were calculated using scenario 1 as reference category. Multivariable logistic regression analyses were performed to assess the contribution to survival of scenario 2 with adjustment for between group differences in potential determinants of probability of survival. A *P*-value of $\leq$0.05 was considered as statistically significant. The statistical software package of SPSS (SPSS for Windows, version 22.0, SPSS Inc, Chicago, IL) was used to analyse the data.

## Results

Fig. 1 depicts the flow chart of the study population. Out of a total of 1546 OHCA EMS notifications during the 24 months study period, 1040 resuscitation attempts were recorded. The group of 506 cases without a resuscitation attempt consisted of 461 cases being pronounced dead on arrival of the EMS and 45 with a "do not resuscitate" statement. Arrests within the ambulance were excluded and occurred in 31 instances. Another 5 cases were excluded, because they were, after sufficient recovery, discharged to a hospital outside the Netherlands and no information on outcome could be acquired. Because the purpose of this study was to evaluate the effect of the TM-system on arrests with a cardiac origin, 171 arrests with a non-cardiac origin were excluded. In 411 (49.3%) cases the dispatch centre decided not to activate the system mostly because the ambulance was already nearby or present at the scene, or the OHCA occurred in a (closed) public place with an on-site AED (such as shopping malls, sport venues etc.) These cases were excluded from the analysis. Hence, the total study population consisted of 422 (presumed) cardiac arrests in which the TM-alert system was activated. In 291 cases (69%) $\geq$1 TM-volunteers attended (scenario 2), and in 131 cases (31%) no responder attended (scenario 1, reference group).

### *Baseline characteristics*

The mean age of these 422 OHCA victims was 68.1 years and 71.6% were male. Table 1 shows the distribution of the baseline