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CLINICAL RESEARCH
Arrhythmia/electrophysiology

Dual dispatch early defibrillation in out-of-hospital cardiac arrest: the SALSA-pilot†

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Aims

Out-of-hospital cardiac arrest (OHCA) is a major public health problem. The objective of this study is to explore the effects of a dual dispatch early defibrillation programme.

Methods and results

In this pilot study, automated external defibrillators (AEDs) were provided to all 43 fire stations in Stockholm during 2005. Fire-fighters were dispatched in parallel with traditional emergency medical responders (EMS) to all suspected cases of OHCA. Additionally, 65 larger public venues were equipped with AEDs. All 863 OHCA from December 2005 to December 2006 were included during the intervention, whereas all 657 OHCA from 2004 served as historical controls. Among dual dispatches, fire-fighters assisted with cardiopulmonary resuscitation (CPR) in 94% of the cases and arrived first on scene in 36%. The median time from call to arrival of first responder decreased from 7.5 min during the control period to 7.1 min during the intervention ($P = 0.004$). The proportion of patients in shockable rhythm remained unchanged. The proportion of patients alive 1 month after OHCA rose from 4.4 to 6.8% [adjusted odds ratio (OR): 1.6; 95% confidence interval (CI): 0.9–2.9]. One-month survival in witnessed cases rose from 5.7 to 9.7% (adjusted OR: 2.0; 95% CI: 1.1–3.7). Survival after OHCA in the rest of Sweden (Stockholm excluded) declined from 8.3 to 6.6% during the corresponding time period (unadjusted OR: 0.8; 95% CI: 0.6–1.0). Only three OHCA occurred at public venues equipped with AEDs.

Conclusion

An introduction of a dual dispatch early defibrillation programme in Stockholm has shortened response times and is likely to have improved survival in patients with OHCA, especially in the group of witnessed cardiac arrests. The increase in survival is believed to be associated with improved CPR and shortened time intervals.

Keywords

Out-of-hospital cardiac arrest • Sudden cardiac death • Ventricular fibrillation • Cardiopulmonary resuscitation • Automated external defibrillators • Fire brigade

Introduction

Sudden out-of-hospital cardiac arrest (OHCA) is a leading cause of death in the Western World.[1] Previous reports have demonstrated low survival rates following OHCA in Stockholm, Sweden, with 3.8% of patients surviving in 1978[2] and 3.6% in 1987.[3] Also more recent studies point to similar poor results with 2.5% of patients being discharged alive after OHCA in 2000[4] and 3.3% in 2000–02.[5] To address this unsatisfactory situation, the SAving Lives in the Stockholm Area (SALSA) project was designed.

Early defibrillation has been shown to improve survival after OHCA[6–8] with survival as high as 74% in witnessed patients defibrillated within 3 min after arrest.[9] The low survival numbers in Stockholm are believed to be a result of a low occurrence of ventricular fibrillation (VF) at the time of arrival of the ambulance [emergency medical responders (EMS)] crew, which in turn most probably is explained by long delay time intervals from cardiac arrest to ambulance arrival and defibrillation.[4,5]

During the last decade, new strategies to improve survival after OHCA by early defibrillation with automated external defibrillators

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(AEDs) have been introduced. These include public-access defibrillation (PAD)[10] and defibrillation initiated by first responders.[11,12] Prior to 2005, no other group besides health care personnel and ambulance personnel performed defibrillation in Stockholm. The aim of this study was to explore whether trained fire-fighters and security officers equipped with AEDs as a parallel resource to the existing EMS organization could decrease response times after OHCA and whether a substantial number of OHCA patients could be treated with fire-fighters as first responders. We also wanted to investigate whether this could result in a higher proportion of patients found in shockable rhythms and to an increased survival.

Methods

With the introduction of the SALSA-project, all 43 fire stations in Stockholm were equipped with AEDs during 2005. Fire-fighters received an 8 h course approved by The National Board of Health and Welfare in the use of AED and defibrillator-cardio pulmonary resuscitation (D-CPR). Simultaneously, 65 public venues (including larger malls, public transport stations, sport stadiums, and 2 major airports) were equipped with AEDs, and local security guards were trained in the use of AEDs and D-CPR. The public venues were selected by the steering committee on the basis of being high-risk locations for OHCA. No stringent inclusion criteria were used; however, all venues had to fulfil the condition of having a large number of persons present during opening hours.

Setting

This study took place in the County of Stockholm with a population of 1 918 104 inhabitants on 31 December 2006. The proportion of women was 50.8% and the proportion of the population older than 65 years was 14.1%.[13] The large majority of inhabitants in the County of Stockholm live in urban areas.

Dispatch organization

At the emergency dispatch centre (EDC) in Stockholm, a structured policy was applied as to when the fire-fighters were to be dispatched. In cases of suspected cardiac arrests, the EDC alerted the nearest available ambulance (EMS) first and thereafter contacted the closest available fire engine via a special unit at the EDC using a computer-mediated alarm code. The fire brigade dispatch was intended to happen simultaneously with the EMS dispatch. The first rescuer to arrive at the victim's side was responsible for performing a quick medical assessment. If the patient was unresponsive and pulseless, CPR was started and the AED was attached. The EMS worked in the same manner as prior to the SALSA-project and took over the full responsibility for the treatment as soon as they arrived. Security guards at the public venues were not alerted from the EDC, but instead via local alarm logistics developed at the respective location.

Defibrillators, time measurements, and data collection

Sixty-three LifePak 500 AEDs (Medtronic Physio-Control) and nine Laerdal Heartstart FR2 AEDs were deployed to ensure that fire brigades carried one to three AEDs at all times. Fire brigades were manned by a crew of two to five fire-fighters during assignments. EMS vehicles carried a crew of two to four persons during assignments. All AEDs used in the study provided voice prompts. Almost all of the 65 AEDs placed at public venues were Medtronic LifePak 500 AEDs.

Most time intervals derive from the database at the EDC which in turn is linked to an atomic clock. When a call to the EDC was received, a computerized database assigned a timestamp automatically. The time points of dispatch of both fire brigades and EMS vehicles were then recorded automatically. The time of arrival at the scene was called in by both fire brigades and EMS ambulances and logged into the database, generating time stamps linked to the corresponding incoming call. To compare time points between fire brigade and EMS, the primary definition of response time was based on the interval from call to arrival at scene. Another reason for why this time interval was chosen is its previous use during the historical control period and in previous OHCA studies in Sweden.

Patients and definitions

All patients suffering from OHCA where any type of resuscitation measure (airway assistance, chest compressions, administration of drugs, intubation, and defibrillation) was started were included in this study. Patients were enrolled regardless of the cause of arrest with the exception of traumatic cardiac arrests. Patients younger than 9 years and in-hospital cardiac arrests were not included. Patients admitted alive were defined as patients admitted alive to a hospital ward and who, accordingly, had not been declared dead in the emergency rooms. A crew-witnessed cardiac arrest was defined as a cardiac arrest that occurred after the arrival of the EMS crew. For each case of OHCA, the EMS crews (mostly two persons, one of whom is usually a nurse) completed a form with relevant information such as age, place of arrest, bystander CPR, witnesses, resuscitation procedure, probable cause of arrest, intervention times, defibrillation, intubation, drug treatment, type of initial rhythm, and clinical findings at first contact.

Historical survival data for Sweden (Stockholm excluded) were collected from the Swedish Cardiac Arrest Register (SCAR) which covers some 70% of the population in Sweden and has been described in detail elsewhere.[4,14] Survival data for Sweden (Stockholm excluded) from SCAR were not manually double-checked in contrast to data for Stockholm. The historical control group from the Stockholm region was based on all OHCA occurring from 1 January 2004 until 31 December 2004. The present study programme was introduced during the beginning of 2005 and was completed on 30 November 2005. All patients with OHCA from 1 December 2005 through 31 December 2006 were included in the interventional part of the study. This study was approved by the local Ethics Committee.

Outcome measures and study design

We designed the study as a prospective cohort study. The primary outcome measures were time intervals from call for assistance at the EDC to the time of arrival of first responder (fire brigade or EMS) and the proportion of OHCA cases to which fire-fighters arrived first. The secondary outcome measures were the proportion of patients found in VF, time intervals from call to first defibrillatory shock for patients in VF, survival to hospital admission, survival to 1 month, and an evaluation of dispatch logistics. The overall objective with the SALSA-programme is an increased survival for patients suffering OHCA in Stockholm. This paper describes the PILOT part of the SALSA-project and the results are presented according to the Utstein-template.[15]

Comparison groups for interpretation of results

The main focus of this article is based on comparisons of the interventional part of the study with historical controls in Stockholm from 2004. Four groups were used for comparisons:

(i) *Interventional* part of the study (SALSA-PILOT) vs. *historical controls* (2004).

(ii) Comparisons of cases with *dual dispatch* (dispatch of both fire brigade and EMS, i.e. our intervention) vs. cases with *EMS dispatch only* (for explanation see Results and Discussion).

(iii) Comparisons in relation to the type of first responder arriving at the scene (i.e. *fire brigades* vs. *EMS*; dual dispatches only).

(iv) Comparisons for survival between *Stockholm* (SALSA) vs. the rest of *Sweden* (Stockholm excluded) where no such interventions like the present one were performed.

For clarification, see flow-charts (*Figure 1A* and *B*).

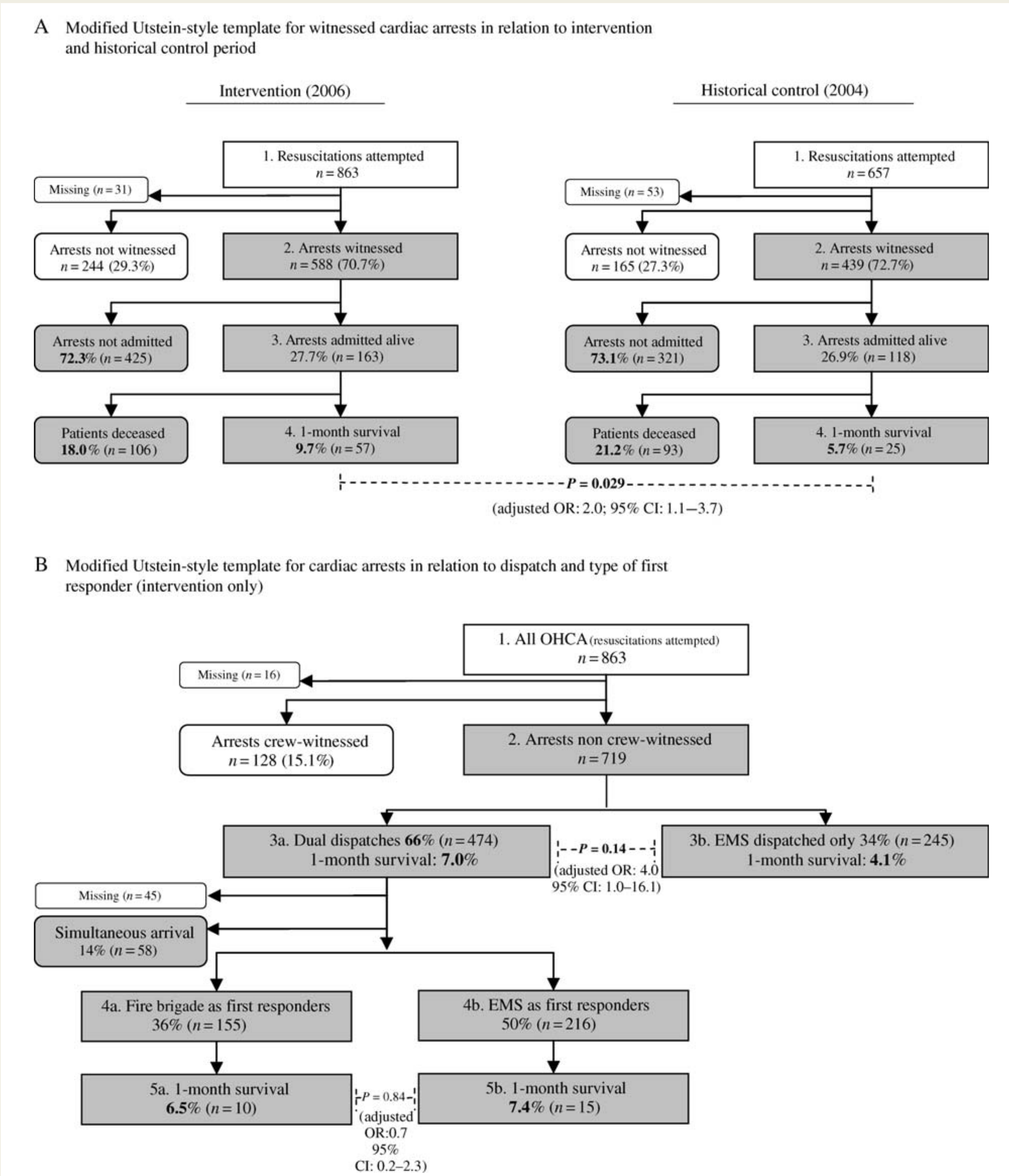

Figure 1 (*A*) Modified Utstein-style template for witnessed cardiac arrests in relation to intervention or historical control period. (*B*) Modified Utstein-style template for cardiac arrests in relation to dispatch and type of first responder.

Statement of responsibility

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Statistical methods

Median time interval comparisons between various groups were assessed with the Wilcoxon rank-sum test. We used Fisher's exact test to compare patient characteristics at the emergency room (*Table 3*).

All comparisons of proportions in survival were tested with the Wald χ^2 test. To control for confounding factors affecting the comparison of survival to hospital and 1-month survival between different groups, i.e. the intervention group and the historical controls, we used logistic regression. First, unadjusted (crude) associations between each of the groups, listed in *Table 3*, with the odds of 1-month survival were estimated in univariable models. Second, to study the adjusted associations, we added the following variables in a multivariable model: sex (male vs. female), age (<median vs. >median), place (home vs. other), aetiology (cardiac vs. non-cardiac), witnessed status (witnessed vs. non-witnessed), bystander-CPR (started vs. non-started), and rhythm (VF vs. non-VF). The associations are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The results were regarded significant if two-tailed test yielded a *P*-value of <0.05. All analyses were performed in SPSS 15.0.

Results

Between 1 December 2005 through 31 December 2006, 863 patients with OHCA were included (*Figure 1A*). The number of OHCA with dual dispatch (dispatch of both the EMS and a fire brigade) was 474 (66% of non-crew-witnessed OHCA; *Figure 1B*). Among dual dispatches, the fire-fighters arrived first on the scene and initiated treatment in 36% of the cases. EMS arrived before fire-fighters in 50% of the cases and they arrived simultaneously in 14%. Fire-fighters remained with the patients and assisted with CPR in 94% of the cases irrespective of who arrived first. No fire brigade dispatch had to be recalled for other assignments. During the historical control from 1 January 2004 through 31 December 2004, a total number of 657 OHCA fulfilled the inclusion criteria.

Patient baseline demographics and characteristics at resuscitation

Data regarding demography and patient characteristics in the different groups are described in *Table 1*. Patients included in the interventional and historical parts of the study were very similar in terms of age and gender. The majority of cardiac arrests occurred at home and the proportion of patients with a presumed cardiac cause did not differ between the groups. An increase in the proportion of patients receiving bystander CPR prior to arrival of the first responder was noted over time. The proportion of patients presenting with VF was similar both in the intervention group and historical controls and between groups of first responders. The proportion of witnessed OHCA remained unchanged over time. The proportion of crew-witnessed OHCA was 15.1% during the intervention and 18.0% during the historical control period ($P = 0.12$).

Table 1 Baseline demographics, characteristics at resuscitation, time intervals, and patients admitted alive to hospital

	Historical control (2004), $n = 657$	Intervention (2006), $n = 863$	Dual dispatch,[a] $n = 474$	EMS only dispatch,[a] $n = 245$	Fire brigade first,[b] $n = 155$	EMS first,[b] $n = 216$
Age (years)						
Median	72.5	71.1	70.1	71.8	72.3	68.3
Sex, male (%)	63.8	67.5	71.5	60.4	74.8	69.9
Cardiac arrest at home (%)	65.4	64.5	68.5	64.5	59.1	72.2
Cardiac aetiology (%)	70.0	67.0	69.2	63.2	67.6	71.7
Bystander-initiated CPR (%)	33.7	39.0	56.8	24.1	56.1	56.9
Witnessed cardiac arrest (%)	72.7	70.7	63.7	68.6	66.4	70.0
VF OHCA (%)	21.0	22.3	24.5	17.3	24.5	28.2
Time interval (median, min)						
Call to arrival of first responder[c]	7.5	7.1	6.6	7.7	6.6	6.6
Call to arrival of EMS	7.5	7.9	7.8	7.7	10.8	6.6
Call to first defibrillation[d]	9.0	8.2	8.0	9.0	7.3	8.7
Fire-fighter CPR (%)	—		94.2	—	100	90.0
Admitted alive to hospital (%)	22.3	22.7	22.2	20.4	20.6	23.1

Intervention: 1 December 2005–31 December 2006. Historical control: 1 January 2004–31 December 2004.
[a]Crew-witnessed OHCA excluded.
[b]Only cases with dual dispatch.
[c]First responder = first vehicle arriving (EMS or fire brigade) at the scene.
[d]Only patients with bystander witnessed VF OHCA.

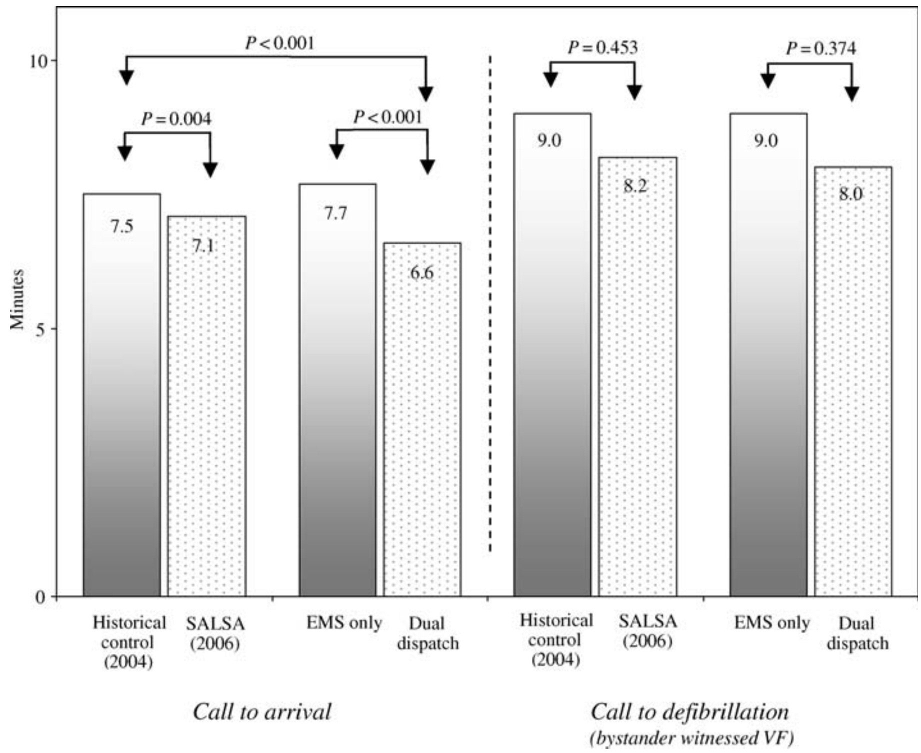

Figure 2 Time intervals comparisons for first responders before and after implementation of SALSA-project and in relation to single or dual dispatch.

Time intervals

The time intervals are presented in *Table 1* and *Figure 2*. The median time from call to arrival of first responder (EMS *or* fire brigade) decreased significantly but modestly. However, when analysing only the EMS, the corresponding time interval instead increased. The time interval from call to arrival was significantly shorter for cases with dual dispatch compared with cases with EMS dispatch only. The time from call to defibrillation among patients with bystander-witnessed VF did not change significantly (*Figure 2*), even if a trend towards decreased time intervals compared with historical controls was observed. A corresponding non-significant decline was found when comparing cases with or without dual dispatch (*Figure 2*).

The proportion of response times <6 min from call to arrival was 37.5% during the intervention (first responder) compared with 32.2% during 2004 ($P = 0.04$). A corresponding difference in the proportion of patients reached <6 min was also found when comparing dual dispatches with EMS dispatches only during the intervention (41.9 vs. 31.5%, respectively; $P = 0.03$).

Dispatching

Fire brigades were dispatched to 66% of all OHCA (crew-witnessed cases excluded) where dual dispatch was intended. In the remaining 34%, only the EMS was dispatched. Despite efforts to minimize time loss at the dispatch centre, a 2 min delay (median) was observed when comparing the interval from dispatch of EMS to the dispatch of fire brigades in corresponding cases. During the historical control period, two to four persons were dispatched on OHCA assignments compared with six to nine persons in cases of dual dispatches during the intervention period.

Patients admitted alive to hospital and survival

No increase in the proportion of patients admitted alive to hospital was observed with 22.3% of the patients being admitted in 2004 and 22.7% during the intervention (*Table 1*). However, the corresponding proportions of patients alive after 1 month rose significantly from 4.4 to 6.8% ($P = 0.047$). The OR for survival during the intervention (vs. historical control) was 1.6 (95% CI: 1.0–2.5). After adjustment for factors associated with survival, the OR for survival remained at 1.6 (95% CI: 0.9–2.9) but the confidence interval widened (*Table 2*). Survival after OHCA in Sweden (Stockholm patients excluded) declined from 8.3 to 6.6% during the same time period (unadjusted OR: 0.8; 95% CI: 0.6–1.0) (*Figure 3*).

Survival rates as well as unadjusted and adjusted odds ratios for survival are presented in *Table 2*. The improved survival was particularly marked among patients with witnessed cardiac arrests in whom an increase from 5.7 to 9.7% was observed. Survival of patients found in VF almost doubled during the intervention. Corresponding survival figures for patients found in non-shockable rhythms were 2.0 and 2.1%, respectively (NS). The adjusted OR for survival among cases with dual dispatch (vs. EMS dispatch only) was 4.0 (95% CI: 1.0–16.1).

Table 2 Survival to 1 month

Variable	No. of cases	Survival (%)	Unadjusted (univariable) OR (95% CI)[a]	Adjusted[b] (multivariable) OR (95% CI)[a]
All patients (24)[c]				
Intervention	863	6.8	1.6 (1.0–2.5)	1.6 (0.9–2.9)
Historical control	657	4.4		
Witnessed cases (19)[c]				
Intervention	588	9.7	1.8 (1.1–2.9)	2.0 (1.1–3.7)
Historical control	439	5.7		
VF cases (21)[c]				
Intervention	184	22.3	2.3 (1.2–4.4)	2.8 (1.3–6.3)
Historical control	125	11.2		
VF + witnessed cases (17)[c]				
Intervention	152	25.7	2.2 (1.1–4.4)	2.8 (1.3–6.3)
Historical control	102	13.7		
Survival in relation to dispatch[d] (31)[c]				
Dual dispatch	474	7.0	1.8 (0.9–3.6)	4.0 (1.0–16.1)
EMS dispatch only	245	4.1		
Survival in relation to first responder[e] (33)[c]				
Fire brigade first	155	6.5	0.9 (0.4–2.0)	0.7 (0.2–2.3)
EMS first	216	7.4		

Intervention: 1 December 2005–31 December 2006. Historical control: 1 January 2004–31 December 2004.
[a]Odds ratio and corresponding 95% confidence interval.
[b]Adjusted for sex (male vs. female), age (<median vs. ≥median), place (home vs. other), aetiology (cardiac vs. non-cardiac), witnessed status (witnessed vs. non-witnessed), bystander CPR (yes vs. no), and rhythm (VF vs. non-VF).
[c]Proportion of patients with partially missing data used in the adjusted models in %.
[d]Crew-witnessed OHCA excluded; intervention only.
[e]Only cases with dual dispatch.

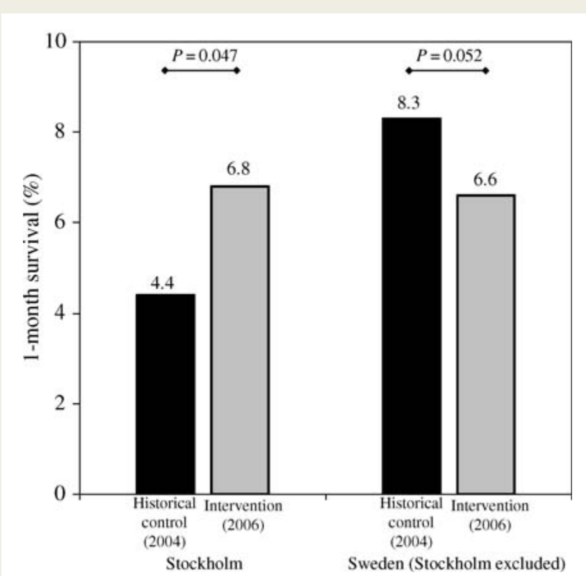

Figure 3 Survival over time (Stockholm compared with the rest of Sweden).

The clinical findings at the time of admission to the emergency room for patients admitted alive are described in *Table 3*. In-hospital survival increased during the study from 19.9% in 2004 to 30.1% during the intervention ($P = 0.034$).

Public venues

Only three OHCA occurred at public venues that were equipped with AEDs. Two of these cardiac arrests occurred at Stockholm international airport and the third case in a car on a highway north of Stockholm. None of these three cardiac arrests survived to hospital discharge.

Discussion

The introduction of a dual dispatch early defibrillation programme has reduced the response times for patients with OHCA in Stockholm and led to a substantial number of OHCA patients being treated with fire-fighters as first responders. Although only intended as a pilot study, the findings also suggest that our intervention might have improved survival. This applies especially to patients with witnessed OHCA in whom survival almost doubled. In contrast, OHCA survival in Sweden (Stockholm

Table 3 Patient characteristics on admission to hospital at the emergency room

	Historical control (2004), $n = 139$	Intervention (2006), $n = 196$	*P*-value
Unconscious patients (%)	93	89	0.34
Spontaneous breathing (%)	49	55	0.31
Palpable pulse (%)	85	87	0.63
Measurable systolic blood pressure (%)	65	72	0.23

excluded) decreased during the same time period. We believe that the increase in survival is mainly associated with improved CPR and shorter time intervals.

Time intervals and failed dispatches of fire-fighters

The time interval from call to arrival of first responder (EMS or fire-fighters) decreased significantly but modestly following the introduction of the project. A larger and more significant improvement in cutting time intervals was, however, achieved when comparing cases with dual dispatches with cases where the fire brigade was not dispatched (*Figure 2*). When analysing EMS response times only, they were found to increase over time.

Fire brigades were dispatched to only 66% of the treated cardiac arrests (crew-witnessed cases excluded). Moreover, among cases with dual dispatch, a 2 min delay was found between dispatch of EMS to dispatch of fire brigades in corresponding cases. More than 200 emergency calls were subsequently analysed in order to find the reasons for the dispatch failures and delays. The most common reason for both proved to be difficulties at the EDC to identify true cases of OHCA at the time of emergency call. This uncertainty resulted in traditional immediate dispatches of an EMS vehicle following which the fire brigade was either not alerted at all or only after some hesitancy. In spite of this 2 min delay that reduces the potential time interval benefits of dual dispatch, the EMS was first on scene in only 50% of the cases.

The possibility of a different traffic congestion situation over time might have affected the results. However, comparisons (summer vs. winter; daytime vs. night time) indicate that the main differences between the intervention and the historical control period remain as do time differences between first responder and EMS arrival delay times (data not shown).

Comparison with other studies

This is the first study that has tried to evaluate a combination of early defibrillation by fire-fighters and PAD by trained lay rescuers. Previous first responder AED programmes have varied regarding the type of intervention, type of control, and cardiac arrest population. Most first responder AED programmes have used police officers as first responders,[11,16–19] some have used both police and fire brigades simultaneously,[12,20,21] and a few have used fire brigades as sole first responders.[7,22,23] Most AED studies have used historical controls for comparisons. More recent studies have, however, leaned towards comparing first responder cases with concurrent EMS. Also, study populations have varied. Most investigations have included all OHCA,[7,11,17–19,22] whereas others have enrolled witnessed arrests only,[13] VF arrests only,[16,20] or OHCA with cardiac aetiology only.[21]

Two of these investigations resemble ours in regard to cardiac arrest population and type of controls. Stiell *et al.*[7] demonstrated a significantly improved survival vs. historical controls of OHCA. After the implementation of a rapid defibrillation programme, survival increased from 3.9 to 5.2% and response times improved significantly. Our project is, however, not fully comparable to this study which consisted of a combination of three interventions (reduction of time intervals through a variety of optimization strategies, more efficient deployment of ambulances, and addition of fire-fighters to perform defibrillation). Myerburg *et al.*[11] reported on a police led defibrillation programme in a large urban and suburban area. Initial response intervals were shortened by 1.4 min compared with a historical control group, and survival from VF OHCA improved significantly from 9.0 to 17.2%.

In-hospital survival

A noteworthy finding in this investigation is the increase in 1-month survival without a corresponding increase in hospital admissions. Similar findings were observed by others in a recent study.[24] One might argue that this finding is mainly due to the contribution of in-hospital factors.[25–28] However, the guidelines for in-hospital treatment have not changed between the historical control period and the intervention, and measures such as hypothermia and primary PCI for STEMI were standard already before 2004. Furthermore, if in-hospital factors would have contributed to a large extent, a corresponding increase in survival in the rest of Sweden (Stockholm excluded) would be expected. This was not the case. We cannot, however, in this pilot study exclude the possible contribution of in-hospital factors on the increase in survival. This especially applies to the fact that we have no data about the use of new treatment strategies (like primary PCI and hypothermia) and that one could suspect that the use of these strategies would increase over time.

Reasons for increased survival

In our investigation, survival among VF OHCA almost doubled compared with historical controls. This increase was, however, not accompanied by a corresponding increase in the proportion of patients presenting with VF as the initial rhythm. Several groups have pointed to a decline in VF arrests during the last decade.[29–31] According to our data, it is within the group of witnessed cardiac arrests that the major survival benefit is to be expected. During the intervention period, all 57 survivors in whom witnessed status could be confirmed were witnessed by either bystanders or EMS-crews. Further investigations are required to assess whether first responder dispatches should be limited to this group of OHCA.

A potential increased public awareness over time because of local media attention might have biased our results. However, in the multivariable model adjusting for baseline characteristics (including bystander CPR as a variable indicating an increased public awareness), the intervention period still emerged as an independent factor for increased survival. Nonetheless, we cannot exclude that higher public awareness could have had a positive effect, perhaps through unmeasured factors such as improved CPR quality and earlier calls to the EDC.

We believe that the increase in survival is mainly associated with improved CPR due to more persons treating the patient with ongoing cardiac arrest and shortened time intervals. Recent investigations have pointed to poor CPR performance in the field. Thus, Wik *et al.*[32] demonstrated that chest compressions were not given during 48% of the time without circulation. Furthermore, Abella *et al.*[33] as well as Edelson *et al.*[34] have shown that insufficient compression depth and pre-shock pauses predict defibrillation failure. In our study, among OHCA with dual dispatch, fire-fighters remained on the scene and performed CPR in >94% of the cases irrespective of who arrived first. It therefore seems evident that OHCA patients were treated by more hands during the first crucial 10–15 minutes with dual dispatch. It is most likely that this addition of two to five persons improves CPR with fewer pauses and better chest compressions.

Type of first responder, public venues, and implications for the future

Some of the numerous strategies about how to increase survival after OHCA involve the expansion of defibrillation beyond conventional EMS and ambulances to non-medical groups. Three strategies can be considered: (i) PAD performed by non-trained lay rescuers, (ii) PAD performed by trained lay people, and (iii) defibrillation by first responders via simultaneously paired dispatches. The cost-effectiveness of PAD has also been discussed.[35,36] Few authors have presented promising results on survival with untrained lay rescuers,[37] whereas several others have pointed to improved survival rates by the use of trained lay rescuers like the PAD-trail,[38] defibrillation in casinos,[9] and in airplanes.[8] The majority have used first responders for intervention. In the present pilot project, we evaluated PAD performed by trained security officers and dual dispatch defibrillation by first responders. No lives were saved by PAD but the number of cases was very low and the length of the intervention limited. A longer evaluation is needed for drawing any conclusions about this part of our investigation. Our overall findings, however, support that patients with OHCA benefit from a dual dispatch early defibrillation programme. What we have especially learned from this pilot-study is the willingness of fire-fighters to contribute to CPR irrespective of whether they arrived first or after the ambulances. In order to confirm the positive results of this study, a 3-year interventional analysis of the SALSA-project is in progress.

Conclusion

An introduction of a dual dispatch early defibrillation programme in Stockholm has shortened response times and is likely to have improved survival in patients with OHCA. The increase in survival is believed to be associated with improved CPR due to more persons treating the patient with ongoing cardiac arrest and shortened time intervals.

Limitations

(1) No information on co-morbidity, chronic medication, or neurological status was available.
(2) A substantial number of in-hospital variables that could influence survival were not available in the database.
(3) Time measurements from call to defibrillation and from arrival at scene to arrival to the side of the patients were not called into the dispatch centre and therefore not linked to atomic clock time. These two time intervals were thus estimated by EMS personnel and the fire-fighters.
(4) In 13 cases of dual dispatch (in which fire brigade reports were completed), corresponding reports from SCAR were not found. Additional analyses excluding these cases did not affect the key results of the study.
(5) Information on some variables was partially missing. These patients were excluded from the multivariable analysis and therefore the precision (i.e. length of confidence interval) was wider for the adjusted ORs compared with the univariable (unadjusted results).

Author contributors

Dr J.H. had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design*: J.H., J.H., H.P., M.R., and L.S. *Acquisition of data*: J.H., G.R., K.B., P.N., R.L., J.H., H.P., and L.S. *Analysis and interpretation of data*: J.H., G.R., P.N., J.H., M.R., H.P., and L.S. *Drafting of the manuscript*: J.H., J.H., M.R., H.P., and L.S. *Critical revision of the manuscript for important intellectual content*: J.H., G.R., K.B., P.N., R.L., J.H., H.P., M.R., and L.S. *Statistical expertise*: H.P. *Obtained funding*: M.R. and L.S. *Administrative, technical, or material support*: J.H., P.N., J.H., M.R., H.P., and L.S. *Study supervision*: J.H., J.H., M.R., and L.S.

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