



Clinical paper

Survival in ventricular fibrillation with emphasis on the number of defibrillations in relation to other factors at resuscitation[☆]

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ABSTRACT

Introduction: Mortality after out of hospital cardiac arrest (OHCA) is high and a shockable rhythm is a key predictor of survival. A concomitant need for repeated shocks appears to be associated with less favorable outcome.

Aim: To, among patients found in ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT) describe: (a) factors associated with 30-day survival with emphasis on the number of defibrillatory shocks delivered; (b) the distribution of and the characteristics of patients in relation to the number of defibrillatory shocks that were delivered.

Methods: Patients who were reported to The Swedish Register for Cardiopulmonary Resuscitation (SRCR) between January 1 1990 and December 31 2015 and who were found in VF/pVT took part in the survey.

Results: In all there were 19,519 patients found in VF/pVT. The 30-day survival decreased with an increasing number of shocks among all patients regardless of witnessed status and regardless of time period in the survey. In a multivariate analysis there were 12 factors that were associated with the chance of 30-day survival one of which was the number of shocks that was delivered. For each shock that was added the chance of survival decreased. Factors associated with an increased 30-day survival included CPR before arrival of EMS, female sex, cardiac etiology and year of OHCA (increasing survival over years). Factors associated with a decreased chance of 30-day survival included: increasing age, OHCA at home, the use of adrenaline and intubation and an increased delay to CPR, defibrillation and EMS arrival.

Conclusion: Among patients found in VF/pVT, 7.5% required more than 10 shocks. For each shock that was added the chance of 30-day survival decreased. There was an increase in 30-day survival over time regardless of the number of shocks. On top of the number of defibrillations, eleven further factors were associated with 30-day survival.

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Introduction

Shockable rhythms are strong key predictors of survival after out of hospital cardiac arrest (OHCA).¹ Recurrence of a shockable rhythm and/or resistance to defibrillation in OHCA are

both common and result in the requirement of more than one defibrillation.^{2,3} Previous studies have shown that survival and the success of a counter shock to terminate VF/pVT declines for every new episode.^{2–4} A very low survival rate among patients with shock resistant VF/pVT has also been reported.⁵ In order to find optimal strategies to improve survival in the population of patients found in VF/pVT, further knowledge about the incidence, characteristics and outcome in relation to the number of shocks is warranted.

The population in Sweden was 8.6 millions in 1990 and 9.8 millions in 2015. The incidence of OHCA where resuscitation is attempted is around 55/100,000 person-years and survival to

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Table 1
Characteristic and outcome in relation to number of shocks. “Cardiac etiology” refers to the assessment reported to the SRCR by the EMS crew.

	1–3 defib. N = 10,729	4–10 defib. N = 7335	>10 defib. N = 1455	p-value
Age (median, year) m = 3.2% (619)	70	70	69	0.001
Female sex (%) m = 2.2% (436)	23.1	19.4	17.1	<0.0001
Witnessed status (%) m = 4.9% (951)				
Crew witnessed	24.5	9.7	7.8	<0.0001
Bystander witnessed	61.2	72.9	76.1	<0.0001
Unwitnessed	14.3	17.3	16.0	<0.0001
Cardiac etiology (%) m = 5.5% (1068)	82.4	85.0	86.3	<0.0001
Place (at home, %) m = 0.7% (133)	48.0	57.6	62.0	<0.0001
Treatment (%)				
Intubation m = 1.0% (191)	41.0	57.1	68.1	<0.0001
Adrenaline m = 0.7% (134)	60.0	88.6	96.5	<0.0001
Amiodarone m = 4.8% (352)	9.9	71.9	87.4	<0.0001
CPR before arrival of EMS (%) m = 1.4% (272)	62.6	59.1	57.8	<0.0001
Delay (median, minutes)				
Collapse-call (n = 10355)	2	2	3	0.13
Collapse-CPR ^a (n = 11333)	3	5	7	<0.0001
Collapse-defib. (n = 11613)	11	12	12	<0.0001
Alert-EMS arrival (n = 15757)	6	6	7	0.003
Survival to 30 days (%) m = 1.5% (293)				
All	28.4	12.7	4.9	<0.0001
Crew witnessed	47.9	18.6	17.1	<0.0001
Bystander witnessed	25.6	13.7	4.0	<0.0001
Unwitnessed	11.8	6.2	3.6	<0.0001
ROSC among non-survivors (%) m = 0.1% (18)	27.3	26.1	20.5	<0.0001

^a Delay from collapse to CPR refers to time to any CPR initiated (bystander, EMS, fire brigade etc).

30 days has improved from 4.8 to 11% from 1992 until 2014.⁶ One of the main reasons for the improved survival rate is probably linked to the increased proportion of cases where CPR was started before arrival of the Emergency Medical Service (EMS) system. This proportion has increased from 33 to 68% (1992–2014).⁷ Survival rates are still low and the challenge is to further improve the chain of survival.⁸

One important finding in the SRCR is that the proportion of witnessed CA-patients found in VF/pVT has decreased from around 49% (1992) to 35% (2014).⁶ This is in agreement with experiences from other centers.^{9–11} In spite of this most of the survivors are still recruited from patients found in VF/pVT and during 2014, 34% of these patients survived to 30 days versus 12% in the early nineties.⁶

It is known that early defibrillation improves survival^{12–14} but could anything more be done for the majority of patients found in VF/pVT who needs more than one shock? Time seems important but there are non-survivors even among EMS-crew witnessed cases of OHCA.¹⁵

In terms of more specific treatment, changing position of the defibrillator pads when dealing with refractory shockable rhythms are recommended by European guidelines.¹⁶ A technique using two defibrillators and synchronized shocks has been described,^{17,18} but evidence is scarce. Percutaneous coronary interventions (PCI) and extracorporeal life support are resource-demanding procedures that could be an option in some settings.^{19–21}

Early PCI after OHCA has been associated with improved survival¹⁹ and there are cases presented where PCI during on-going CPR has been successful.²⁰ One problem is how to perform CPR with high quality during the transport to hospital. Here mechanical chest compression might be a bridge between the scene and the catheterization laboratory (cath-lab).²² A pathway to the cath-lab could be one further chance to improve survival among patients found in VF/pVT. However, a new pathway requires more knowledge about the epidemiology of VF/pVT. Is it possible to predict which patients who will require a large number of defibrillations? Furthermore, what is the association between the number of shocks required and the chance of survival?

Aim

To among patients found in VF/pVT evaluate:

- 1) The distribution and characteristics of patients in relation to the number of shocks delivered.
- 2) The association between various factors at resuscitation and 30-day survival with a particular focus on the number of shocks delivered.

Method, settings and definitions

Method

This is an observational study based on data from the The Swedish Register for Cardiopulmonary Resuscitation – SRCR.

Population

The SRCR was started in 1990 and in the end of 2015 more than 82,000 patients with OHCA were reported (6). Each year about 5000 OHCA are reported with a slight increase during the last five years. Coverage over these last five years has been estimated to be close to 100%. From 1 of January 1990 to 31 of December 2015, all patients with OHCA, VF/pVT as the first registered rhythm and reported to the SRCR were included in the analysis. Patients in whom the number of shocks was missing were excluded from analysis. In order to evaluate the impact of time, the study cohort was divided into five periods as shown in Table 2. Grouping was made to correspond to national changes in CPR guidelines.

The Swedish Register for Cardiopulmonary Resuscitation

The register is classified as a Swedish national quality register since 1993. It is given a financial support by the Swedish welfare society. The aim of the SRCR is to identify factors affecting outcome and to guide development of cardiac arrest care particularly by eliminating weak links in the chain of care. The participation in the registry is voluntary and each EMS system can choose to stop

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