# Multiple shocks or early transfer for shock refractory ventricular fibrillation?

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It has been over 20 years since Dr. Michael Callaham wrote his editorial describing prehospital emergency care as a "scanty science."[1] Even then, there was robust evidence supporting the use of defibrillation for the treatment of out-of-hospital cardiac arrest (OHCA) patients presenting in ventricular fibrillation (VF). Occupying the critical third link in the "chain of survival,"[2] defibrillation remains a time-sensitive cornerstone in the treatment of VF arrest. Survival from VF decreases by 10% per minute, highlighting the critical importance of early defibrillation.[3] However, despite significant advances in resuscitation efforts, such as improving cardiopulmonary resuscitation (CPR) quality, earlier access to defibrillation, airway management, and antiarrhythmic medications, there are some VF patients who remain in VF. How should we best manage this subset of patients? Should prehospital healthcare providers continue to provide multiple defibrillation attempts on scene, or should early transport to the emergency department occur, where staff and equipment for alternative therapies and post-resuscitation care are available? Currently, there is a paucity of evidence in the literature to suggest the optimal strategy in this challenging patient population.

In this edition of *CJEM*, Cournoyer et al. present data from a registry cohort study assessing the relationship between ongoing defibrillation attempts and outcomes of prehospital return of spontaneous circulation (ROSC) and survival to hospital discharge for OHCA patients presenting in shockable rhythms.[4] Of note, only 30% of the study cohort received advanced life support (ALS) interventions. As such, these findings may provide guidance to prehospital systems which provide primarily basic life support (BLS) to OHCA patients in refractory VF. The findings from this study suggest a progressive decrease in prehospital ROSC from 54% after a single defibrillation, to 24% following nine shocks for patients presenting in VF. Similarly, survival to hospital discharge decreased from 33% after a single successful defibrillation to only 8% after nine defibrillation attempts. Using multivariable regression, the authors were able to demonstrate an inverse relationship between increasing shock number and survival to hospital discharge (adjusted odds ratio = 0.88 [95% confidence interval: 0.85 to 0.92], $p < 0.001$). The authors concluded that survival is still possible after multiple defibrillation attempts, an important consideration for similar systems treating patients who do not respond immediately to defibrillation when presenting in VF.

Findings from the study by Cournoyer et al. are consistent with previous research in this area.[4] Holmen et al. abstracted data from a Swedish cardiac arrest registry over a 25-year time frame beginning in 1990 and reported a progressive decrease in 30-day survival with increasing defibrillation attempts for patients presenting in VF.[5] Specifically, the 30-day survival was 28.7% for patients receiving 1–3 defibrillation attempts, compared to 12.7% for those receiving 4–10 defibrillation attempts, and 4.9% for those who received greater than 10 defibrillation attempts. The Swedish system differed from the system described in this edition of *CJEM* because it had a higher proportion of ALS interventions performed, but as well noted, survival can still occur even after a large number of defibrillation attempts.

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The study by Cournoyer et al.[4] was not without limitations. This was a cohort study using data from a cardiac arrest registry from one prehospital system in Quebec. Although it is noted that 30% of the cohort received ALS interventions, the provision of amiodarone occurred in only 6% of all cases and the median (IQR) dose of epinephrine was only 2 mg (2, 5), suggesting the vast majority of the care provided was BLS. CPR quality[6] focusing on maintaining guideline compliant compression rate and depth while minimizing shock and compression pauses was not reported in the study. Additionally, in-hospital post-resuscitative management such as targeted temperature management[6] and percutaneous coronary intervention[6] (PCI) were not recorded, making it difficult to assess their possible influence on the reported outcomes. Given that the data were abstracted from ambulance call reports, we cannot be certain the proportion of patients truly in refractory VF (where VF is never terminated during the resuscitation) or recurrent VF (where VF is terminated only to recur) – two conditions for which outcomes vary greatly.[7] Finally, the outcome most important to patients and their families, neurologically intact survival, was not captured in this study.

What guidance can be provided from this research regarding future management of shock-refractory VF? Perhaps these findings should encourage us to explore alternative strategies and therapies for the resuscitation of this subset of patients. The Minnesota Resuscitation Consortium has suggested one such alternative pathway.[8] Their approach is to begin mechanical CPR in the prehospital setting immediately following three failed defibrillation attempts, and transport patients directly to the cardiac catheterization lab where extracorporeal membrane oxygenation (ECMO) is promptly initiated. Patients undergo early PCI to open a coronary occlusive lesion, the most common culprit for patients presenting in refractory VF. Although the survival data are rather impressive (48% neurologically intact survival with Cerebral Performance Category score $\leq 2$), the majority of North American prehospital systems will not have the resources to initiate ECMO and PCI in this subset of patients. Additional defibrillation strategies for successful termination of refractory VF are currently being explored by Canadian researchers.[9] An on-going pilot study comparing the effectiveness of double sequential external defibrillation and vector change defibrillation with standard defibrillation for patients remaining in refractory VF after three successive failed defibrillation attempts (https://clinicaltrials.gov/ct2/show/NCT03249948) is underway. Finally, esmolol, a short-acting IV-administered beta blocker, has shown promise in the management of shock refractory VF,[10] but further adequately powered randomized controlled trials are required before this treatment option may be considered.

The work by Cournoyer et al.[4] offers prehospital providers a great deal to ponder. What is clear, regardless of ALS or BLS care, is that resuscitation should not be terminated in the field for patients in refractory VF given the potential for survival demonstrated in this work. In fact, termination of resuscitation guidelines was not designed to include this subset of patients and should not be applied. To improve the survival from refractory VF, we must continue to advance the science behind alternative resuscitation strategies. But until that work has been completed, early prehospital defibrillation with a focus on rapid transport to the hospital remains the most viable option to save lives.

**Keywords:** Cardiac arrest resuscitation, defibrillation, prehospital care, refractory ventricular fibrillation

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