

ORIGINAL ARTICLE

Defibrillation Strategies for Refractory Ventricular Fibrillation

Sheldon Cheskes, M.D., P. Richard Verbeek, M.D., Ian R. Drennan, A.C.P., Ph.D.,
Shelley L. McLeod, Ph.D., Linda Turner, Ph.D., Ruxandra Pinto, Ph.D.,
Michael Feldman, M.D., Ph.D., Matthew Davis, M.D.,
Christian Vaillancourt, M.D., Laurie J. Morrison, M.D., Paul Dorian, M.D.,
and Damon C. Scales, M.D., Ph.D.

ABSTRACT

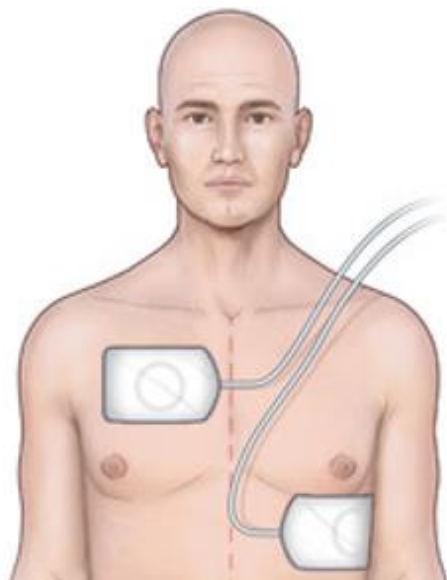
BACKGROUND

Despite advances in defibrillation technology, shock-refractory ventricular fibrillation remains common during out-of-hospital cardiac arrest.

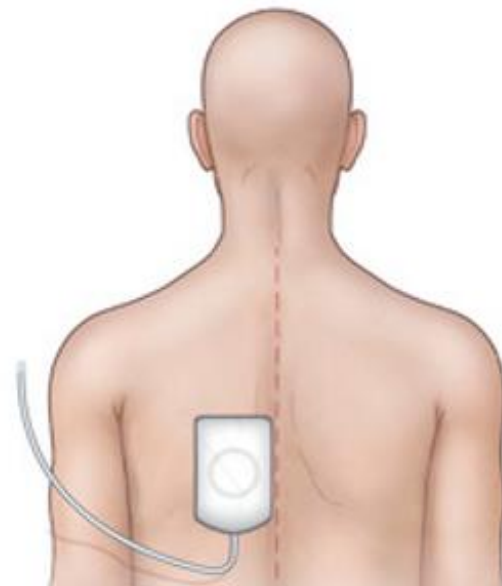
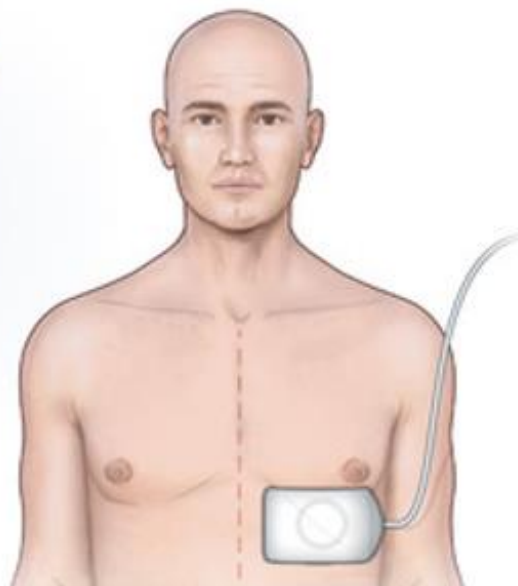
- ✓ **Double sequential external defibrillation (DSED)**; rapid sequential shocks from two defibrillators)
- ✓ **vector-change (VC) defibrillation** (switching defibrillation pads to an anterior-posterior position)

Both have been proposed as defibrillation strategies to improve outcomes in patients with refractory ventricular fibrillation.

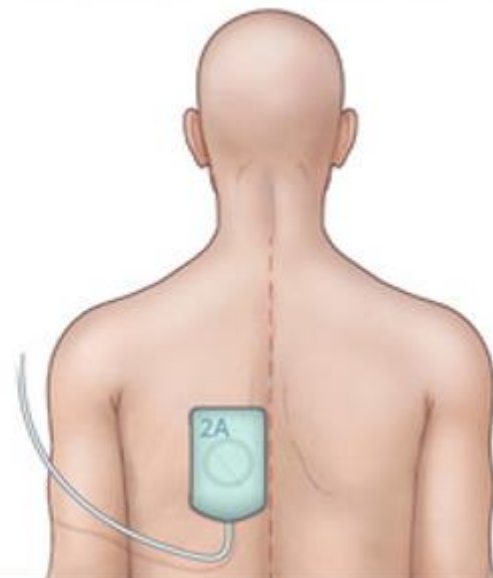
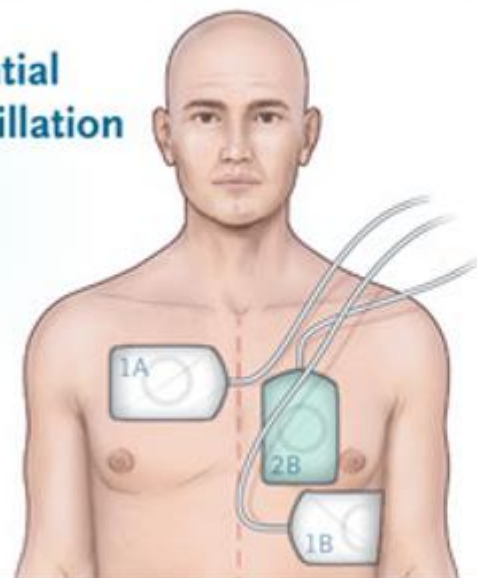
**Standard
Defibrillation**



**Vector-Change
Defibrillation**



**Double Sequential
External Defibrillation**



METHODS

Cluster-randomized trial with crossover among six Canadian paramedic services to evaluate DSED and VC defibrillation as compared with standard defibrillation in adult patients with refractory ventricular fibrillation during out- of-hospital cardiac arrest.

Patients were treated with one of these three techniques according to the strategy that was randomly assigned to the paramedic service.

- ***The primary outcome:*** survival to hospital discharge.
- ***Secondary outcomes :***
 - ✓ Termination of ventricular fibrillation,
 - ✓ Return of spontaneous circulation,
 - ✓ Good neurologic outcome (modified Rankin scale score of 2 or lower (indicating no symptoms to slight disability) at hospital discharge.

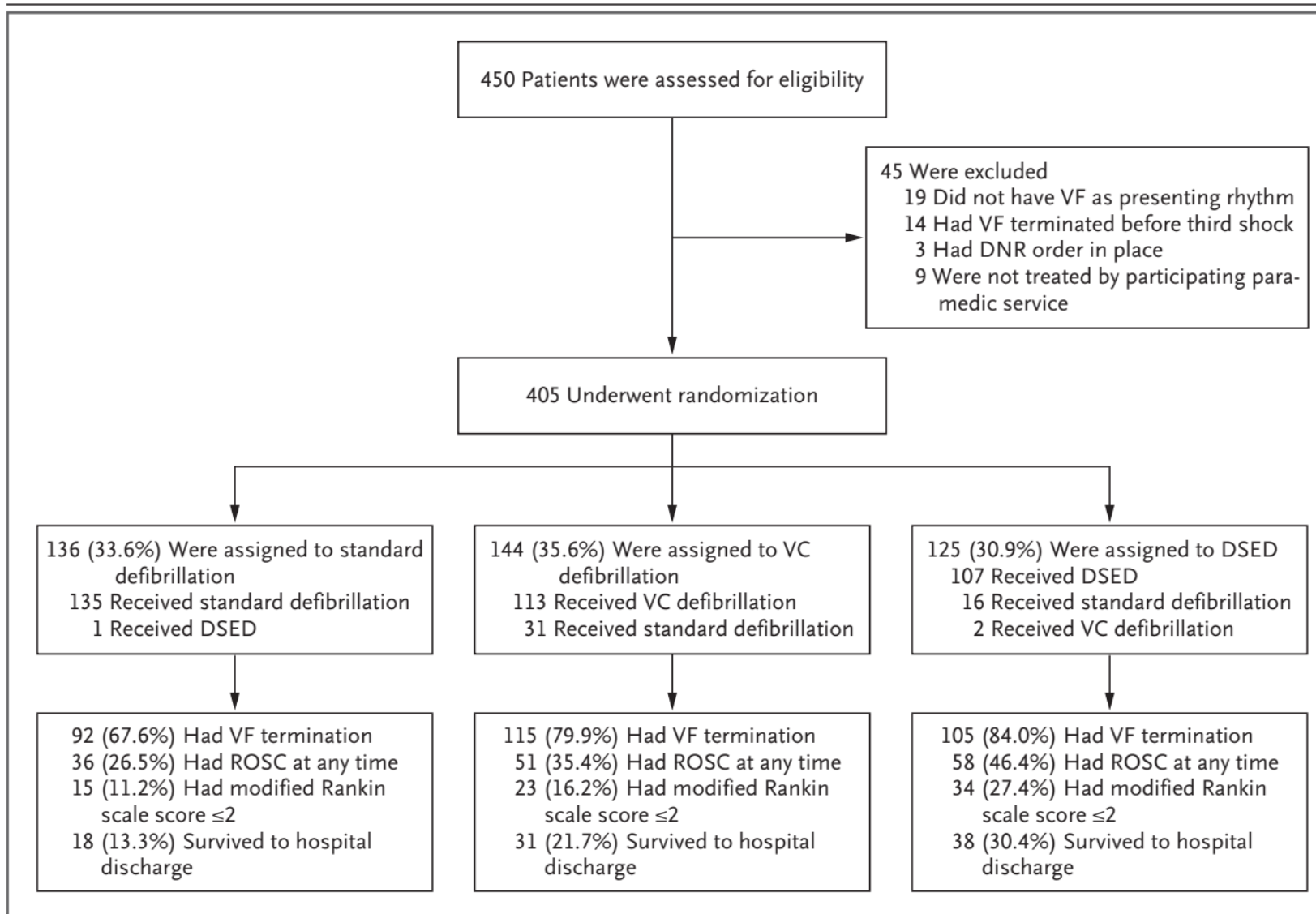


Figure 2. Trial Participants, Randomization, and Outcomes.

For survival to hospital discharge, data were missing for one patient in the standard group and one patient in the VC group. For the modified Rankin scale score, data were missing for two patients each in the standard and VC groups and for one patient in the DSED group. Modified Rankin scale scores range from 0 (no symptoms) to 6 (death). DNR denotes do not resuscitate, ROSC return of spontaneous circulation, and VF ventricular fibrillation.

Table 1. Characteristics of the Patients.*

Characteristic	Standard Defibrillation (N = 136)	VC Defibrillation (N = 144)	DSED (N = 125)
Age — yr	64.0±14.4	63.8±13.2	63.0±16.8
Male sex — no. (%)	109 (80.1)	127 (88.2)	106 (84.8)
Bystander-witnessed cardiac arrest — no. (%)	82 (60.3)	110 (76.4)	83 (66.4)
Bystander CPR performed — no. (%)	74 (54.4)	90 (62.5)	71 (56.8)
Public location of cardiac arrest — no. (%)	41 (30.1)	51 (35.4)	36 (28.8)
Median response time (IQR) — min†	7.4 (5.7–9.9)	7.4 (6.9–9.0)	7.8 (6.0–9.4)

* Plus–minus values are means ±SD. CPR denotes cardiopulmonary resuscitation, DSED double sequential external defibrillation, IQR interquartile range, and VC vector change.

† Response time is defined as the time from the 911 call to the arrival of paramedics at the scene. Data on first response by fire services personnel were excluded, since these data were not collected in the pilot study.

Table 2. Event Characteristics.*

Characteristic	Standard Defibrillation (N=136)	VC Defibrillation (N=144)	DSED (N=125)
Median time from initial call to first shock (IQR) — min†	10.2 (8.2–13.2)	10.4 (8.8–12.6)	10.2 (8.8–11.8)
Prehospital intubation — no. (%)	52 (38.2)	72 (50.0)	53 (42.4)
Preshock pause — sec‡	6.5±7.0	6.1±6.0	6.4±7.6
Postshock pause — sec§	4.8±3.9	5.2±5.8	4.5±2.2
Compression rate per minute¶	109.8±8.0	111.1±8.4	111.7±8.7
Compression depth — cm	6.0±1.0	5.9±1.0	5.7±0.9
Chest compression fraction — %**	83.1±8.1	80.8±8.7	79.1±9.5
No. of standard shocks	7.4±3.0	4.2±2.1	3.9±1.4
No. of shocks to first ROSC††	5.5±1.6	5.3±1.7	5.7±1.9
Antiarrhythmic drug administered — no. (%)	110 (80.9)	106 (73.6)	92 (73.6)
Amiodarone dose — mg	403.4±75.8	392.9±76.5	378.5±75.4
Lidocaine dose — mg	185.7±73.9	175.7±60.6	162.5±83.3
Median time from arrival of EMS to first antiarrhythmic drug administration (IQR) — min‡‡	11.0 (8.0–14.0)	11.6 (9.0–16.0)	11.0 (8.0–15.5)
Epinephrine administered — no. (%)	129 (94.9)	133 (92.4)	107 (85.6)
Epinephrine dose — mg	4.2±2.2	4.2±2.0	4.0±2.1
Median time from arrival of EMS to first epinephrine dose (IQR) — min‡‡	8.7 (6.0–11.5)	9.0 (6.0–14.0)	8.8 (5.4–13.4)
Median time from arrival of EMS to first ROSC (IQR) — min‡‡	14.8 (10.6–20.0)	15.8 (12.5–19.4)	14.0 (11.0–22.0)
Median time from arrival of EMS to departure from scene (IQR) — min§§	25.0 (21.3–32.2)	27.5 (23.3–33.6)	26.5 (21.0–33.8)

Table 3. Primary and Secondary Outcomes.

Outcome	Standard Defibrillation (N = 136)	VC Defibrillation (N = 144)	DSED (N = 125)	Adjusted Relative Risk (95% CI)*	
				DSED vs. Standard	VC vs. Standard
	<i>number of patients/total number (percent)</i>				
Survival to hospital discharge†	18/135 (13.3)	31/143 (21.7)	38/125 (30.4)	2.21 (1.33–3.67)	1.71 (1.01–2.88)
Termination of ventricular fibrillation	92/136 (67.6)	115/144 (79.9)	105/125 (84.0)	1.25 (1.09–1.44)	1.18 (1.03–1.36)
ROSC	36/136 (26.5)	51/144 (35.4)	58/125 (46.4)	1.72 (1.22–2.42)	1.39 (0.97–1.99)
Modified Rankin scale score ≤ 2 ‡	15/134 (11.2)	23/142 (16.2)	34/124 (27.4)	2.21 (1.26–3.88)	1.48 (0.81–2.71)

Survival to hospital discharge appeared to be higher with DSED and VC defibrillation than with standard defibrillation among patients with refractory ventricular fibrillation during out-of-hospital cardiac arrest.



The NEW ENGLAND
JOURNAL of MEDICINE