Emergency Department use of Esmolol in Refractory Ventricular Fibrillation

Brian E Driver MD
David W Plummer MD
Stephen W Smith MD

Hennepin County Medical Center
Department of Emergency Medicine
Minneapolis, MN
USA

Background & Objectives

- Refractory ventricular fibrillation (RVF) is difficult to treat and carries a high mortality rate
- Treatment with epinephrine:
  - Activates **α-1** receptors: *this is probably helpful*
  - Activates **β-1** and **β-2** receptors: *this is probably harmful*
- Esmolol has been increasing used in our ED for RVF unresponsive to standard treatments

Methods

- Retrospective observational analysis of all patients between 1/2011 and 2/2014 who:
  1. received esmolol in the ED *and*
  2. had a diagnosis of:
     - Cardiac arrest *or*
     - Ventricular fibrillation *or*
     - Pulseless ventricular tachycardia
- Excluded patients who received esmolol either before arrest or after sustained return of spontaneous circulation (ROSC)

Results

Table 1: Patient characteristics and pre-hospital management

Patient number	Age (y)	Arrest location	Witnessed Arrest	Time from call to EMS arrival (min)	Bystander CPR	Initial Rhythm	Pre-hospital defibrillation attempts	Pre-hospital adrenaline dose (mg)	Pre-hospital amiodarone dose (mg)	Total pre-hospital time (min)
1	65	Home	Yes	9	Yes	VF	4	4	300	25
2	56	Public	Yes	0	Yes	VF	5	4	450	18
3	60	Other	No	7	Yes	VF	5*	3	450	16
4	45	ED	Yes	N/A	N/A	VF	N/A	N/A	N/A	N/A
5	53	Home	Yes	11	N/A†	VT	2	0	300	43
6	44	Public	Yes	3	No	VF	7	1	0	29

*not including defibrillation attempts by the patient's implantable cardioverter-defibrillator

† Awake on EMS arrival; Cardiac arrest occurred during the initial evaluation

Results

Table 2: Medications received during cardiac arrest prior to esmolol

Patient number	Total adrenaline dose, including pre-hospital (mg)	Total amiodarone dose, including pre-hospital (mg)	Sodium bicarbonate dose (meq)	Lidocaine dose (mg)	Other medications administered
1	9	300	300	200	1,2,4,5,6
2	8	450	250	250	1,2,3,5,6
3	5	450	400	250	1,3,5
4	7	450	200	100	1,2,5
5	5	300	200	100	1,2,3,4,5
6	3	300	200	100	1, 2, 6

1: calcium chloride; 2: magnesium sulfate; 3: vasopressin; 4: epinephrine infusion; 5: lidocaine infusion; 6: atropine

Results

Table 3: Patient details and outcomes

Patient number	Defibrillation attempts prior to esmolol	Temporary ROSC before esmolol	ED LOS / CA duration (min) at time of esmolol bolus	Esmolol loading dose (mcg/kg) / infusion rate (mcg/kg/min)	Temporary ROSC after esmolol	Sustained ROSC after esmolol	Time from esmolol to sustained ROSC (min)	STEMI	Total defibrillation attempts	Total ED CPR time (min)	Total CPR time (min)	Survival to admission	Survival to discharge	Modified Rankin score at follow-up
1	10	X	34 / 59	500 / 50		X	31	No	19	65	88	X		
2	8	X	25 / 43	500 / 100		X	13	Yes	9	38	68	X	X	1
3	5*	X	23 / 39	500 / 50	X		No ROSC	Unknown	8*	76	99			
4	5		34 / 34	500 / 100	X		No ROSC	Yes	8	41	41			
5	4		14 / 57	500 / 100		X	14	Yes	5	28	56	X	X	2
6	13		20 / 49	500 / 0		X	9	No	14	29	58	X	X	3

*Does not include ICD firings; ICD fired every 2-3 minutes until it failed approximately 30 minutes after ED arrival

CA: cardiac arrest; ED: emergency department; ICD: implantable cardioverter-defibrillator; LOS: length of stay; ROSC: return of spontaneous circulation; STEMI: ST elevation myocardial infarction

Discussion

- Esmolol appeared to help achieve sustained ROSC when **all other therapies failed**
- Four of six patients achieved sustained ROSC after esmolol administration
- Three of six survived to discharge in good neurologic condition despite prolonged CPR times of 68, 56, and 49 minutes.
- Benefit is likely from blocking the beta effects of endogenous and exogenous catecholamines

Conclusion

- Further prospective study of beta-blockade in cardiac arrest is warranted
- Beta-blockade should be considered in patients with refractory ventricular fibrillation before cessation of resuscitative efforts