

## Commentary

# Time-dependent interventions

Max Harry Weil and Wanchun Tang

Institute of Critical Care Medicine, Palm Springs, California, USA

Correspondence: Max Harry Weil, [weilm@911research.org](mailto:weilm@911research.org)

Published online: 11 November 2003

*Critical Care* 2004, **8**:11-12 (DOI 10.1186/cc2395)

This article is online at <http://ccforum.com/content/8/1/11>

© 2004 BioMed Central Ltd (Print ISSN 1364-8535; Online ISSN 1466-609X)

### Abstract

The contribution by Pepe and colleagues provides additional evidence that initial defibrillation is not necessarily the optimal intervention for victims of cardiac arrest and especially when cardiac arrest has been untreated for more than 3 min. Precordial compression therefore remains the mainstay of basic life support cardiopulmonary resuscitation after sudden death. It is increasingly apparent that neither epinephrine whether in conventional or high doses nor vasopressin improve ultimate survival. To the contrary, there is evidence favoring  $\beta_1$ -adrenergic blockade.

**Keywords**  $\alpha$ -methylnorepinephrine, cardiopulmonary resuscitation, defibrillation, end-tidal CO<sub>2</sub>, epinephrine

A reappraisal of the priorities of cardiopulmonary resuscitation by Pepe and colleagues [1] calls attention to the evidence that defibrillation may not be the optimal initial intervention. Initial precordial compression after more than perhaps 3 minutes of untreated cardiac arrest greatly improves the likelihood of successful conversion of ventricular fibrillation with restoration of spontaneous circulation [2,3]. Since it is often very difficult to gauge this time interval, and whether it exceeds 3 min, a number of both preclinical investigators [4–6] and clinical investigators [7,8] have sought an electrocardiographic predictor of the likelihood that an electrical shock will restore circulation. It is to this extent that we applaud the authors' call for caution lest the availability and promotion of automated external defibrillators diminishes the preparedness of the rescuer to proceed with more conventional basic life support. The authors appropriately point to the time dependency of basic life support interventions.

Pepe and colleagues then extend their discussion to advanced cardiac life support, and especially pharmacological interventions. In the context of the time dependency of interventions, they are not prepared to discard the possibility that high-dose epinephrine will improve outcome. Indeed, they favor the use of cocktails, entertaining the possibility that epinephrine may be administered conjointly with antioxidants and anti-arrhythmic drugs. Although we agree with Pepe and colleagues in implicating the myocardial energy/supply relationship as an

important issue, we wish to point out that beta-adrenergic agonists, and to a lesser extent the  $\alpha_1$  actions, greatly increase myocardial energy consumption and thereby intensify the severity of myocardial injury [9,10]. Although the alpha-adrenergic effects increase coronary perfusion pressure and transiently increase myocardial blood flow, the downside is major. The inotropic and chronotropic effects produce greater global myocardial ischemia, greater post-resuscitation ventricular ectopy and recurrent ventricular tachycardia, and recurrent ventricular fibrillation. Even more importantly, the adrenergic inotropic and chronotropic actions result in greater severity of post-resuscitation myocardial dysfunction.

Although epinephrine has been used as a resuscitative drug for more than a century, and although there is evidence that epinephrine may facilitate initial resuscitation, there is no proof of ultimate clinical benefit in terms of survival. To the contrary, we suspect that vasopressor agents with no inotropic and chronotropic actions are likely to come to the fore. This has prompted interest in more selective vasopressor agents, including  $\alpha$ -methylnorepinephrine [10] and nonadrenergic vasopressin [11,12]. Moreover, as yet unpublished preclinical studies from our group now suggest a place for beta-adrenergic blocking agents.

Looking to the future, we also see an opportunity for much improvement in sequencing interventions. In support of the conclusions reached by Pepe and colleagues, additional

precision in sequencing cardiopulmonary resuscitation interventions has a high likelihood of improving outcomes. Perhaps one measurement, not cited by the authors, is end-tidal carbon dioxide. Both experimentally and clinically, end-tidal carbon dioxide has been a noninvasive monitor of blood flow generated by precordial compression [13,14]. It serves as quality control of precordial compression and allows chest compression to remain uninterrupted. No longer will advanced cardiac life support rescuers need electrocardiographic confirmation of the return of spontaneous circulation because it is overtly signaled by an overshoot in the end-tidal carbon dioxide.

## Competing interests

None declared.

## References

1. Pepe PE, Fowler RL, Roppolo LP, Wigginton JG: **Clinical review: Reappraising the concept of immediate defibrillatory attempts for out-of-hospital ventricular fibrillation.** *Crit Care* 2003, **7**:in press.
2. Tang W, Weil MH, Sun S, Yamaguchi H, Povoas HP, Marn Perna A, Bisera J: **The effects of biphasic and conventional monophasic defibrillation on postresuscitation myocardial function.** *J Am Coll Cardiol* 1999, **34**:815-822.
3. Tang W, Weil MH, Sun S, Povoas HP, Klouche K, Kamohara T, Bisera J: **A comparison of biphasic and monophasic waveform defibrillation after prolonged ventricular fibrillation.** *Chest* 2001, **120**:948-954.
4. Noc M, Weil MH, Gazmuri R, Sun S, Bisera J, Tang W: **Ventricular fibrillation voltage as a monitor of the effectiveness of cardiopulmonary resuscitation.** *J Lab Clin Med* 1994, **124**:421-426.
5. Noc M, Weil MH, Tang W, Sun S, Perna A, Bisera J: **Electrocardiographic prediction of the success of cardiac resuscitation.** *Crit Care Med* 1999, **27**:708-714.
6. Povoas H, Weil MH, Tang W, Bisera J, Klouche K, Barbatsis A: **Predicting the success of defibrillation by electrocardiographic analysis.** *Resuscitation* 2002, **53**:77-82.
7. Eftestol T, Sunde K, Aase SO, Husoy JH, Steen PA: **Predicting outcome of defibrillation by spectral characteristics and non-parametric classification of ventricular fibrillation in patients with out-of-hospital cardiac arrest.** *Circulation* 2000, **102**:1523-1529.
8. Eftestol T, Sunde K, Steen PA: **Effects of interrupting precordial compression on the calculated probability of defibrillation success during out-of-hospital cardiac arrest.** *Circulation* 2002, **105**:2270-2273.
9. Tang W, Weil MH, Sun S, Noc M, Yang L, Gazmuri RJ: **Epinephrine increases the severity of postresuscitation myocardial dysfunction.** *Circulation* 1995, **92**:3089-3093.
10. Sun S, Weil MH, Tang W, Kamohara T, Klouche K: **Alpha-methylnorepinephrine, a selective alpha<sub>2</sub>-adrenergic agonist for cardiac resuscitation.** *J Am Coll Cardiol* 2001, **37**:951-956.
11. Lindner KH, Prengel AW, Pfenniger EG, Lindner IM, Strohmenger HU, Georgieff M, Lurie KG: **Vasopressin improves vital organ blood flow during closed-chest cardiopulmonary resuscitation in pigs.** *Circulation* 1996, **91**:215-221.
12. Lindner KH, Prengel AW, Brinkmann A, Strohmenger HU, Lindner IM, Lurie KG: **Vasopressin administration in refractory cardiac arrest.** *Ann Intern Med* 1996, **124**:1061-1064.
13. Weil MH, Bisera J, Trevino RP, Rackow EC: **Cardiac output and end-tidal carbon dioxide.** *Crit Care Med* 1985, **13**:907-909.
14. Falk JL, Rackow EC, Weil MH: **End-tidal carbon dioxide during cardiopulmonary resuscitation.** *N Engl J Med* 1988, **318**:607-611.