

## Letter by Nanthakumar and Waxman Regarding Article, "Sudden Cardiac Arrest and Death Following Application of Shocks From a TASER Electronic Control Device"

To the Editor:

We read with interest the important article by Zipes. Zipes has reported 8 cases of ventricular fibrillation (VF) after TASER shocks.<sup>1</sup> His findings indeed validate animal reports that have shown that TASER discharges can stimulate the myocardium. His findings are predicted by our early work on the vector, duration of the TASER discharge, and the associated sympathetic stress that are related to the onset of myocardial capture, the degree of myocardial capture, and the propensity to ventricular fibrillation.<sup>2</sup>

Two important facts that Dr Zipes produced in his article need attention.

Zipes has demonstrated 1 episode of asystole following TASER discharge and another recording in which it was difficult to differentiate fine VF from asystole.<sup>1</sup> Although there are many mechanisms, including respiratory effects, whereby TASER shocks could lead to asystole, Zipes' report highlights the need to consider how TASER-induced ventricular tachycardia/VF might appear as asystole. The 2 mechanisms to consider are (a) transition of VF to asystole secondary to hyperkalemia and (b) continuation of VF in a deeper layer of heart muscle with electric silence in the epicardial regions.<sup>3</sup> Among Zipes' tracings that revealed asystole, recordings were performed long after the initial discharge. Cases 5 and 8 were indeed performed after a prolonged period, 13 minutes and 30 minutes after the discharge, respectively. Swerdlow et al<sup>4</sup> described that the heart rhythm of  $\approx 90\%$  of 56 cases of death associated with TASER were severe bradyarrhythmias or asystole. Transition from VF to asystole after a long time from discharge to initial recording could be due to potassium accumulation in the myocardium leading to termination of the VF. In addition, after long durations of VF, the epicardium may not reveal any activity, and, thus, the surface ECG does not reflect the activity within the myocardium. Thus, recordings made long after VF onset with surface leads, in our opinion, may appear as asystole, and this may explain the discrepancy in the literature where long-duration VF masquerades as asystole.<sup>4</sup> Zipes' work suggests that it is possible that TASER causes ventricular tachycardia/VF in some subjects, and the collapse ECG shows VF, and, in other cases such as cases 5 and 8, it may be possible that VF transforms to asystole as time passes by.

A second feature of Zipes' study highlights is the lack of information on the temporal sequence of myocardial capture in relation to TASER shock. This temporality is important, because it is not known how long a discharge is needed before myocardial stimulation will occur, and this issue has practical implications. In the series of patients by Zipes even those with just 1 TASER shock were found to be in VF. This brings to light the fact that we need to determine exactly when during the discharge does one induce rapid ventricular capture and VF, and how consistent or erratic does this capture have to be for deleterious consequences to evolve. This needs to be carefully studied to give practical guidance to law enforcement officers, because it may determine the safe duration of TASER discharge to reduce unintended consequences such as VF. This would precede the safety step of having an automated external defibrillator for monitoring after a collapse incidence.

It is important to recognize the valuable contribution made by Dr Zipes in this area, because he sheds light on a complicated issue.

## Disclosures

Dr Waxman has served as an expert witness in litigation relevant to the topic of the article about which this letter is written.

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*Circulation*. 2013;127:e257

doi: 10.1161/CIRCULATIONAHA.112.122499

*Circulation* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

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Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://circ.ahajournals.org/content/127/1/e257>

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# Correction

In the article by Nanthakumar and Waxman, “Letter by Nanthakumar and Waxman Regarding Article, ‘Sudden Cardiac Arrest and Death Following Application of Shocks From a TASER Electronic Control Device’,” which was published in the January 1/8, 2013 issue of the journal (*Circulation*. 2013;127:e257), Dr Waxman neglected to disclose that he served as an expert witness in litigation relevant to the topic of the article. The current online version of the letter has been corrected. The authors apologize for the oversight.