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Time boundaries of three-phase time-sensitive model for ventricular fibrillation cardiac arrest

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Background: Recent clinical evidence has suggested that the pathophysiology of ventricular fibrillation (VF) cardiac arrest may consist of three time-sensitive phases, namely electrical, circulatory, and metabolic. According to this model of cardiopulmonary resuscitation (CPR), the optimal treatment of cardiac arrest is phase-specific. The potential survival benefit of bystander cardiopulmonary resuscitation (BCPR) depends in part on ischemic time (i.e., the collapse-to-shock interval), with the greatest benefit occurring during the circulatory (second) phase. However, the time boundaries between phases are not precisely defined in the current literature.

Purpose: The purpose of the present study was to determine the time boundaries of the three-phase time-sensitive model for VF cardiac arrest.

Methods: We reviewed 20,741 adult patients with initial VF after witnessed out-of-hospital cardiac arrest from a presumed cardiac origin who were included in the All-Japan Utstein-style registry from 2013 to 2017. We excluded patients who underwent bystander defibrillation prior to arrival of emergency medical services personnel. The study end point was 1-month neurologically intact survival (Cerebral Performance Category scale 1 or 2). Collapse-to-shock interval was defined as the time from collapse to first shock delivery by emergency medical services personnel. Patients were divided into two groups, BCPR (n = 11,606, 56.0%) and non-BCPR (n = 9135, 44.0%), according to whether they had received BCPR or not.

Results: The rate of 1-month neurologically intact survival in the BCPR group was significantly higher than that in the non-BCPR group (27.9% [3237/11,606] vs 17.9% [1632/9135], P < 0.0001; adjusted odds ratio [OR], 1.90; 95% confidence interval [CI], 1.75–2.07; P < 0.0001). Overall, increased collapse-to-shock interval was associated with significantly decreased adjusted odds of 1-month neurologically intact survival (adjusted OR for each 1-minute increase, 0.94; 95% CI, 0.93–0.95; P < 0.0001). In the BCPR group, the ranges of collapse-to-shock interval that were associated with increased adjusted 1-month neurologically intact survival were from 7 minutes (adjusted OR, 1.95; 95% CI, 1.44–2.63; P < 0.0001) to 17 minutes (adjusted OR, 2.82; 95% CI, 1.62–4.91; P = 0.0002) as compared with those in the non-BCPR group. However, the increase in neurologically intact survival of the BCPR group became statistically insignificant as compared with that of the non-BCPR group when the collapse-to-shock interval was outside these ranges.

Conclusions: The above-mentioned findings suggest that the time boundaries of the three-phase time-sensitive model for VF cardiac arrest may be as follows: electrical phase, from collapse to <7 minutes; circulatory phase, from 7 to 17 minutes; and metabolic phase, >17 minutes onward from collapse.