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Selected Topics: Prehospital Care

A NEW RULE FOR TERMINATING RESUSCITATION OF OUT-OF-HOSPITAL CARDIAC ARREST PATIENTS IN JAPAN: A PROSPECTIVE STUDY

SOS–KANTO 2012 Study Group

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☐ **Abstract—Background: The American Heart Association and European Resuscitation Council guidelines for cardiopulmonary resuscitation present rules for termination of resuscitation (TOR) in cases of out-of-hospital cardiac arrest (OHCA). In Japan, only doctors are legally allowed TOR in OHCA cases. Objective: This study aimed to develop a new TOR rule that suits the actual situations of the Japanese emergency medical services system. Methods: Five different combinations of the TOR rule criteria were compared regarding specificity and positive predictive value (PPV) for 1-month survival with unfavorable neurologic outcomes. The criteria were unwitnessed by emergency medical service personnel, unwitnessed by bystanders, initial unshockable rhythm in the field, initial asystole in the field, no shock delivered, no prehospital return of spontaneous circulation, unshockable rhythm at hospital arrival, and asystole at hospital arrival. Results: A total of 13,291 cases were included. The following combination provided the highest specificity and PPV for predicting 1-month unfavorable neurologic outcomes and death: unwitnessed by bystanders, initial asystole in the field, and asystole at hospital arrival. The specificity and PPV for the combination of the three criteria for predicting 1-month unfavorable neurologic outcomes were 0.992 and 0.999, and for predicting death at 1 month after OHCA were 0.986 and 0.998, respectively. Conclusions: OHCA patients fulfilling the criteria unwitnessed by bystanders and asystole in the field and at hospital arrival had universally poor outcomes. Termination of resuscitation after hospital arrival for these patients may decrease unwarranted treatments.**

☐ **Keywords—asystole; cardiopulmonary resuscitation; decision support techniques; out-of-hospital cardiac arrest; specificity**

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) remains a major public health problem worldwide. Regardless of the progress in resuscitation practices, OHCA outcomes remain poor (1,2). The American Heart Association (AHA) and the European Resuscitation Council (ERC) guidelines for cardiopulmonary resuscitation (CPR) have rules for the termination of resuscitation (TOR) for OHCA patients in an out-of-hospital setting (3–7). For example, the basic life support (BLS) TOR rule, which has been the most recommended, has three criteria: arrest was not witnessed by emergency medical service (EMS) personnel, no shock delivered, and no prehospital return of spontaneous circulation (ROSC) (6). However, EMS personnel are legally prohibited from terminating resuscitation in Japan (8–10). Almost all OHCA patients, including those with minimal potential for survival, are transported to a hospital, which expends medical resources on patients unlikely

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to recover. Currently, TOR in the field is not possible in Japan; therefore, it is necessary to develop a new TOR rule based on the assumption that most OHCA patients may arrive at the emergency department.

Goto et al. analyzed the All-Japan Utstein Registry of the Fire and Disaster Management Agency (FDMA) during the years 2005–2009 to develop and validate a new TOR rule for physicians in the emergency department (9). The TOR rule developed by Goto et al. proposes that physicians can terminate resuscitation of OHCA patients who meet the following three criteria: unwitnessed by bystanders, initial unshockable rhythm in the field, and no prehospital ROSC. Importantly, this rule is aligned with the actual condition of Japan's EMS system. In addition, this TOR rule has high specificity (0.903, 95% confidence interval [CI] 0.894–0.911) for 1-month mortality. However, the AHA and ERC guidelines suggest that if the lower limit of the 95% CI of a diagnostic test is < 0.9, it should be used very cautiously for prognostication purposes (11,12).

The FDMA All-Japan Utstein Registry analyzed by Goto et al. includes outcomes at 1 month or at discharge, whichever is earlier, which carries a risk of overestimating cerebral performance category (CPC) scores, because some patients were discharged with a CPC score of 3 or 4 that lowered to 1 or 2 upon later transfer to another hospital (13). Furthermore, because the All-Japan Utstein Registry of the FDMA is a nationwide sample of OHCA patients, it includes hospitals where OHCA patients with a do-not-attempt-resuscitation order or no-resuscitation-desired are mainly transported. In addition, although EMS personnel may judge that there is no prehospital ROSC upon checking pulsation in a moving ambulance, ROSC at hospital arrival can still be recognized. Therefore, although Goto's TOR is an excellent rule, verification is considered necessary. By contrast, the Survey of Survivors after Cardiac Arrest, conducted in the Kanto Area of Japan in 2012 (SOS–KANTO 2012) consistently used outcomes at 1 month. SOS–KANTO 2012 also mainly included OHCA patients treated at tertiary emergency medical centers and involves little variation in medical treatment level after hospitalization. In addition, SOS–KANTO 2012 included electrocardiogram (ECG) waveform data at hospital arrival, which we assessed as an alternative to prehospital ROSC.

This prospective study aimed to develop a new TOR rule that is suitable for an EMS system in which personnel are prohibited from TOR (e.g., Japan) and that has the highest specificity and positive predictive value (PPV) for 1-month survival with unfavorable neurologic outcomes compared to Goto's TOR and the BLS TOR rule.

METHODS

Study Design and Setting

SOS–KANTO 2012 was a prospective multicenter observational study comprising 16,452 OHCA patients who were transported to 67 emergency hospitals in the Kanto region in Japan between January 2012 and March 2013. The 67 emergency hospitals belong to the Japanese Association for Acute Medicine of Kanto, and many of these hospitals have critical care centers. The study analyzed the pre- and in-hospital records for all included OHCA patients, and data were collected according to the Utstein-style templates of recording OHCA patient information (14). Details of the study design and data collection of the SOS–KANTO 2012 were reported previously (15–17). This study was approved by the Institutional Review Boards of all 67 institutions. The need for informed consent was waived according to the guidelines of the Japanese government.

EMS Systems in Japan

The Kanto region in Japan consists of seven prefectures, including the capital Tokyo. Both prehospital treatments, provided by EMS personnel and health care providers, and in-hospital treatments, provided by physicians, are based on the national guidelines of the Japan Resuscitation Council (8). In Japan, at least one emergency lifesaving technician (ELST) rides in the ambulance (1). ELSTs can use semi-automated external defibrillators, place an adjunct airway, and insert an IV line. Specially trained ELSTs are permitted to insert tracheal tubes and administer IV adrenaline under online medical supervision (10). However, EMS personnel are prohibited by law from terminating resuscitation in the field. Most OHCA patients are transported to hospitals, whether or not they achieve ROSC, except in cases with obvious signs of death, such as decapitation, incineration, decomposition, rigor mortis, or dependent lividity (2). Additionally, EMS personnel in Japan do not use end-tidal CO_2 monitoring.

Participants

All OHCA patients transported by EMS personnel to participating institutions during the study period were eligible for inclusion in the SOS–KANTO 2012. Of these, the present study included adult OHCA patients only (18 years or older). Exclusion criteria were cases with initial resuscitation performed inside the hospital or clinic or missing data for onset location, 1-month neurologic outcomes, witnessed by bystanders, prehospital shock delivery, prehospital ROSC, initial ECG wave form in the field, or ECG waveform at hospital arrival.