External Validation of the Universal Termination of Resuscitation Rule for Out-of-Hospital Cardiac Arrest in British Columbia

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Study objective: The Universal Termination of Resuscitation Rule (TOR Rule) was developed to identify out-of-hospital cardiac arrests eligible for field termination of resuscitation, avoiding futile transportation to the hospital. The validity of the rule in emergency medical services (EMS) systems that do not routinely transport out-of-hospital cardiac arrest patients to the hospital is unknown. We seek to validate the TOR Rule in British Columbia.

Methods: This study included consecutive, nontraumatic, adult, out-of-hospital cardiac arrests treated by EMS in British Columbia from April 2011 to September 2015. We excluded patients with active do-not-resuscitate orders and those with missing data. Following consensus guidelines, we examined the validity of the TOR Rule after 6 minutes of resuscitation (to approximate three 2-minute cycles of resuscitation). To ascertain rule performance at the different time junctures, we recalculated TOR Rule classification accuracy at subsequent 1-minute resuscitation increments.

Results: Of 6,994 consecutive, adult, EMS-treated, out-of-hospital cardiac arrests, overall survival was 15%. At 6 minutes of resuscitation, rule performance was sensitivity 0.72, specificity 0.91, positive predictive value 0.98, and negative predictive value 0.36. The TOR Rule recommended care termination for 4,367 patients (62%); of these, 92 survived to hospital discharge (false-positive rate 2.1%; 95% confidence interval 1.7% to 2.5%); however, this proportion steadily decreased with later application. The TOR Rule recommended continuation of resuscitation in 2,627 patients (38%); of these, 1,674 died (false-negative rate 64%; 95% confidence interval 62% to 66%). Compared with 6-minute application, test characteristics at 30 minutes demonstrated nearly perfect positive predictive value (1.0) and specificity (1.0) but a lower sensitivity (0.46) and negative predictive value (0.25).

Conclusion: In this cohort of adult out-of-hospital cardiac arrest patients, the TOR Rule applied at 6 minutes falsely recommended care termination for 2.1% of patients; however, this decreased with later application. Systems using the TOR Rule to cease resuscitation in the field should consider rule application at points later than 6 minutes. [Ann Emerg Med. 2017;■:1-8.]

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INTRODUCTION

Background

Emergency medical services (EMS) care for more than 300,000 out-of-hospital cardiac arrests in the United States per year.[1] Historically, EMS personnel transport all out-of-hospital cardiac arrest patients, with or without return of spontaneous circulation, to the hospital. As a result, EMS personnel transport many out-of-hospital cardiac arrest patients for whom resuscitation efforts are ultimately futile. Emergency transport to the hospital for a patient with ongoing cardiopulmonary resuscitation (CPR) poses a risk to paramedic and public safety.[2,3]

To address this problem Verbeek et al[4] derived the Universal Termination of Resuscitation Rule (TOR Rule) to identify out-of-hospital cardiac arrest patients who would not survive resuscitation if transported to the hospital, potentially allowing field termination of efforts. The rule recommends termination of resuscitation without transport to the hospital if all of the following 3 criteria are met: the arrest is not witnessed by EMS (fire department or paramedics), there are no shocks delivered, and there is no return of spontaneous circulation; otherwise, transport to the hospital is recommended.[4,5] In the landmark validation study, the TOR Rule was applied after no more than 3 cycles (each cycle was 1 to 2 minutes in duration) of CPR

Editor's Capsule Summary

What is already known on this topic

The Universal Termination of Resuscitation Rule (TOR Rule) offers guidance for terminating out-of-hospital cardiac arrest care after approximately 6 minutes of resuscitation.

What question this study addressed

What is the accuracy of the TOR Rule if it is applied at later care points?

What this study adds to our knowledge

In this study of 6,994 out-of-hospital cardiac arrests treated in British Columbia, the TOR Rule incorrectly recommended care termination after 6 minutes of resuscitation for 92 patients (2.1%). TOR Rule accuracy improved when applied at later points.

How this is relevant to clinical practice

Emergency medical services systems might consider TOR Rule application at resuscitation points later than 6 minutes.

and rhythm analysis. The positive predictive value for death was 99.5% when termination was recommended.[5] The use of the TOR Rule is recommended by the American Heart Association guidelines, with application advised after three 2-minute cycles of resuscitation.[6-8] The TOR Rule has been independently and externally validated in multiple populations; however, the time juncture of rule application has varied.[9-12]

Importance

First, since the development and validation of the TOR Rule, the proportion of survivors from out-of-hospital cardiac arrest has substantially increased[4,13,14] and guidelines for CPR quality have changed,[8,15] both of which could affect rule performance. Second, the TOR Rule sought to decrease the rate of futile transports in systems that routinely transport all out-of-hospital cardiac arrest patients to the hospital after initial on-scene efforts by paramedics, including those for whom return of spontaneous circulation is not achieved. In contrast, in some systems paramedics routinely provide full on-scene resuscitation, with unsuccessful efforts typically ending in pronouncement of death without transport to the hospital.[2] It is unclear how the TOR Rule should be applied in systems that do not routinely transport pulseless patients to the hospital; should resuscitation termination be determined after 3 cycles of care or extended to later points? Third, because the likelihood of survival changes with duration of elapsed failed resuscitation,[16,17] it is unclear how the performance of the rule is affected by time of application.

Goals of This Investigation

We sought to independently validate the TOR Rule in a Canadian metropolitan EMS system that does not routinely transport cardiac arrest patients to the hospital, examining the rule's performance when applied at the 6-minute juncture, as well as at subsequent points of elapsed resuscitation.

MATERIALS AND METHODS

Study Design

We analyzed prospectively collected data on out-of-hospital cardiac arrest patients treated in British Columbia. The institutional review boards and ethics committees of Providence Health Care and the University of British Columbia approved this study.

Setting

This study took place in the 4 major metropolitan regions of the province of British Columbia: Victoria, Vancouver, the Fraser Valley, and Kelowna, where collectively 3.3 million citizens reside, nearly three quarters of the province's total population.[18]

The provincial British Columbia Ambulance Service and local fire department first responders provide coordinated out-of-hospital emergency medical care. Fire department personnel are trained in basic cardiopulmonary life support,[19] including the use of automated external defibrillators. Paramedics are organized in teams of 2 paramedics per vehicle, with ambulances categorized as advanced life support (ALS) if at least one paramedic is ALS certified.[20] Typically, fire department first responders, a basic life support (BLS) crew, and an ALS crew will attend an out-of-hospital cardiac arrest, in that order of arrival. British Columbia Ambulance Service policy dictates what patients must be provided resuscitative treatments (Appendix E1, avilable online at http://www.annemergmd.com).[21] ALS paramedics can provide advanced skills such as intubation, cricothyroidotomy, chest decompression, and intraosseous access, and can deliver intravenous drugs used in advanced cardiac life support resuscitation.[20]

The TOR Rule is not used in British Columbia. British Columbia Ambulance Service policy states that before termination of efforts, all patients must undergo resuscitation for at least 30 minutes.[21] Approval of

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