Resuscitation 85 (2014) 486–491

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Implementation trial of the basic life support termination of resuscitation rule: Reducing the transport of futile out-of-hospital cardiac arrests☆

Laurie J. Morrison[a,b,c,*], Don Eby[d,e], Precilla V. Veigas[a], Cathy Zhan[a], Alex Kiss[c,f], Vince Arcieri[g], Paul Hoogeveen[h], Chris Loreto[i], Michelle Welsford[j,k], Tim Dodd[j], Elma Mooney[l], Marty Pilkington[i], Cathy Prowd[d], Erica Reichl[m], Jim Scott[l], Jeanette M. Verdon[m], Tim Waite[n], Jason E. Buick[a,c], P. Richard Verbeek[a,b,h]

[a] Rescu, Keenan Research Centre, Li Ka Shing Knowledge Institute at St. Michael's Hospital, University of Toronto, Toronto, Ontario, Canada
[b] Division of Emergency, Department of Medicine, University of Toronto, Toronto, Ontario, Canada
[c] Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario, Canada
[d] Southwest Ontario Regional Base Hospital Program, London Health Sciences Centre, Owen Sound Site, Ontario, Canada
[e] Division of Emergency, Department of Medicine, Western University, London, Ontario, Canada
[f] Department of Research Design & Biostatistics, Sunnybrook Health Sciences Centre, Institute for Clinical and Evaluative Sciences, Toronto, Ontario, Canada
[g] Peterborough Regional Health Centre, Peterborough, Ontario, Canada
[h] Sunnybrook Centre for Prehospital Medicine, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada
[i] Northeastern Ontario Prehospital Care Program, Health Sciences North, Timmins Site, Ontario, Canada
[j] Centre for Paramedic Education and Research, Hamilton Health Sciences Centre, Hamilton, Ontario, Canada
[k] Division of Emergency Medicine, Department of Medicine, McMaster University, Hamilton, Ontario, Canada
[l] Northeastern Ontario Prehospital Care Program, Health Sciences North, Sault Ste. Marie Site, Ontario, Canada
[m] Regional Paramedic Program for Eastern Ontario, Ottawa, Ontario, Canada
[n] Medavie EMS Ontario (MEMSO Muskoka), Muskoka, Ontario, Canada

ARTICLE INFO

Article history:
Received 11 September 2013
Received in revised form 8 December 2013
Accepted 12 December 2013

Keywords:
Cardiopulmonary resuscitation
Cardiac arrest
Emergency medical services

ABSTRACT

Background: The basic life support (BLS) termination of resuscitation (TOR) rule recommends transport and continued resuscitation when cardiac arrest is witnessed by EMT-Ds, or there is a return of spontaneous circulation, or a shock is given, and prior studies have suggested the transport rate should fall to 37%.

Methods and results: This real-time prospective multi-center implementation trial evaluated the BLS TOR rule for compliance, transport rate and provider and physician comfort. Both provider and physician noted their decision-making rationale and ranked their comfort on a 5-point Likert scale. Functional survival was measured at discharge. Of 2421 cardiac arrests, 953 patients were eligible for the rule, which was applied correctly for 755 patients (79%) of which 388 were terminated. 565 patients were transported resulting in a reduction of the transport rate from 100% (historical control) to 59% ($p < 0.001$). The BLS TOR rule was not followed in 198 eligible patients (21%) and they were all transported despite meeting the criteria to terminate. Providers cited 241 reasons for non-compliance: family distress, short transport time interval, younger age and public venue. All 198 transported patients, non-compliant with the rule, died. Both providers and physicians were comfortable with using the rule to guide TOR (median [IQR] of 5 [4,5]; $p < 0.001$).

Conclusions: This implementation trial confirmed the accuracy of the BLS TOR rule in identifying futile out-of-hospital cardiac arrest (OHCA) resuscitations, significantly reduced the transport rate of futile OHCA and most providers and physicians were comfortable following the rule's recommendations.

© 2013 Elsevier Ireland Ltd. All rights reserved.

1. Background

Emergency medical technicians who are trained in basic life support and the use of automated external defibrillators (EMT-D) are either licensed or certified independently (USA) or are delegated under the license of a medical director (Canada) to perform medical acts including cardiopulmonary resuscitation (CPR)

☆ A Spanish translated version of the summary of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2013.12.013.

* Corresponding author at: Rescu, St. Michael's Hospital, 30 Bond Street, Toronto, ON M5B 1W8, Canada.
E-mail address: MorrisonL@smh.ca (L.J. Morrison).

0300-9572/$ – see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.resuscitation.2013.12.013

and defibrillation for cardiac arrest patients. Some regions employ emergency medical technician-paramedics (EMT-P) who can perform advanced life support such as intubation, gain vascular access and administer intravenous medications. After an unsuccessful resuscitation attempt, an EMT-P can contact an on-line physician to terminate resuscitation. For some communities served by EMT-D providers, the practice of termination of resuscitation for failed resuscitation does not exist, and it is mandated that 100% of all cardiac arrest patients are transported to the emergency department (ED). This is a costly practice as it means out-of-hospital and in-hospital resources are expended on futile resuscitations that could be redirected to other patients.[1–4] It also puts EMT-P providers at risk for needle stick injuries and both EMT-Ds and EMT-Ps and the public at risk for motorized vehicle accidents occurring when patients are rushed to the ED.[5–10] A termination of resuscitation (TOR) rule is an important intervention that could ensure consistency in care, better alignment of resources when continued resuscitation is medically futile and reduced risks to the provider, the patient and the public.

The 2011 position paper from the National Association of EMS Physicians advocates for the implementation of a TOR rule to reduce the transport of futile resuscitations and provide a more consistent approach to all out-of-hospital cardiac arrest (OHCA) patients.[11] This is helpful even for EMT-Ps, as the variability in decisions to terminate can be high and unpredictable when left to the discretion of the on-line medical control (physicians and nurses).[12] To address this, the Basic Life Support (BLS) TOR rule was derived[13] and prospectively validated.[14] It recommends transportation to the nearest ED and continued resuscitation if there is a return of spontaneous circulation or a shock is delivered in the prehospital setting or the arrest is witnessed by the EMT-D.[13] The TOR rule theoretically reduces the number of transports from 100% to 37% without compromising the resuscitation of potential survivors. The BLS TOR rule was externally validated through a number of studies across Canada[15] and the United States.[16–18] A retrospective Japanese study[19] evaluated the TOR rule's ability to predict functional survival as well as survival to discharge. Given this body of evidence, the BLS TOR was recommended by the American Heart Association in the 2010 guidelines.[20]

Sasson et al. published a number of barriers to TOR protocol implementation including legislation, advocacy and remuneration. It was suggested that these barriers be addressed prior to implementation.[21] The rule has not been evaluated with real-time implementation to determine an optimal strategy and the psychological impact on the EMTs is unknown. The objective of this study is to evaluate the implementation of the BLS TOR rule in a real-time setting.

2. Methods

2.1. Study design and setting

The Termination of Resuscitation Implementation Trial (TORIT) was a multi-center prospective observational implementation study of the BLS TOR rule. There were seven participating regions in Ontario, Canada with populations ranging from 43,165 to 721,053 people and population densities of 14.5 to 525.6 people per square kilometer.[22] These regions were served by eight emergency medical services and 1250 providers. All participating emergency medical services received approval from their Institutional Research Ethics Boards to conduct this trial with a waiver of consent.

2.2. Study population

The study population consisted of consecutively enrolled adult patients who were treated by EMT-Ds for OHCA.[23] Patients were excluded if they received advanced cardiac life support, were under 18 years of age, were obviously dead as defined by local legislation, had a written or verbal do-not-resuscitate order or suffered an arrest from an obvious cause (e.g. drowning, hanging, trauma).[23]

2.3. Study protocol

The protocol for EMT-D providers treating a cardiac arrest patient included cardiopulmonary resuscitation and the use of an automated external defibrillator according to the American Heart Association guidelines.[24,25] They were trained in the study protocol by their medical directors or their designate and this training included role-playing scenarios reinforcing best practices in death notification and addressing family grief.[26] Initial resuscitation involved confirming cardiac arrest, securing the airway and starting ventilations with 100% oxygen delivered in accordance with a provincially-approved protocol. Patients with a confirmed cardiac arrest received upfront chest compressions while waiting for the defibrillator to be turned on and the pads attached then early analysis followed by four 2-min intervals of cardiopulmonary resuscitation and repeat analysis before considering the application of the BLS TOR rule. Based on the BLS TOR rule, patients were transported to the nearest ED with ongoing resuscitation if the arrest was witnessed by EMT-D providers or a shock was applied by any responder (lay or trained) or a return of spontaneous circulation of any duration was observed prior to moving toward the ambulance.

For patients who did not meet the transport criteria, the base hospital physician was contacted by EMT-Ds concurrent or after the fourth rhythm analysis. Resuscitation continued as per protocol while EMT-Ds conveyed aspects of the case and the TOR rule recommendation to the on-line physician. The base hospital physician would then decide to cease resuscitation or not based on the BLS TOR protocol, or their own judgment, and document accordingly. Failure to reach the on-line physician resulted in a default of continued resuscitation and transport of the patient to the nearest ED. Both EMT-Ds and the on-line physicians completed standardized data forms noting their decision-making rationale and scoring their comfort with the BLS TOR rule recommendations. Trained data guardians located at a central site abstracted the data and entered it into a password-secured database that conformed to the Utstein variables.[23]

2.4. Outcome measures

The primary outcome measure was the transport rate of OHCA patients with implementation of the BLS TOR rule compared to the current standard where 100% of patients treated by EMT-Ds are transported to the closest ED. Secondary outcomes included BLS TOR rule compliance, an immediate assessment of EMT-D and on-line physician comfort in applying the rule using a 5-point Likert scale ranging from "very comfortable" to "very uncomfortable," and overall survival to discharge. The psychological comfort of EMT-Ds was also evaluated at two time points following BLS TOR implementation using a validated survey, usually at least 6 and 12 months post-implementation.[27] To optimize the response rate the survey was conducted at continuing medical education events. Functional survival (cerebral performance category [CPC][28,29] score) was recorded at discharge or after six months in-hospital where a CPC of 1–2 was good and 3–5 was poor.

2.5. Statistical analysis

Statistical analysis was performed using SAS software version 9.1 (SAS Institute, Cary, NC, USA) and Microsoft Excel version 2005 (Microsoft Corp., Richmond, Washington, USA). Continuous variables are reported as means and standard deviations. Categorical

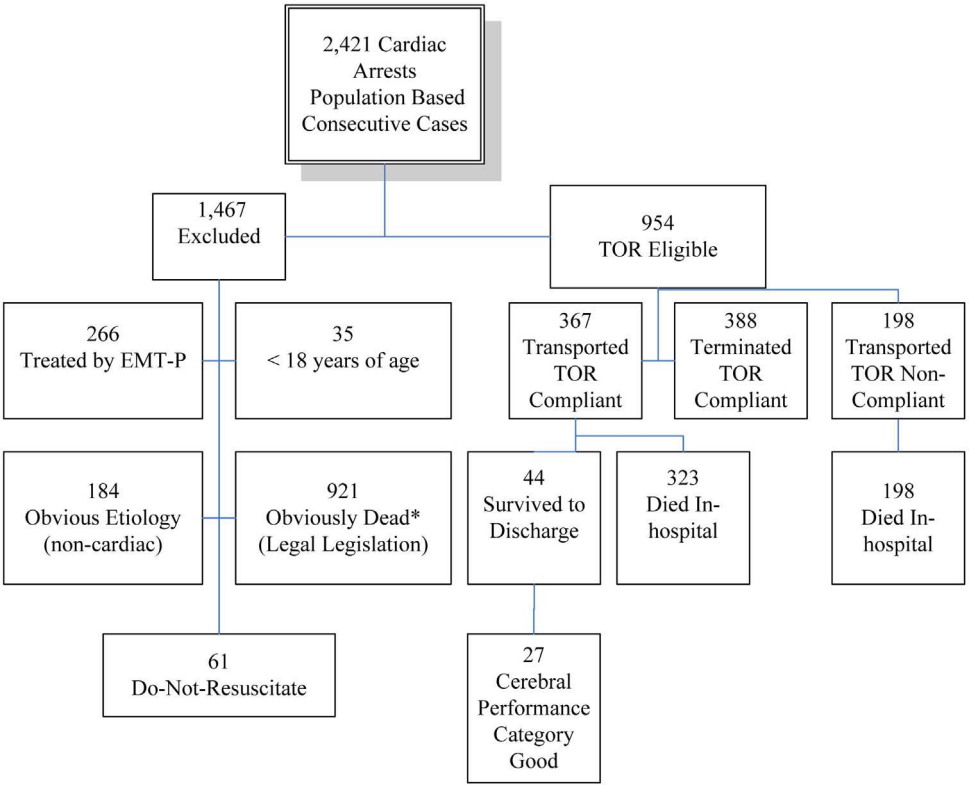

Fig. 1. TORIT enrollment.

variables are reported as counts and percentages. Significance was set at $\alpha = 0.05$. Comfort scores on the validated comfort scale[30] may range from a low of 22 to a high of 110. To be able to obtain a confidence interval around this score, a sample size of 50 responses per site allows the calculation of a two-sided 95% confidence interval, with assumed standard deviation of 10, to have a margin of error of less than 3% (2.8% specifically). The sample size calculation was run using PASS Version 8.0.8 (Hintze, J. [2008] PASS 2008. NCSS, LLC. Kaysville, Utah.)

3. Results

From 1 January 2006 to 30 September 2008, there were 2421 OHCAs in the participating regions. Of these cases, 1467 were excluded and the remaining 954 were attended to by an EMT-D and were used in the analysis (Fig. 1).

Table 1 shows the demographics of the eligible patients who were enrolled with BLS TOR applied and those who were eligible but the BLS TOR rule was not applied (non-compliant). Table 2 shows that the TOR rule was correctly applied in 755 cases (79% compliance) resulting in 388 terminations and 367 transports. There were 198 transports of eligible patients who met the criteria for termination but either the EMT-D or the physician opted for transport and continued resuscitation (21% non-compliance). The overall study transport rate of 59% remains statistically significant when compared to the historical control of 100% ($p < 0.001$).

Table 2 also shows the arrest characteristics of all eligible patients. Of the 367 enrolled and transported cases, 44 (4.6%) survived to hospital discharge. More than half (61%) had good cerebral performance category score upon discharge. There were 198 (21%) cases eligible for termination of resuscitation based on the BLS TOR rule that were transported to the ED with ongoing resuscitation; EMT-Ds cited at least one reason per case (241 reasons/198 cases) for not terminating resuscitation (Fig. 2). Of these 198 cases, physicians chose to transport rather than follow the rule and terminate resuscitation in 30 cases representing a non-compliance rate of 4%. All 198 of the TOR eligible and non-compliant patients died in hospital. There were a total of 11 protocol variations in the enrolled and terminated group where EMTs contacted the on-line physician for BLS TOR en-route to the hospital instead of prior to transport as per protocol. There were no protocol variations in the enrolled and transported group.

Among all terminated or transported cases, 91% of EMT-Ds were "comfortable" or "very comfortable" immediately after applying the BLS TOR rule when compared to neutral comfort ($p < 0.001$), with 6% of cases missing comfort scores. When the rule suggested terminating resuscitation, 80% of base hospital physicians were "comfortable" or "very comfortable" ($p < 0.001$) immediately after the call, with 14% of cases missing comfort scores.

The mean EMT's psychological comfort score, as measured on the survey[30] remote from the event, was 87 (±14, range 27, 110) at Time 1 and 86 (±13, range 41, 110) at Time 2 across all sites.[30] The response rate for this comfort level was 80% at Time 1 and 67% at Time 2. Respondents were similar across both time intervals with a mean age of 38 (SD 10), 75% were male with 13 (SD 10) mean years of experience, and 95% had performed a field pronouncement at least once in the past year prior to the survey.

4. Discussion

The BLS TOR rule has been derived[13] prospectively[14,27] and externally validated.[15–18] Our real-time study showed that EMT-Ds implemented the BLS TOR rule accurately, resulting in a significant reduction in the transport rate of futile OHCA patients. The reduced transport rate to the Emergency Department was anticipated to be low (37%) and significantly different from the historical transport rate of 100%, based on prior research.[14] The observed transport rate was 59%. The observed increase in transport rate was

Table 1
Study demographics.

	Eligible patients for TOR rule		
	Enrolled and terminated	Enrolled and transported	Not enrolled and transported
Patients			
N (=953)	388	367	198
Age (years) – Mean ± SD	69.5 ± 13.3	65.8 ± 15	65.1 ± 14.8
Age range (years) – minimum, maximum	2196	1998	1997
Male sex – no. (%)	247 (63.7)	254 (69.2)	131 (66.2)
Response time intervals (Mean ± SD, minutes)			
Crew notified to first arrival on scene	11.1 ± 10	7.8 ± 5.3	8.7 ± 6.7
Arrival on scene to patient contact	2.5 ± 9.6	1.6 ± 2.5	1.7 ± 2.6
On scene time	39.8 ± 19.5	15.6 ± 6.3	15.4 ± 5.7

Table 2
Arrest characteristics.

	Eligible patients for TOR rule			
	Enrolled and terminated	Enrolled and transported	Not enrolled and transported	Total
Total number of arrests	388	367	198	954
Cardiac arrest – no. (%)				
Unwitnessed	388 (100)	256 (70)	194 (98)	38 (88)
Witnessed by fire or emergency medical services	0 (0)	105 (28)	2 (1)	107 (11)
Missing/unknown	0 (0)	7 (2)	2 (1)	9 (1)
Shock delivered – no. (%)				
Yes	0 (0)	258 (70)	1 (1)	259 (27)
No	388 (100)	109 (30)	195 (98)	692 (73)
Missing/unknown	0 (0)	1 (0)	2 (1)	3 (0.3)
Return of spontaneous circulation – no. (%)				
Yes	0 (0)	63 (17)	0 (0)	63 (7)
No	388 (100)	298 (81)	196 (99)	882 (92)
Missing/unknown	0 (0)	7 (2)	2 (1)	9 (1)
Transport rate	0/388(0%)	367/954 (38.5%)*	198/954 (20.7%)	565/954 (59.2%)**

* Transport rate when TOR rule was correctly applied.
** Transport rate when TOR rule was correctly applied and when discretion used to override TOR rule recommendation to terminate.

attributed to allowing for EMT-D discretion based on willingness to apply the rule given the circumstances of the event and their emotional response, and represents important nuances that affect real life application. EMT-Ds used discretion and did not follow the rule when faced with increased family distress, a short transport time to hospital, a public location and a younger patient age. This discretionary option was exercised in about 20% of cases and we believe contributed to the overall high level of provider and physician comfort in using the rule. A second key implementation strategy that most likely contributed to reasonable compliance (79%) and high comfort levels for both the provider and the physician was access to an on-line physician. This was new for EMT-Ds,

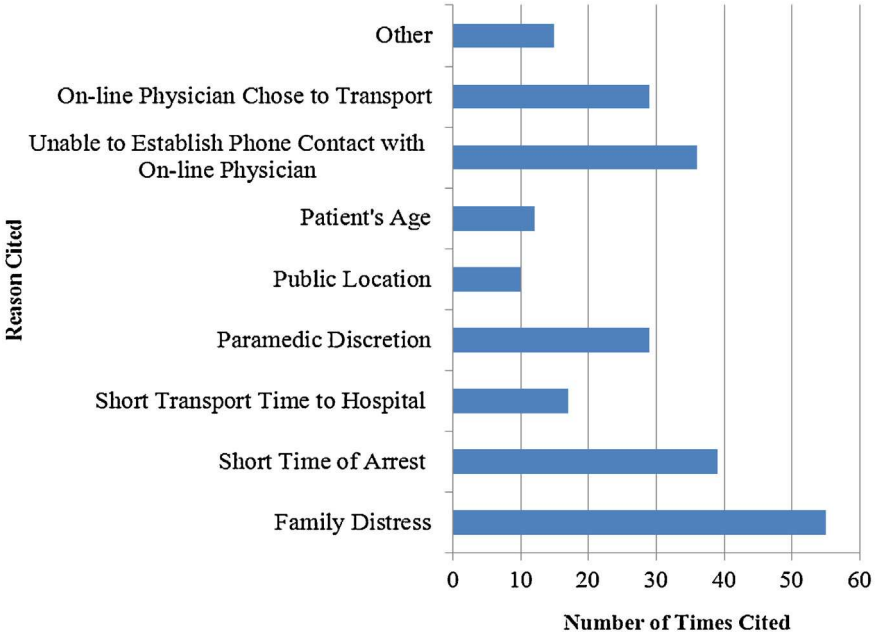

Fig. 2. Discretionary rationale for TOR non-compliance, *N* = 198 (241 reasons cited in 198 cases).

and ensured that the rule was applied correctly. Over time the continued access to direct physician oversight should be revisited, as it may not be required if EMTs and physicians remain comfortable with the implementation and compliance remains the same (79%) or better.

Implementing the BLS TOR rule is advantageous for many reasons. There are significant risks inherent to rapidly transporting patients to the hospital. Ambulances are more likely to be involved in a motor vehicle collision than vehicles of similar size,[5] and the majority of injuries and fatalities occur during "lights and sirens" driving.[6–10] Given the lack of benefit of further resuscitation in patients who fit the BLS TOR rule, it is difficult to justify the increased risk of serious injury to EMT-Ds and the public with transport in these situations.

Terminating resuscitation in the field has an economical advantage. An American study estimated that transporting a patient to be pronounced dead on arrival would cost between $2000 and $95,000 (US) per patient depending upon the extent of ED resuscitative efforts and overall would amount to $500 million (US) annually.[1,2] Another US study estimated that in a year, Medicare spent $58 million (US) nationally on ambulance, physician and hospital reimbursement for futile cardiac arrest resuscitation attempts.[3] The authors concluded that futile resuscitations terminated in the out-of-hospital setting would not inadvertently affect potential survivors and would reduce health care costs.

In addition to cost and efficiency benefits, there is a benefit of providing support and comforting grieving families. Studies have shown that family members were comfortable with resuscitation being terminated in the prehospital setting[31] and were more comfortable at home with family and friends than in the hospital waiting room.[32] Family questions about treatment were satisfactorily answered by emergency personnel[31] and families of non-transported patients were satisfied with the prehospital treatment.[32,33] The on-scene time interval was significantly longer for termination (Table 1) and it is advisable that all BLS providers receive training in death notification.[34]

In this implementation study, most EMT-Ds were "comfortable" or "very comfortable" immediately after terminating resuscitation. EMT-Ds remained comfortable at follow-up testing at both time intervals and had response rates of 80% and 67%. The level of comfort achieved in this study was anticipated based on prior literature. In a prospective validation study of Canadian providers, 71% were comfortable or very comfortable.[35] In another study evaluating EMT comfort with withholding resuscitation, 98% of Seattle EMTs indicated the decision to withhold resuscitation was "easy" or "moderately easy" to make in the field.[36] Hall and colleagues demonstrated similar results[37]; however, they noted that EMTs are significantly less comfortable with pediatric resuscitation attempts and would respond differently to nearly identical scenarios of an adult and a pediatric patient.[37]

Physicians providing on-line oversight in this implementation study were also comfortable terminating resuscitations and reaffirming the rule in on-line discussions with the EMT-Ds in 97% of cases where they were consulted. This high compliance rate and level of comfort are in stark contrast to another study that demonstrated considerable variability of termination practices when left to the discretion of on-line medical control.[12] Eckstein et al. showed rates of termination varied from 5% to 37% across institutions and on-line medical control (physicians and nurses). The authors raised concerns about the consistency of physician decision making and postulated the need for rules to guide termination of resuscitation and address the obvious ethical, logistical and economic issues that arise if the decision is left to the discretion of on-line medical control.[12]

5. Limitations

This study may lack generalizability across other EMS services or regions as it addressed the barriers to implementation unique to a Canadian study population. What is helpful and most likely applicable to all services, regions and countries is that implementation is dependent upon identifying the barriers and directly addressing them in a strategy, which was the purpose of this study. One aspect of implementation which was overlooked was the impact on affiliated services such as police, coroner and body removal involved in field termination of resuscitation. Implementation of the BLS TOR rule changed the processes other agencies used for handling OHCAs. Public agencies such as Police Services and the Coroner's office along with individual businesses, like funeral homes and body removal services, were impacted by changes in emergency medical service termination of resuscitation practices; however, the impact on these services was not measured during this study.

Despite attempts to inform these agencies in advance of the changes, there were occasional local problems that needed to be resolved prior to or after implementation. Notwithstanding these local implementation challenges, the BLS TOR rule has been implemented throughout the Province of Ontario with the support of these agencies and regional processes have become seamless, suggesting the employed implementation strategy was endorsed. The study was also limited by the lack of consistent time interval (6 and 12 months) to measure EMT psychological comfort remote from the event in all participating services. The survey was distributed during continuing education and many of the services only trained once a year. In two services the survey was not distributed correctly and response rate was low and had to be repeated at the next encounter, contributing to a delay in reporting the results. In all services, the TOR rule was implemented after the implementation study was completed and as such the psychological comfort measured at both time intervals was relevant to current practice. The comfort scores of the services where there was a delay were not noticeably different from the other services where the time periods were 6 months apart (data not shown).

This trial was launched when services were adhering to the 2005 American Heart Association guidelines[26] and follow-up surveys completed after the changeover to the 2010 guidelines.[38] The 2010 guidelines recommended the BLS TOR.[20] The only change in resuscitation practice for BLS in 2010 was to increase monitoring of the quality of continuous chest compressions. This change was adopted by the participating services and it is unlikely that it would impact on the implementation of the BLS TOR.

6. Conclusion

In conclusion, a real-time evaluation of the BLS TOR rule resulted in 79% compliance in the application of the rule, 100% accuracy in identifying all those patients where continued resuscitation is futile and significantly reduced the transport rate of cardiac arrest patients with ongoing futile resuscitation to an Emergency Department. A reasonable non-compliance rate of 21% permitted EMT-Ds and physicians to employ discretion based on the situation. This implementation strategy of the BLS TOR rule resulted in a high level of comfort for the participating EMT-Ds and on-line physicians. EMS systems may want to consider implementing this simple strategy to enhance the BLS TOR rule application in their system.

Funding

This study was funded by a grant from the Canadian Institutes of Health Research (CIHR). This funding source did not have any involvement in any part of this study.

Conflicts of interest statement

None of the authors have any conflicts of interest to disclose.

Acknowledgements

The authors would like to thank all the staff and physicians at the participating base hospitals, EMTs, and steering committee members for their valuable support during the study.

References

1. Bonnin MJ, Pepe PE, Kimball KT, Clark Jr PS. Distinct criteria for termination of resuscitation in the out-of-hospital setting. JAMA 1993;270:1457–62.
2. Gray WA, Capone RJ, Most AS. Unsuccessful emergency medical resuscitation – are continued efforts in the emergency department justified. N Engl J Med 1991;325:1393–8.
3. Suchard JR, Fenton FR, Powers RD. Medicare expenditures on unsuccessful out-of-hospital resuscitations. J Emerg Med 1999;17:801–5.
4. Kellermann AL, Staves DR, Hackman BB. In-hospital resuscitation following unsuccessful prehospital advanced cardiac life support: 'heroic efforts' or an exercise in futility. Ann Emerg Med 1988;17:589–94.
5. Ray AF, Kupas DF. Comparison of crashes involving ambulances with those of similar-sized vehicles. Prehosp Emerg Care 2005;9:412–5.
6. Auerbach PS, Morris Jr JA, Phillips Jr JB, Redlinger SR, Vaughn WK. An analysis of ambulance accidents in Tennessee. JAMA 1987;258:1487–90.
7. Clawson JJ, Martin RL, Cady GA, Maio RF. The wake-effect – emergency vehicle-related collisions. Prehospital Disaster Med 1997;12:274–7.
8. Custalow CB, Gravitz CS. Emergency medical vehicle collisions and potential for preventive intervention. Prehosp Emerg Care 2004;8:175–84.
9. Kahn CA, Pirrallo RG, Kuhn EM. Characteristics of fatal ambulance crashes in the United States: an 11-year retrospective analysis. Prehosp Emerg Care 2001;5:261–9.
10. Saunders CE, Heye CJ. Ambulance collisions in an urban environment. Prehospital Disaster Med 1994;9:118–24.
11. National Association of EMS. Physicians Termination of resuscitation in non-traumatic cardiopulmonary arrest. Prehosp Emerg Care 2011;15:542.
12. Eckstein M, Stratton SJ, Chan LS. Termination of resuscitative efforts for out-of-hospital cardiac arrests. Acad Emerg Med 2005;12:65–70.
13. Verbeek PR, Vermeulen MJ, Ali FH, Messenger DW, Summers J, Morrison LJ. Derivation of a termination-of-resuscitation guideline for emergency medical technicians using automated external defibrillators. Acad Emerg Med 2002;9:671–8.
14. Morrison LJ, Visentin LM, Kiss A, et al. Validation of a rule for termination of resuscitation in out-of-hospital cardiac arrest. N Engl J Med 2006;355:478–87.
15. Ong ME, Jaffey J, Stiell I, Nesbitt L. Comparison of termination-of-resuscitation guidelines for basic life support: defibrillator providers in out-of-hospital cardiac arrest. Ann Emerg Med 2006;47:337–43.
16. Sasson C, Hegg AJ, Macy M, Park A, Kellermann A, McNally B. Prehospital termination of resuscitation in cases of refractory out-of-hospital cardiac arrest. JAMA 2008;300:1432–8.
17. Richman PB, Vadeboncoeur TF, Chikani V, Clark L, Bobrow BJ. Independent evaluation of an out-of-hospital termination of resuscitation (TOR) clinical decision rule. Acad Emerg Med 2008;15:517–21.
18. Ruygrok ML, Byyny RL, Haukoos JS. Validation of 3 termination of resuscitation criteria for good neurologic survival after out-of-hospital cardiac arrest. Ann Emerg Med 2009;54:239–47.
19. Kajino K, Kitamura T, Iwami T, et al. Current termination of resuscitation (TOR) guidelines predict neurologically favorable outcome in Japan. Resuscitation 2013;84:54–9.
20. Morrison LJ, Kierzek G, Diekema DS, et al. Part 3: ethics: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2010;122:S665–75.
21. Sasson C, Forman J, Krass D, Macy M, Kellermann AL, McNally BF. A qualitative study to identify barriers to local implementation of prehospital termination of resuscitation protocols. Circ Cardiovasc Qual Outcomes 2009;2:361–8.
22. Focus on Geography Series, 2011 Census – Province of Ontario. Statistics Canada Catalogue no. 98-310-XWE2011004. Statistics Canada, 2011. http://www12.statcan.gc.ca/census-recensement/2011/as-sa/fogs-spg/Facts-pr-eng.cfm?Lang=Eng&TAB=1&GK=PR&GC=35 (accessed 03.11.12).
23. Jacobs I, Nadkarni V, Bahr J, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries: a statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Councils of Southern Africa). Circulation 2004;110:3385–97.
24. American Heart Association. Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2005;112(Suppl.):IV1–203.
25. Berg RA, Hemphill R, Abella BS, et al. Part 5: adult basic life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2010;122(Suppl. 3):S685–705 [Epub 22.10.10].
26. ECC Committee, Subcommittees and Task Forces of the American Heart Association. 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2005;112:IV1–203.
27. Morrison LJ, Verbeek PR, Zhan C, Kiss A, Allan KS. Validation of a universal prehospital termination of resuscitation clinical prediction rule for advanced and basic life support providers. Resuscitation 2009;80:324–8.
28. Safar P, Bircher NG. Cardiopulmonary cerebral resuscitation: basic and advanced cardiac and trauma life support: an introduction to resuscitation medicine. 3rd ed. Philadelphia: W.B. Saunders; 1988.
29. A randomized clinical trial of calcium entry blocker administration to comatose survivors of cardiac arrest. Design, methods, and patient characteristics. The Brain Resuscitation Clinical Trial II Study Group. Control Clin Trials 1991;12:525–45.
30. Morrison LJ, Cheung MC, Redelmeier DA. Evaluating paramedic comfort with field pronouncement: development and validation of an outcome measure. Acad Emerg Med 2003;10:633–7.
31. Delbridge TR, Fosnocht DE, Garrison HG, Auble TE. Field termination of unsuccessful out-of-hospital cardiac arrest resuscitation: acceptance by family members. Ann Emerg Med 1996;27:649–54.
32. Edwardsen EA, Chiumento S, Davis E. Family perspective of medical care and grief support after field termination by emergency medical services personnel: a preliminary report. Prehosp Emerg Care 2002;6:440–4.
33. Schmidt TA, Harrahill MA. Family response to out-of-hospital death. Acad Emerg Med 1995;2:513–8.
34. Ponce A, Swor R, Quest TE, Macy M, Meurer W, Sasson C. Death notification training for prehospital providers: a pilot study. Prehosp Emerg Care 2010;14:537–42.
35. Morrison LJ, Verbeek PR, Vermeulen MJ, et al. Derivation and evaluation of a termination of resuscitation clinical prediction rule for advanced life support providers. Resuscitation 2007;74:266–75.
36. Feder S, Matheny RL, Loveless Jr RS, Rea TD. Withholding resuscitation: a new approach to prehospital end-of-life decisions. Ann Intern Med 2006;144:634–40.
37. Hall 2nd WL, Myers JH, Pepe PE, Larkin GL, Sirbaugh PE, Persse DE. The perspective of paramedics about on-scene termination of resuscitation efforts for pediatric patients. Resuscitation 2004;60:175–87.
38. Berg RA, Hemphill R, Abella BS, et al. Part 5: adult basic life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2010;122:S685–705.