EM ADVANCES

The "delay effect" of donning a gown during cardiopulmonary resuscitation in a simulation model

Leah Watson, MD;[*] William Sault, BA, ACP;[†] Randy Gwyn, RN, ICP;[†] P. Richard Verbeek, MD[‡]

ABSTRACT

Objective: We sought to determine whether the use of currently issued gowns delays initiation of chest compressions and ventilations during cardiopulmonary resuscitation and whether simple gown modifications can reduce this delay.

Methods: Firefighter defibrillation instructors were allocated into pairs and videotaped while performing standardized cardiac arrest scenarios. Three scenarios were compared: "no gown," "standard gown" and "modified gown." Key time intervals were extracted from videotaped data.

Results: Ninety-five scenarios were analyzed. Mean time interval to chest compression was 39 seconds (95% confidence interval [CI] 34–43) for "no gown" scenarios, 71 seconds (95% CI 66–77) for "standard gown" scenarios and 59 seconds (95% CI 54–63) for "modified gown" scenarios ($p < 0.001$). Time to first ventilation was 146 seconds (95% CI 134–158), 238 seconds (95% CI 224–253) and 210 seconds (95% CI 198–223) in the 3 groups, respectively ($p < 0.001$). Post hoc testing showed that the time differences between all groups were statistically significant.

Conclusion: Standard gowns protect front-line care providers but cause significant delays to chest compressions and ventilations, potentially increasing patient morbidity and mortality. Minor gown modifications, including pre-tied neck straps and longer waist ties that tie in front, allow for easier use and shorter delays to time-critical interventions. Future research is required to reduce care delays while maintaining adequate protection of emergency medical service providers from infectious disease.

Keywords: cardiopulmonary resuscitation, personal protective equipment, gown, prehospital, delay

RÉSUMÉ

Objectif : Nous avons cherché à déterminer si l'utilisation des blouses de protection couramment distribuées retarde le début des compressions thoraciques et des ventilations lors de la réanimation cardio-pulmonaire et si de simples modifications aux blouses pourraient réduire ce retard.

Méthodes : Les pompiers instructeurs en défibrillation ont été mis en paire et ont été enregistrés sur bande magnétoscopique pendant qu'ils réalisaient des scénarios normalisés d'arrêt cardiaque. Nous avons comparé les trois scénarios suivants : « sans blouse », « modèle actuel de blouse » et « modèle modifié ». Les intervalles de temps clés ont été extraits des données de la bande vidéo.

From the *Emergency Medicine Residency Program, University of Toronto, Toronto, Ont., the †Toronto Fire Service, Toronto, Ont., and the ‡Division of Emergency Medicine, Sunnybrook Health Sciences Centre, Sunnybrook–Osler Centre for Prehospital Care, University of Toronto, Toronto, Ont. This paper was presented at the National Association of EMS Physicians (NAEMSP) Annual Meeting in Tucson, Ariz., January 2006.

Submitted May 9, 2007; Revised Oct. 17, 2007; Accepted Oct. 21, 2007

This article has been peer reviewed.

CJEM 2008;10(4):333-8

Résultats : Des 95 scénarios analysés, les intervalles de temps moyen avant les compressions thoraciques étaient de 39 secondes (intervalle de confiance [IC] à 95 %, 34 à 43) pour les scénarios « sans blouse », de 71 secondes (IC à 95 %, 66 à 77) pour les scénarios avec le « modèle actuel de blouse » et de 59 secondes (IC à 95 %, 54 à 63) pour les scénarios avec le « modèle modifié » ($p < 0,001$). Le temps écoulé avant la première ventilation était respectivement de 146 secondes (IC à 95 %, 134 à 158), de 238 secondes (IC à 95 %, 224 à 253) et de 210 secondes (IC à 95 %, 198 à 223) pour les trois groupes ($p < 0,001$). Les épreuves post hoc ont montré que les différences de temps entre les groupes étaient statistiquement significatives.
Conclusion : Les modèles actuels de blouses protègent les fournisseurs de soins de première ligne, mais retardent de façon significative le début des compressions thoraciques et des ventilations, ce qui risque d'augmenter la morbidité et la mortalité des patients. Si l'on apportait des modifications mineures à la blouse, telles que la pose de cordons pré-attachés à l'encolure et de cordons à la taille qui seraient plus longs et se noueraient à l'avant, cela faciliterait son utilisation et réduirait le laps de temps avant le début d'interventions pour lesquelles le temps est crucial. Il faut entreprendre d'autres recherches pour réduire le temps avant le début des soins tout en continuant de protéger adéquatement les fournisseurs de services médicaux d'urgence contre les maladies infectieuses.

Introduction

Since the severe acute respiratory syndrome (SARS) outbreak in 2003, significant changes have occurred in the way health care providers manage potentially infectious patients. Prehospital care providers are at particular risk of exposure to serious infectious diseases since they are the first response to undifferentiated patients in the community and may be exposed to an infectious outbreak even before the outbreak situation is recognized. Many recommendations focus on the use of personal protective equipment (PPE) to mitigate exposure to respiratory droplets during high-risk respiratory procedures in any patient regardless of symptoms.[1] Ongoing global concerns regarding the threat of pandemic flu further emphasize the need for PPE to be adopted as standard equipment for prehospital care providers, much the same way that body fluid precautions were instituted for the prevention of blood-borne diseases. If PPE is to become standard equipment for prehospital care providers, consideration must be given to the design and ease of use, with particular attention paid to the potential delays that donning PPE can impose on time-critical patient care interventions.

Our hypothesis was that donning a protective gown delays the initiation of resuscitation. The primary objective was to determine the degree of delay that donning a protective gown has on the time-critical patient care interventions of chest compressions and ventilations in a simulated cardiac arrest scenario. The secondary objective was to determine if the use of a modified gown could reduce the delay in resuscitation when compared with the use of a standard gown.

Methods

Setting and subjects

The Toronto Fire Services serve a population of 2.5 million citizens and respond to about 1500 out-of-hospital cardiac arrests per year. This prospective study of simulated cardiac arrests took place in a classroom at the Toronto Fire Academy. The study period was determined by the Toronto Fire Services instructor recertification schedule, and simulated cardiac arrest scenarios were performed using defibrillator mannequins (Laerdal Medical).

In addition to their training as firefighters, Fire Services instructors had backgrounds ranging from first aid instructor, advanced care and primary care paramedics, and registered nurses. All were required to recertify in a revised automated external defibrillator (AED) protocol (Fig. 1) that incorporated changes from the 2005 cardiopulmonary resuscitation (CPR) guidelines.[2] A brief information session about the proposed study was given to all AED instructors and only those interested in participating were recruited. Of the 61 instructors who were approached, 58 agreed to participate and all provided written consent before commencing the study. The Sunnybrook Health Sciences Centre Ethics Review Board approved the study.

Study procedures

Each fire station has 1 AED instructor assigned to each shift. Participating AED instructors were from different fire halls or different shifts, and were therefore unlikely to have instructed together previously. The AED instructors paired themselves to perform standardized cardiac arrest

https://doi.org/10.1017/S1481803500010332 Published online by Cambridge University Press

scenarios in a 2-rescuer model and were randomized to 1 of 3 groups: "no gown" (Fig. 2), "standard gown" (Fig. 3) or "modified gown" (Fig. 4). PPE for the "no gown" group included an N95 respirator, gloves and eye protection. PPE for the "standard gown" group included these items plus a standard issue gown (Universal Cover Gown, cat. no. 2200PG, Allegiance Private Brand Medical/Surgical Products), reflecting current recommendations for prehospital care providers in Ontario[3] in place since the 2003 SARS outbreak. The modified gown used in the study incorporated 2 simple modifications: pre-tied neck straps and lengthened waist ties that enabled tying at the front.

Simulated cardiac arrest scenarios were run as per the Toronto Fire Services AED protocol, which requires 2 rescuers. Rescuers were instructed to arrive "on scene" with all necessary equipment required for a medical call. Once the victim was determined to be in cardiac arrest, rescuers would don the required PPE. The only differences in PPE among the 3 groups were whether or not a protective gown was put on and the type of gown actually donned (standard or modified). The role of the first rescuer was to perform chest compressions while the second rescuer confirmed absent vital signs, assembled AED and ventilation equipment, and maintained a mask-to-victim seal during the resuscitation. The second rescuer also helped the first rescuer don PPE so the first rescuer could initiate resuscitative efforts as quickly as possible.

Outcomes

Scenarios were recorded by a volunteer videographer using a Sony video recorder. Predetermined outcome time intervals were extracted from the videotapes using a digital video recorder and measured to the nearest second based on the recording time displayed on the digital recorder. The measured intervals included length of time to don the modified and standard gowns, time from initial mannequin contact to initiation of chest compressions and time to begin ventilations using a bag valve mask device. As well as assessing potential resuscitation delays, we compared the time required to put on the modified versus the standard gown.

Time to don the standard gown was measured from the application of the first sleeve to securing the last of either the neck or waist ties. For the modified gown, we measured the time from placing the pre-tied neck ties over the rescuer's head or application of the first sleeve to securing the waist ties. Time to chest compressions was measured from the time of initial mannequin contact to the first chest compression administered by the first rescuer. Time to ventilations

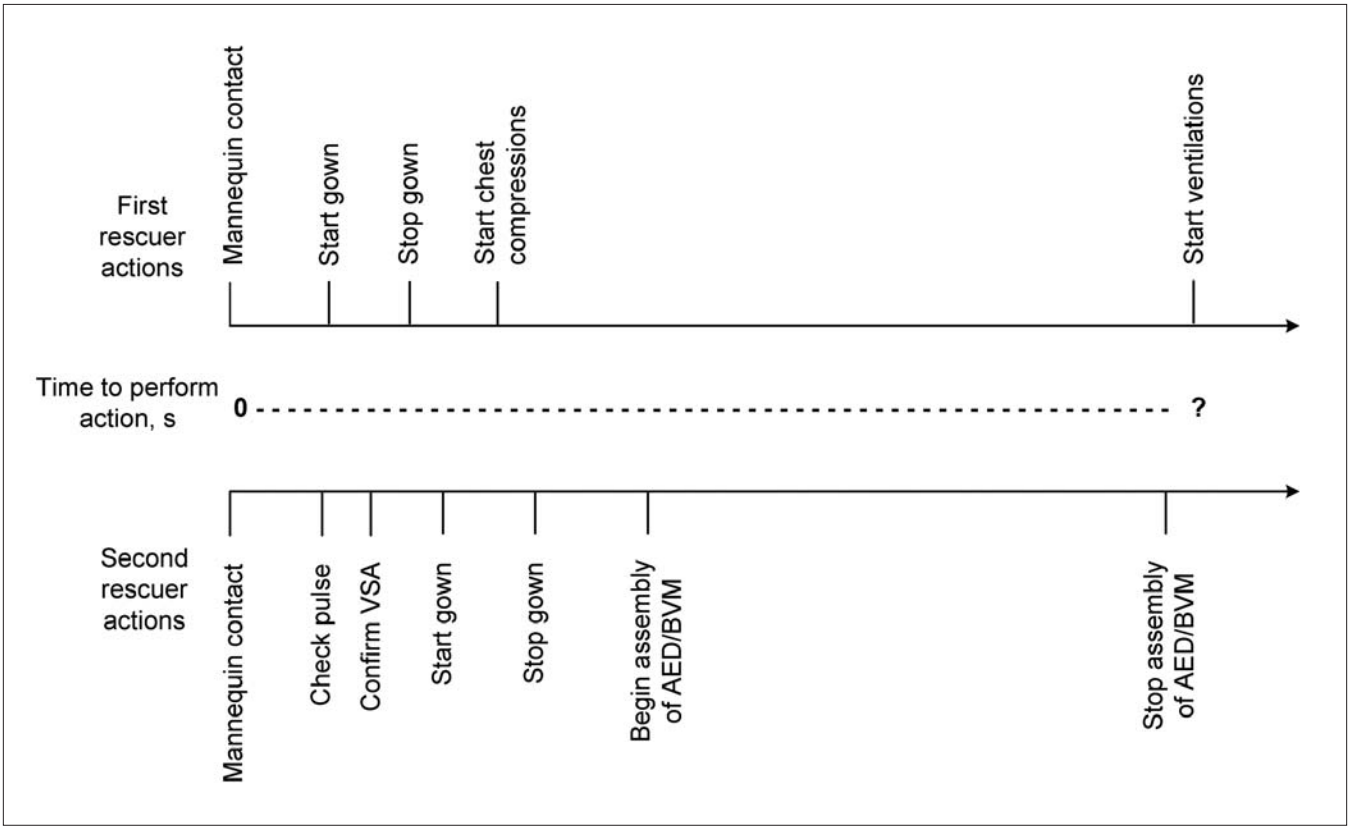

Fig. 1. Automated external defibrillator (AED) protocol. BVM = bag valve mask, VSA = vital signs absent.

https://doi.org/10.1017/S1481803500010332 Published online by Cambridge University Press

was measured from the initial mannequin contact to the first compression of the bag valve mask device by the first rescuer. The "no gown" group served as the control.

Data analysis

A Student *t* test was used to analyze the difference in the time taken for the first and second rescuers to put on the standard and modified gowns. Analysis of variance (ANOVA) was used to determine the interaction between the gown configurations and the time to initiation of chest compressions and ventilations. Significant differences between groups were further analyzed using the post-hoc Tukey *t* test. In all instances, $p < 0.05$ was considered statistically significant.

Results

Experience as an AED instructor ranged from 2 to 11 years. Of the 110 standardized cardiac arrest scenarios that were videotaped, 95 were analyzed, including 25 in the "no gown" group, 34 in the "standard gown" group and 36 in the "modified gown" group. Fewer "no gown" scenarios were included because of time limitations imposed by the duration of the training session. Overall, 15 scenarios were excluded because of protocol breaches or technical problems that precluded visualization of the participants while donning the PPE. Protocol breaches included 1 or both rescuers not donning the gown when the scenario called for it, putting the gown on improperly or equipment failure.

The mean time to put on the standard gown was 37 seconds (95% confidence interval [CI] 32–42) for the first rescuer and 40 seconds (95% CI 35–45) for the second rescuer. Modifications to the standard gown reduced the time to 22 seconds (95% CI 19–25) and 25 seconds (95% CI 21–29), respectively ($p < 0.001$ for both groups). Mean time to chest compressions was 39 seconds (95% CI 34–43) in the "no gown" group versus 71 seconds (95% CI 66–77) in the "standard gown" group, a difference of 32 seconds ($p < 0.01$). Time to chest compression fell to 59 seconds (95% CI 54–63) in the "modified gown" group, an absolute reduction of 12 seconds

Fig. 2. Personal protective equipment for the "no gown" group: gloves, N95 respirator and eyewear only.

Fig. 3. Personal protective equipment for the "standard gown" group. Neck ties that are secured behind the head (left). Waist ties that are secured behind the back (right).

Fig. 4. Personal protective equipment for the "modified gown" group. Pre-tied neck ties that can be slipped over the head (left). Lengthened waist ties that can be tied in front (right).

https://doi.org/10.1017/S1481803500010332 Published online by Cambridge University Press

($p < 0.01$). ANOVA for all 3 groups was $p < 0.001$ (Fig. 5).

Mean time to ventilations was 146 seconds (95% CI 134–158) in the "no gown" group, 238 seconds (95% CI 224–253) in the "standard gown" group and 210 seconds (95% CI 198–223) in the "modified gown" group (ANOVA, $p < 0.001$). Between-group comparisons were all significant (Fig. 5).

Discussion

Given the current global concern about infectious diseases, it is imperative that front-line health care workers use PPE when caring for undifferentiated patients in the prehospital setting. During the 2003 Toronto SARS outbreak, paramedics were among the first health care workers to contract SARS. The first SARS case encountered by emergency medical services (EMS) personnel presented as a cardiac arrest. Overall, 527 paramedics were quarantined during the outbreak, 68 developed SARS symptoms and 5 developed confirmed cases.[4] Following the SARS outbreak, new PPE guidelines were established for paramedics and firefighters.

The requirement for PPE in the prehospital setting can create a competing interest with regard to balancing the need for adequate responder protection versus timely intervention for critically ill patients, especially those in cardiac arrest. Rapid CPR and defibrillation reduce morbidity and mortality after prehospital cardiac arrest,[5–7] and changes to the 2005 CPR guidelines emphasize these concepts.[8] Yet delays caused by donning comprehensive PPE may compromise the time-critical interventions of CPR and airway management — the interventions most likely to require PPE to prevent respiratory droplet transmission. For every minute of downtime without CPR, survival has been estimated to decrease by 7%–10%, and our data show that the act of donning a protective gown leads to a 30-second delay in initiating CPR.[9] Our study also documented a delay to ventilation of 92 seconds, largely because the second rescuer must don PPE without assistance before assembling the airway equipment and AED.

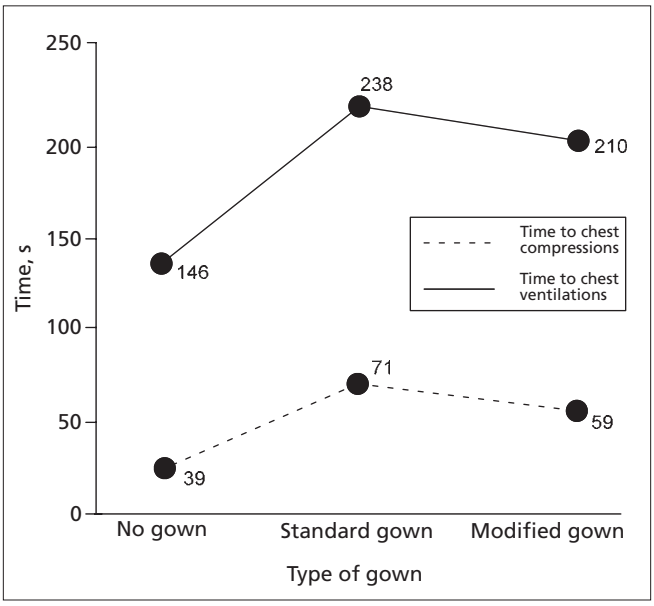

Fig. 5. Time to chest compressions and ventilations.

It is debatable whether protective gowns should be used in the prehospital environment given the delays they impose on patient care. Infection rates among health care providers during influenza outbreaks are as high as 59%.[10] Strict adherence to infection control practices such as handwashing and wearing PPE can reduce these to about 10%.[10] In the absence of vaccines for novel influenza strains that are likely to be the causative agents of a pandemic, infection rates in a naive population would be much higher and have a much greater impact on the 15–35-year-old population segment.[10] Respiratory viruses are transmitted by droplet, aerosol or contact, and numerous studies have shown that respiratory viruses can survive on inanimate surfaces for several days, depending on the organism.[11,12] Moreover, transmission rates for respiratory viruses are highly variable depending on the organism. Protective gowns minimize the potential for indirect transmission of the organism to the care provider via contact or droplet transmission from personal items such as clothing, pagers and other equipment. While medical equipment and surfaces within an ambulance are easily decontaminated between calls, uniforms are not. To date, there are no studies that demonstrate which combination of PPE is most effective in reducing transmission to care providers; however, the Centers for Disease Control and Prevention (CDC) recommend full PPE for health care providers when managing patients with respiratory illnesses.[13]

Ideally, a protective gown should be quick to put on and easy to use. It should also be comfortable and not restrict upper body movement, which is important when rescuers are performing physical assessments, assembling equipment or performing rescue tasks. The delays demonstrated in this study show that current gowns are not well suited to the prehospital setting. The one-size-fits-all design is suboptimal for care providers who work in widely variable environmental situations. Gowns may be too large when worn over light clothing or too small to fit over bulky outerwear. They can also be uncomfortably warm to work in because they retain body heat. As well, most gowns are constructed from easily torn paper-based materials.

https://doi.org/10.1017/S1481803500010332 Published online by Cambridge University Press

Limitations

Our study had several limitations. First, our participants could not be blinded to the type of gown they used during the test scenarios. All of our participants were trained AED instructors who had extensive practice with the AED protocol through the regular teaching sessions they perform outside of the recertification process. These instructors were more likely to be efficient with the required tasks, which could falsely reduce the actual time required for the average rescuer to complete the scenario. It is also difficult to determine the impact on time to complete tasks such as donning a gown in a clinical setting. While the 30-second delay reported here is statistically significant, our study was not designed to determine the clinical significance of this time delay on patient outcome. Other time-saving measures, such as having prehospital care providers don PPE before arriving at the scene, may be helpful, but we did not study these.

Conclusion

Standard gowns protect front-line care providers but impose significant delays to chest compressions and ventilations, potentially increasing patient morbidity and mortality. Minor gown modifications, including pre-tied neck straps and longer waist ties that tie in front allow for easier use and shorter delays to time-critical interventions. Future research is required to reduce these time delays while maintaining adequate protection of EMS providers from infectious disease.

Competing interests: None declared.

References

1. Ontario Ministry of Health and Long Term Care. SARS Provincial Operations Centre. Directives to all Ontario prehospital care providers and ambulance communications services. 2003. Available: www.health.gov.on.ca/english/providers/program/pubhealth/sars/docs/new_normal/dir_prehospital_care.pdf (accessed 2008 May 27).

2. American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care, adult basic life support [supplement]. Circulation 2005;112:IV-1-203.

3. Ontario Ministry of Health and Long-Term Care. Provincial Infectious Diseases Advisory Committee (PIDAC). Preventing febrile respiratory illnesses: protecting patients and staff. 2005. Available: www.health.gov.on.ca/english/providers/program/infectious/diseases/best_prac/bp_fri_080406.pdf (accessed 2008 May 27).

4. Verbeek PR, McClelland IW, Silverman AC, et al. Loss of paramedic availability in an urban emergency medical services system during a severe acute respiratory syndrome outbreak. Acad Emerg Med 2004;11:973-8.

5. Stiell IG, Wells G, Field B, et al. Improved out-of-hospital cardiac arrest survival through the inexpensive optimization of an existing defibrillation program. JAMA 1999;281:1175-81.

6. Wik L, Hansen T, Fylling F, et al. Delaying defibrillation to give basic cardiopulmonary resuscitation to patients with out-of-hospital ventricular fibrillation. JAMA 2003;289:1389-95.

7. Cobb LA, Fahrenbruch CE, Walsh TR, et al. Influence of cardiopulmonary resuscitation prior to defibrillation in patients with out-of-hospital ventricular fibrillation. JAMA 1999;281:1182-8.

8. American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care, part 7.2: adult basic life support [supplement]. Circulation 2005;112:IV-58-66.

9. American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care, part 4: adult basic life support [supplement]. Circulation 2005;112:IV-18-34.

10. Cinti S. Pandemic influenza: Are we ready? Disaster Manag Response 2005;3:61-7.

11. Kramer A, Schwebke I, Kampf G. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infect Dis 2006;6:130.

12. Booth TF, Kournikakis B, Badien N, et al. Detection of airborne severe acute respiratory syndrome (SARS) coronavirus and environmental contamination in SARS outbreak units. J Infect Dis 2005;191:1472-7.

13. Center for Disease Control and Prevention. Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings 2007. Available: www.cdc.gov/ncidod/dhqp/pdf/guidelines/Isolation2007.pdf (accessed 2008 May 27).

Correspondence to: Dr. P. Richard Verbeek, Sunnybrook–Osler Centre for Prehospital Care, 10 Carlson Ct., Suite 640, Etobicoke ON M9W 7K6; rverbeek@socpc.ca