The Training on Medical Corpsmen for Tracheal Intubation and Tracheotomy Using SimMan Simulation and Living Goats

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ABSTRACT

Objective: To improve skills of tracheal intubation and tracheotomy on medical corpsmen using SimMan simulation and experiments on living goats.

Methods: A total of 90 medical corpsmen from one certain group army were trained for the skills of tracheal intubation and tracheotomy using medical simulator and experiments on living goats. Both theoretical tests and practical examinations were performed on all medics to evaluate the efficacy of such training program.

Results: Only 25.6% and 15.6% of all medics have previously received trainings related to tracheal intubation and tracheotomy, respectively. Before training, these medics got an average score of 35.3 marks in the theoretical test, and the successful rate of tracheal intubation was only 18.9%. Their performances in both tests, however, increased to 85.2% and 81.1% respectively after training. All these differences were of statistical significance compared to those before training ($p<0.01$). In a further practical test related to tracheotomy, 14 randomly selected medical corpsmen reached a 71.4% successful rate after training compared to only 14.3% before training ($p<0.01$).

Conclusion: Training modules combined both simulator and goat experiments are effective in improving tracheal intubation techniques on medics especially those from primary units.

Keywords: Goat experiments, medical corpsmen, tracheal intubation and tracheotomy

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INTRODUCTION

Respiratory tract injury has been reported to be the third leading cause for battlefield mortalities in both Afghanistan and Iraq wars (1). Advanced ventilation techniques including tracheal intubation and tracheotomy is one the three critical skills in battlefield emergency treatment(2), in which medical corpsmen play an important role in the primary care of wounded personnel in the frontier(3). US army requests each solider to gain basic medical skills including ventilation, hemostasis, bandaging, fixation, identification and handling with traumatic shock via a 15-day training followed by rigorous examination before the deployment(4). According to statistics, US army medics had a successful rate of cricothyroid laryngotomy as high as 67%(5). Chinese people's liberation army (PLA), however, has not conducted any special training of tracheal intubation or tracheotomy on medics from primary units. As it is the inherent responsibility for military hospitals to provide medical support(6), we perform the following works in an attempt to develop a new training module for tracheal intubation and tracheotomy techniques on PLA medical corpsmen.

MATERIALS AND METHODS

Research objects

A total of 90 military corpsmen from one certain group army were recruited in this study. They were all males, aging between 19 and 33 years, with an average age at 21.3±2.2 years.

Questionnaire survey and Examination

survey was performed on all subjects before the training, using a self-designed questionnaire

including general information and previous training experiences related to tracheal intubation and tracheotomy. The theoretical test (full mark=100) examined both basic knowledge of tracheal intubation and tracheotomy. A further practical test of tracheal intubation was performed on simulators both before and after the training. 14 randomly selected medics were also recruited into a second practical test on living goats for tracheotomy, due to the limited number of available healthy goats.

Training programs

The training included a multi-media lecture related to tracheal intubation and tracheotomy techniques, in addition to demonstrations of tracheal intubation and tracheotomy on SimMan simulator and living goats.

Animal models

30 healthy adult goats (both males and females, average age=12 month, average body weight=20 kg) were firstly anesthetized by intramuscular injection of ketamine (15 mg/kg) followed by 0.25 mg atropine before the surgery. After anesthesia, a percutaneous tracheostomy was performed using procedures: 1) Goats were laid flat with complete exposure of the cervix and were undergone routine sterilization and draping. 2) After confirming the puncture site and trachea fixation, a central puncture was made between 2nd and 3rd (or 3rd and 4th) tracheal cartilage rings. The puncture needle (with sleeve) was fixed after an obvious breakthrough sense, and was extracted with large amounts of air. The guide wire was then inserted into the sleeve, which was then removed to fix the guide wire. 3) A

horizontal incision of approximately 10 mm length was performed around the primary puncture site, in which the percutaneous rotating dilator was inserted along the guide wire and was rotated in a clockwise direction to dilate soft tissues anterior to the trachea in addition to the anterior tracheal wall. 4) The dilator was extracted after a completed dilation and the guide along with tracheal sleeve was installed with the help of guide wire, which was then removed. 5) Adequate sputum suction was applied to clean the airway, with the airbag inflation and the fixation of tracheal sleeve.

Statistics

SPSS 13.0 software package (IBM Corp., US) was used to process all collected data. The chi-square test was used to compare the ratios between groups. Means among two groups and multiple groups were compared using student t-test and analysis of variance (ANOVA), respectively.

RESULTS

Previous related experiences in medics

In the survey performed on all 90 medical corpsmen before training, only 23 (25.6%) and 14 (15.6%) people have previously received trainings related to tracheal intubation and tracheotomy, respectively. Their training routes were further categorized in Table 1. All medics received related trainings in college or from courses outside their servicing units: none of them has obtained related techniques within their primary servicing units. This clearly indicates the weakness of PLA medical support system in the primary units, which

have urgent needs for the improvement of first-aid skills and supports from higher level military hospitals.

Theoretical and practical scores of medics

Theoretical test scores about tracheal intubation and tracheotomy along with successful rates of tracheal intubation and tracheotomy both before and after the training were tabulated in Table 2. Our training modules significantly improved medics' theoretical scores from 35.3 marks to 85.2 marks ($p<0.01$), suggesting a critical role of such training programs in improving medical corpsmen's basic knowledge. When testing their skills of tracheal intubation, more than 80% of total people successfully completed the whole procedure, in a sharp contrast to only 18.9% before such training. In a further practical test about tracheotomy, only 14 randomly selected medics were included due to the limited number of animals. A consistent result was still obtained, as 71.4% of medics had completed this surgery successfully, which was significantly higher than 14.3% before the training. All these results collectively support the efficacy of animal training combined with simulations.

Effects of medics' backgrounds on test scores

Both theoretical test scores and successful rates of tracheal intubation were compared between medical corpsmen with different military service times and education levels, as shown in Table 3. In each category, either theoretical or practical scores improved significantly after the training, suggesting that such training program is effective for all medics with various backgrounds. When one checked the military service time, it was

interesting that medics with different servicing times had similar performance in theoretical tests but not practical tests. This result was consistent with our previous survey, which showed that only a few medics had received continuous training after their graduation and recruitment. However, a higher servicing time did help medics to obtain more experiences related to tracheal intubation techniques. Furthermore, the education level had positive relationships with medics' test scores, as shown by better performance both before and after training in medical corpsmen who have received college education. These results raise the importance of recruiting more medics with higher education levels.

DISCUSSION

Military hospitals should focus on the improvement of the army's medical support capacity as a whole besides their daily duties such as medical and healthcare service for military officers and soldiers. In fact, one basic requirement for a modern army is the advanced skills of primary treatment against battlefield wounds. Experiences from previous warfare all revealed that medical corpsmen were the primary safeguard of wounded personnel in the frontier. US army has always focused on the training of medics from primary units, as their medics must receive systematic trainings about emergency treatment by multimedia lectures, simulators and animal experiments(7, 8) and are required to pass rigorous examination before being deployed to the battlefield(9). The improvement of medical skills in medical corpsmen can only be achieved via systematic and continuous training. US army has a long history of using cadavers and plastic mannequins in the training of cricothyroidotomy techniques(10). These

methods, however, own some inherent weakness such as the lack of physiological simulation efficiency in cadavers and incomprehensive anatomical structures of mannequins. Thus US army has recently developed new modules of daily training such as the so called CriciSim simulator (11) or a hepatic-enabled computer-based simulator(10). These simulation-based training programs obtained satisfactory effects regarding the improvement of surgical skills. For example, the inclusion of CriciSim simulator in a six-month advanced skills training class on 65 medics in Iraq dramatically improved students' self-assessed comfort levels ($p<0.001$) (11). The application of simulator, however, may not be feasible for all primary medical units in PLA nowadays due to its relatively expensive cost and maintenance difficulty. Therefore we investigated the possibility of recruiting living goats, which have similar size as humans and are easier to keep, in the training program along with simulators and obtained satisfactory results.

This is the first study that PLA medics received professional training related to advanced ventilation techniques. Before training, only around 20% of all 90 medical corpsmen had received previous training related to tracheal intubation or tracheotomy. As a result they only got an average score of 35.3 marks in the theoretical test, in addition to the successful rate of tracheal intubation and tracheotomy at only 18.9% and 14.3%, respectively (Table 2), suggesting an urgent need for advanced ventilation skills in all medics from primary units. A further analysis of the route by which medics have received such training revealed that none of them have been trained within their primary servicing units (Table 1), clearly suggesting the importance of improving medical skills in PLA primary units(12). After training, theoretical test score were elevated to 85.2%, in consistent with the successful

rate of tracheal intubation and tracheotomy at 81.1% and 71.4%, respectively (Table 2). All these performances had significant increments compared to scores before the training ($p<0.01$), advising the importance of systematic training about advanced ventilation skills. Furthermore, education level had significant effects on test results of medics both before and after training (Table 3), suggesting the importance of recruiting medical corpsmen with higher education levels. In addition, the military service time also showed a positive relationship with the practical score before training (Table 3), indicating the need for keeping a stable group of medical corpsmen via extending their servicing time.

As the primary defense for national territories, Chinese PLA should be well prepared for the possible high-tech local warfare, in which large amounts of wounds could occur within a short time(13). Medical corpsmen being familiar with advanced ventilation techniques can help in saving more soldiers' lives from critical injuries. Therefore, it is of realistic significance for all PLA medics to improve their skills of advanced ventilation. This study provides a useful and effective method in training medical corpsmen for tracheal intubation and tracheotomy skills using both simulators and living goats, and is worth for widely promoted in primary units, although the detailed training program can be further elaborated.

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Conflict and interest The authors declare that they have no conflict of interests.

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Table 1: Medics training routes

	Tracheal intubation		Tracheotomy	
	N	Percentage	N	Percentage
Training outside	16	69.6	10	71.4
In college	7	30.4	4	28.6
In primary units	0	0	0	0
Total	23	100	14	100

Table 2: Theoretical test scores (mean±SEM) and successful rates (%) of medics

	Theoretical score		Tracheal intubation		Tracheotomy	
	N	Score	N	Successful rate	N	Successful rate
Before (2/14)	90	35.3±5.1	90	18.9(17/90)	14	14.3
After (10/14)[a]	90	85.2±12.4[a]	90	81.1(73/90)[a]	14	71.4

[a], $p<0.01$ comparing to those before training

Table 3: General information and test scores of medics

		Before training		After training	
	N	Theoretical score	Successful rate	Theoretical score	Successful rate
Military service time					
≤ 2 years	33	33.2±7.3	6.1(2/33)	82.3±14.3	75.8(25/33)
>2 years	57	36.5±6.4[a]	19.3(11/57)	86.9±13.5	84.2(48/57)
Education level					
Below college	79	33.7±5.9	11.4(9/79)	83.1±13.2	78.5(62/79)
College & above	11	46.8±8.2[b]	36.4(4/11)[c]	100.3±15.7[b]	100.0(11/11)

Note: [a], $p<0.05$ comparing to those with <2 years' service time; [b], $p<0.01$, [c], $p<0.05$ comparing to those below college.