Instructor-based Real-time Multimedia Medical Simulation to Update Concepts of Difficult Airway Management for Experienced Airway Practitioners

Pin-Tarng Chen¹,², Hung-Wei Cheng¹,², Chia-Rong Yen¹,², I-Wen Yin³, Ying-Che Huang¹,², Chao-Chun Wang¹,³, Mei-Yung Tsou¹,², Wen-Kuei Chang¹,², Huey-Wen Yen¹,², Cheng-Deng Kuo⁴,⁵, Kwok-Hon Chan¹,²*

¹Department of Anesthesiology, and ⁴Biophysics Laboratory, Department of Research and Education, Taipei Veterans General Hospital, ²National Yang-Ming University School of Medicine, and ⁵Institute of Emergency and Critical Care Medicine, National Yang-Ming University School of Medicine, Taipei, and ³Department of Anesthesiology, Lotung Poh-Ai Hospital, Yilan, Taiwan, R.O.C.

Background: We integrated lecture, real-time multimedia display and medical simulation into a new renewal airway management training protocol for experienced nurse anesthetists.

Methods: Trainees of the Taiwan Association of Nurse Anesthetists from northern Taiwan and junior residents from our department were enrolled into the training program. A 4-hour renewal curriculum in the management of airway emergencies was developed, which consisted of a 2-hour general lecture (including 4 divided sections) and a 2-hour instructor-based real-time multimedia medical simulation of 4 specific techniques. After detailed explanation of each specific instrument at the beginning of each simulation, the instructors demonstrated accurate and successful management of 4 airway crises from clinical experience by using a standardized human patient simulator situated on the stage of the conference room. Meanwhile, real-time display of instructors’ performance, responsive physical parameters and images from specific instruments were conducted by video camera and video processor, and projected on a 3-frame screen. Brief summary and feedback were performed after each simulation. Trainees completed a questionnaire 6 months after they participated in the training program.

Results: Two hundred and forty-two nurse anesthetists and 13 young residents were trained with this protocol. The questionnaire revealed that the renewal training program was useful. Participants updated their knowledge of difficult airway management, gained more confidence, improved performance, and provided effective assistance in handling airway crises.

Conclusion: Renewing practice guidelines and teaching airway management skills, especially for difficult airway crises and protection of personnel, continues to be an important issue. Instructor-based real-time multimedia simulation is a fast, useful and systematic renewal educational method for many participants with extensive experience of airway management to update their knowledge about difficult airway management, and acquire improved decision-making and communication capabilities, skills of specific airway management. [J Chin Med Assoc 2008;71(4):174–179]

Key Words: airway, crisis resource management, multimedia, simulation

*Correspondence to: Dr Kwok-Hon Chan, Department of Anesthesiology, Taipei Veterans General Hospital, 201, Section 2, Shih-Pai Road, Taipei 112, Taiwan, R.O.C.
E-mail: khchan@vghtpe.gov.tw • Received: August 14, 2007 • Accepted: January 21, 2008
and personnel safety, inefficiency and long training duration. The complexity of clinical conditions may make training strategies more difficult to develop. Importantly, individual resident or nurse anesthetists may not experience scenarios that are rare or unusual in manner and with a frequency that is sufficient to prepare them for similar circumstances in the future.

Successful management of difficult airway and airway crisis relies heavily on teamwork, conversance with treatment algorithms, and facility in and proficiency with available alternative instruments. The Difficult Airway Algorithm was developed by the American Society of Anesthesiologists (ASA) in 1993. As mentioned above, many alternative methods have been invented for management of airway crisis, including evolved videolaryngoscope and laryngeal mask airway (LMA), etc. The Difficult Airway Algorithm was updated and published in 2003. However, after brief investigation, we found that the new guidelines were not well known and popularized, especially among nurse anesthetists. Furthermore, most of them had no notion of how to assist the doctor during a specific procedure, such as fiberoptic intubation (FOI) through LMA, and there was no renewal airway management protocol for nurse anesthetists.

Specific training in managing clinical crises and optimizing teamwork in acute situations was begun just over a decade ago within anesthesiology by Gaba and colleagues and was termed Anesthesia Crisis Resource Management (ACRM). ACRM is a conceptual framework for responding to crisis that was first developed by the airline industry in the early 1970s. The ACRM curriculum, which was originally designed for anesthesiologists, is now applied to many areas of medicine and health care where acute care medical skills and teamwork are essential for effective team performance.

The purposes of full-scale simulation have been reported as being to assess medical student performance in anesthesia-related scenarios, to detect gaps in medical student knowledge in anesthesia, to observe and quantify technical performance of novice anesthetists, and to evaluate physicians with lapsed medical skills. Most importantly, the standardized patient simulator has been operated to simulate such critical illnesses as cardiac events and airway crisis under the principles of ACRM for junior residents and advanced cardiovascular life support training in many hospitals.

This was the first time that we integrated the lectures, screen and simulation-based scenarios for advanced airway practitioners. We report the program to popularize the Difficult Airway Algorithm and new alternative methods by using this new multimedia approach for experienced nurse anesthetists.

Methods

Description of the pilot program
The participants were certificated nurse anesthetists in northern Taiwan who were recruited from the Taiwan Association of Nurse Anesthetists (TANA) for this renewal of airway management by using e-mail. The trainees from TANA and junior residents from our department were enrolled into the training program. All of the trainees from TANA were working at different hospitals at the time of this program. A 4-hour curriculum in the management of airway emergencies was developed, which consisted of a 2-hour general lecture and then a 2-hour multimedia medical simulation. The intention of this program was to integrate medical knowledge, practice and decision-making into realistic simulation. All sections were conducted in the large conference room of the hospital and instructed by board-certificated anesthesiologists, nurse anesthetists and specialists in medical simulation. The handouts for the lecture and medical simulation were sent to each participant by post 2 weeks before the training program.

Lecture
The 4 sections of the 2-hour lecture were: (1) difficult airway management and patient safety; (2) prediction of difficult intubation, practice guidelines and decision-making in difficult airway management; (3) the role of nurse anesthetists in difficult airway management; and (4) advanced airway management.

Instructor-based real-time multimedia medical simulation
There were 4 divided sections focusing on 4 specific devices of difficult airway management according to the resources available in northern Taiwan. These 4 sections included nasal FOI, FOI via LMA, new videolaryngoscope (GlideScope®, Saturn Biomedical Systems Inc., Burnaby, British Columbia, Canada), and cricothyrotomy (Table 1). After detailed explanation of each specific instrument at the beginning of each section, 1 standardized human patient simulator (SimMan®, Laerdal, Stavanger, Norway) situated on the stage of the conference room was operated to simulate 4 different airway crises from clinical experience (Table 1). Importantly, the airway of the “patient” could be simulated as being in various difficult airway conditions. An operator, in an adjacent control room,
operated the computer to change the vital signs and physiologic responses to simulate an evolving clinical situation.

The lecturer described the scenarios designed to focus on specific aspects of team performance and airway management algorithm at the beginning of each simulation session. The instructors from the anesthesiology department demonstrated the correct techniques and the lecturer commented on the demonstrations during each simulation session. The multimedia simulation displayed on a 3-frame screen in a real-time fashion consisted of: (1) close-up of instructors’ performance and accurate procedures from video camera, or images from fiberoptic bronchoscope (FOB) or videolaryngoscope; (2) frames of scenarios and steps to perform the proper procedures; (3) responsive physical parameters (Figure 1). For example, during the second scenario, the FOB was prepared to perform intubation through LMA. The video adapter was connected to the FOB on the small camera at its tip. Through video processor, the pictures during the whole procedure of FOI through LMA were displayed on the center of the screen. During the last scenario, a real-time display of a close-up of instructors’ performance was achieved by video camera. At the conclusion of each scenario, the lecturer provided a brief summary and feedback on the simulation.

**Evaluation**

A written course feedback survey in the form of a questionnaire was administered 6 months after the trainees had participated in the program. Participants were asked to assess: (1) the overall quality of the program; (2) whether or not the program goals were met; (3) the quality of the lectures; (4) the quality of multimedia simulations; (5) the realism of the scenarios; (6) the quality of the simulation environment and equipment;
(7) the usefulness of the program; (8) the augmentation of airway management concepts and techniques in clinical application; and (9) further familiarity with the steps of specific procedures on a 5-point Likert scale ranging from excellent to poor (1 = poor, 2 = fair, 3 = adequate, 4 = very good, 5 = excellent). In addition, free text comments were solicited.

Results

Characteristics of participants
Two hundred and fifty-five participants were trained in this program. Among them, 13 were junior residents, 80 were nurse anesthetists from our anesthesiology department, and 162 were nurse anesthetists from other hospitals. All nurse anesthetists were certified and experienced in airway management.

Program evaluation
Questionnaires for course feedback were obtained from 189 participants (response rate, 70%). There were no exclusions of the questionnaires and results. Overall evaluation was extremely positive. The means and standard deviations of the 8 course evaluations (overall program, meeting course goals, lecture, multimedia simulations, realism, environment and equipment, usefulness of the program, and augmentation of abilities) are depicted in Figure 2.

The survey data were: overall program, $4.56 \pm 0.49$; course goals met, $4.38 \pm 0.6$; quality of lecture, $4.45 \pm 0.57$; multimedia simulations, $4.44 \pm 0.57$; realism, $4.42 \pm 0.57$; environment and equipment, $4.4 \pm 0.57$; usefulness of the program, $4.3 \pm 0.62$; augmentation of abilities $4.8 \pm 0.39$; and familiarity with procedures $4.8 \pm 0.47$. There were no fair or poor ratings by any participant.

Free text comments of the participants revealed that the training program was quite useful. Participants described the course as filling an important void in their update on the airway management algorithm. Examples of comments are: “Nurse anesthetists improved communication with anesthesiologists in difficult airway management after participating in multimedia medical

![Figure 2. Course feedback from participants was organized by questions on a 5-point Likert scale ranging from excellent to poor. There were no ratings of fair or poor.](image-url)
simultaneous display of all images in the 3-frame screen. After this multimedia simulation, they comprehended how these advanced procedures could be performed, and they acquired more skill and ability to do well in similar clinical cases.

Discussion

Establishing an airway is of paramount importance in the field of clinical anesthesia, and teamwork is one of the most important cornerstones during difficult airway management. Effective assistance from nurse anesthetists is crucial for successful intubation. This heavily relies on familiarity with the Difficult Airway Algorithm and the preparation of equipment. Though there are advanced inventions in airway management technologies, there is no uniform and effective training protocol for experienced airway practitioners to update their knowledge and techniques. Furthermore, the importance of optimal airway management and protection of health care personnel is greatly appreciated after the outbreak of severe acute respiratory syndrome (SARS) in many countries.12

In a case of unanticipated difficult intubation, we performed FOI through LMA. The images of the whole procedure were displayed on a monitor through the video adapter and the video processor assembly. We found unexpectedly that the display of real-time images could be greatly appreciated in teaching image-guided airway management. In order to help nurse anesthetists to acquire skills and update their medical knowledge for airway management, we designed the new renewal training protocol using lecture and medical simulation.

To our knowledge, this is the first program to perform FOI through LMA. The images of the whole procedure were displayed on a monitor through the video adapter and the video processor assembly. We found unexpectedly that the display of real-time images could be greatly appreciated in teaching image-guided airway management. In order to help nurse anesthetists to acquire skills and update their medical knowledge for airway management, we designed the new renewal training protocol using lecture and medical simulation.

To the best of our knowledge, this is the first report to combine real-time multimedia display with simulation in renewal airway management training for such a large number of experienced practitioners. Unlike participant-based medical simulation, we designed this instructor-based medical simulation of
4 different scenarios focused on anticipated and unanticipated airway crises. In other words, each of the scenarios was simulated and conducted by the instructors. During most difficult airway management, the nurse anesthetists play the role of assistant. During the simulations, instructors of both anesthesiologists and nurse anesthetists demonstrated successful management including accurate decision-making and techniques, preparation of equipment, proper cooperation between anesthesiologists and nurse anesthetists. Most of the participants agreed that the instructor-based simulation was useful and practical, and they gained more confidence in clinical practice afterwards. The questionnaires also revealed that instructor-based simulation training was perceived by trainees to be more enjoyable and beneficial.

In conclusion, it is our opinion that a large number of participants with extensive airway management experience can update their knowledge about difficult airway management from general lecture, and acquire better abilities of decision-making and communication, skills of specific airway management, from instructor-based multimedia medical simulation. Also of note, they can gain more confidence, improve performance and learn how to effectively assist in handling airway crises.

Acknowledgments

We would like to thank the staff members of TANA for their efforts in the preparation of the course, and the anesthesia faculty who participated in and helped to improve the course and allowed data collection.

References

1. Practice guidelines for management of the difficult airway: a report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology 1993;78:597–602.
2. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology 2003;98:1269–77.
3. Erratum. Anesthesiology 2004;101:565.
4. AANA journal course: update for nurse anesthetists. The SLAM Emergency Airway Flowchart: a new guide for advanced airway practitioners. AANA J 2004;72:431–9.
5. Howard SK, Gaba DM, Fish KJ, Yang G, Sarnquist FH. Anesthesia crisis resource management training: teaching anesthesiologists to handle critical incidents. Aviation Space Environ Med 1992;63:763–70.
6. Blum RH, Raemer DB, Carroll JS, Sunder S, Feinstein DM, Cooper JB. Crisis resource management training for an anesthesia faculty: a new approach to continuing education. Med Educ 2004;38:45–55.
7. Morgan PJ, Cleave-Hogg DM. Evaluation of medical students’ performance using the anesthesia simulator. Med Educ 2000;34:42–5.
8. Morgan PJ, Cleave-Hogg DM, DeSouza S, Tarshis J. Identification of gaps in the achievement of undergraduate anesthesia educational objectives using high-fidelity patient simulation. Anesth Analg 2003;97:1690–4.
9. Morgan PJ, Cleave-Hogg DM, DeSouza S, Tarshis J. High-fidelity patient simulation: validation of performance checklists. Br J Anaesth 2004;92:388–92.
10. Forrest FC, Taylor MA, Postlethwaite K, Aspinall R. Use of a high-fidelity simulator to develop testing of the technical performance of novice anesthetists. Br J Anaesth 2002;88:338–44.
11. Rosenblatt MA, Abrams KJ; New York State Society of Anesthesiologists, Inc; Committee on Continuing Medical Education and Remediation; Remediation Sub-Committee. The use of a human patient simulator in the evaluation of and development of a remedial prescription for an anesthesiologist with lapsed medical skills. Anesth Analg 2002;94:149–53.
12. Ting CK, Liu HT, Chen KY, Liu CK, Tsou MY, Chan KH, Tsai SK. Using a CO2 detector to confirm endotracheal intubation in SARS patients. Can J Anaesth 2005;52:446–7.
13. Devitt JH, Kurrek MM, Cohen MM, Cleave-Hogg D. The validity of performance assessments using simulation. Anesthesiology 2001;95:36–42.
14. Weller JM, Bloch M, Young S, Maze M, Oyesola S, Wyner J, Dob D, et al. Evaluation of high fidelity patient simulator in assessment of performance of an anesthesiologist with lapsed medical skills. Anesth Analg 1998;86:1160–4.
15. Murray DJ, Boulet JR, Kras JF, McAllister JD, Cox TE. Acute care skills in anesthesia practice: a simulation-based resident performance assessment. Anesthesiology 2004;101:1084–95.