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Original Research

Enhancing Patient Safety through Education in a Low-to-Middle-Income Country: Training in the Correct Application of Cricoid Pressure

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Introduction

Cricoid pressure (CP) is applied to occlude the esophagus in patients at an increased risk of regurgitation and aspiration of gastric contents during endotracheal intubation.[1,2] CP involves downward pressure on the cricoid cartilage to compress the esophagus against the vertebral body, thus occluding the lumen of the esophagus and preventing aspiration of gastric contents into the lungs.[2] Aspiration of gastric contents into the pulmonary tree can lead to major morbidity and mortality.[3,4] Mendleson reported acid aspiration in 66 obstetrics patients, and the potentially fatal pulmonary complication following acid aspiration is known as Mendleson's syndrome.[5]

Correct application of CP involves a downward force of 30 to 40 Newtons (about 3 to 4 kg) applied on the cricoid cartilage with the thumb and index finger during induction of anesthesia and endotracheal intubation in patients believed to have a full stomach.[6] Operating room (OR) and critical care nurses and technicians are responsible for its application. CP should be applied only by trained personnel with knowledge of the relevant anatomy, technique, and force required for its effective application.[7–9] A review of the literature shows that there is a marked deficiency in knowledge about the optimal pressure required for occluding the esophagus and in the skill of applying CP correctly and consistently among healthcare professionals routinely responsible for this task.[7–13] Incorrect application of CP can put patients at risk of aspiration. Inadequate knowledge and skill leading to ineffective CP application may be the reason for the doubts and concerns that have been raised about its usefulness.[6] Therefore, it is imperative to ensure the effectiveness of CP by its correct application before rejecting it from routine practice.[14] This correct practice, in turn, is dependent on effectiveness of teaching and training techniques used by the trainers.[15]

Training of relevant personnel is essential for ensuring quality of practice and enhancing patient safety. Beckford and colleagues have reported in their systematic review that education and training significantly improve CP application practices.[15] The objectives of this study were to (1) evaluate the effectiveness of structured CP workshops in improving knowledge and skills pertaining to CP application during endotracheal intubation among anesthesiology technicians and critical care nurses responsible for its application and to (2) assess the retention of skills 2 months after the workshops.

Materials and Methods

Approval was granted by the University Ethics Review Committee (2474-Ane-ERC-13), and written informed consent was obtained from all participants. The project was funded by the University Research Grant (URC 131003ANES). Five workshops were conducted by the authors on correct application of CP. The workshop participants included anesthesia technicians responsible for assisting anesthesiologists in ORs and critical care nurses working in intensive care units and emergency rooms. Head nurses of relevant clinical areas and technician supervisors were requested to nominate participants from their areas for each workshop. Twenty participants were enrolled for each workshop, except for 1 where there were 22 participants.

The duration of each workshop was 5 hours. The workshop was composed of didactic teaching and hands-on practice (Appendix 1). The didactic component included interactive lectures on the anatomy of the neck and airway, pathophysiology of regurgitation and aspiration, and the role of CP in its prevention (Appendix 2). Each lecture was 10 to 15 minutes long. The lecture was followed by a 5-minute video on the correct application of CP, developed by 1 of the authors, with a 10-minute discussion. For hands-on training and practice, 3 stations were prepared consisting of (1) a calibrated and serviced kitchen weighing scale with a maximum weighing capacity of 5 kg (Figure 1), (2) a tracheostomy trainer model (Sakamoto Tracheotomy Trainer M172, Sakamoto Model Corporation Osaka, Japan [described below]) attached to a pressure sensor at the level of the cricoid ring with a digital display of the applied pressure (Figure 2), and (3) a 50-mL syringe (BD Luer-Lok) adjusted upright on a stand with the piston pulled out to

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the 50-mL mark and the nozzle blocked (Figure 3). After testing with an electronic scale, a marker was placed at the level of 33 mL as a pressure of 3 kg (30 Newtons) was generated when the plunger of an empty, blocked 50-mL syringe was compressed from 50 mL to the 33-mL mark. This was similar to the technique described by other authors.[7,10]

Efforts were made to obtain a training model as close to real life as possible so that, after attending the workshop, the attendees would be able to apply their learning in real-life scenarios. After a thorough search, a training model was identified that had been validated for training in the application of CP and was designed specifically for this purpose, the Life/Form Cricoid Pressure Trainer by Nasco (LF03760U).[16] However, a vendor for this product/company was unavailable in the authors' region, and no response was received on repeated attempts to contact the company. It was therefore planned to use a tracheostomy trainer model for this purpose (Smiths Medical Tracheostomy Head TOT100). With the help of the Biomedical Department, a calibrated digital weighing scale was attached underneath the trachea of the model to assess the weight generated on pressing the cricoid ring. The model was placed in a wooden frame, which was covered in front by a black fiberglass sheet. The weight generated on pressing the cricoid ring was displayed on the fiberglass (Figure 2).

A 20-minute preworkshop test (pretest), consisting of 12 multiple-choice questions (MCQs) covering the theoretical and practical aspects of CP application, was administered at the beginning of the workshop (Appendix 3). Each MCQ carried 1 mark. The pretest was conducted to assess participants' baseline knowledge regarding CP application. The MCQs were constructed by experienced academic Anesthesiology faculty with more than 15 years of experience after in-depth review of the literature. The questions were then reviewed by medical education faculty for quality and structure. A pretest for assessment of participants' baseline skills in the application of CP and amount of force applied was conducted following the MCQ test. This included assessment of force applied on a kitchen weighing scale, a 50-mL syringe, and the tracheostomy trainer model, with the weighing scale and pressure display on the trainer turned away from the participants and the syringe kept unmarked to keep the participants blinded to the force generated. The capability of maintaining the pressure for 1 minute was also tested on the trainer model. The pretests were followed by the didactic teaching session. For hands-on teaching and practice, participants were divided into 3 groups of 6 to 7 participants. The correct technique for application of CP and the amount of force to be applied were taught and practiced at the different stations with the weighing scales visible to them and the syringe marked at 33 mL. Each group spent 20 minutes at each station. The participants were then allowed another 20 minutes to practice at all stations. Following this, a posttest was conducted for knowledge and hands-on skill. Hands-on skill was assessed by testing the pressure applied on the weighing scale, syringe, and trainer model, with the weighing scale shielded from view and the 33-mL mark on the syringe removed with markings facing away from the participant. Maintenance of pressure for 1 minute was tested on the trainer model. The written posttest consisted of the same MCQs as the pretest with the order of the questions changed. Last, feedback was provided by the authors, and a debriefing session was held where the participants were encouraged to reflect on what they had learned and how it would help them in their work. To assess the retention of skills in effective application of CP, participants were invited to return 2 months after each workshop, and their practical skills were reassessed on the 50-mL syringe, weighing scale, and tracheostomy trainer. The individual test scores were not shared among the participants or with any other individual.

All statistical analyses were performed using statistical packages for social science version 19 (SPSS Inc, Chicago, Illinois). Mean and standard deviation were estimated for correct score of the participants, and paired *t* tests were applied to compare mean scores of pre-post and interval assessments. Frequencies and percentages were computed for participants' correct responses, and pre-post effect and retention of knowledge were evaluated by a McNemar statistical test for each MCQ and hands-on assessment. A *P* value of ≤.05 was considered significant. Improvement in knowledge was assessed from the difference between the mean scores of the pretest and posttest.

Results

The 5 workshops were conducted from October 2015 to December 2018, as the grant extended over a 3-year period. A total of 102 anesthesia technicians and critical care nurses attended the 5 workshops. The mean score for the preworkshop knowledge assessment was 7.12 ± 2.32, whereas the mean score for the postworkshop test was 12.32 ± 2.12. This difference is statistically significant ($P < .01$) and indicates that 73% more questions were answered correctly by the participants in the posttest. On analysis of individual questions, responses to all (except 1) questions were improved in the posttest conducted immediately following the workshop (Table 1). Similarly, posttraining mean score (out of 10) for skill assessment was significantly higher than the pretraining score (6.31 ± 0.96 versus 2.72 ± 2.00; $P < .0005$), indicating overall 131% higher scores than observed on the pretest. The scores for individual components of the CP application technique are provided in Table 2.

Of the 102 participants, 74 (73.5%) appeared for the assessment sessions conducted 2 months after each workshop to assess the retention of skills. Assessment of hands-on skills was conducted to analyze the retention of skills. A significant decrement (20%) in scores was observed compared with the immediate posttraining skills assessment scores when matched with the same 74 participants (5.15 ± 1.71 versus 6.45 ± 0.86; $P < .0005$) (Table 3), although the scores were better than the preworkshop assessment scores (5.15 ± 1.71 versus 2.72 ± 2.00; $P < .005$).

Discussion

This study revealed gaps in knowledge and skills regarding correct and effective application of CP among anesthesia technicians and critical care nurses who are routinely involved in assisting anesthesiologists during endotracheal

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intubation. Other researchers have reported similar observations when studying the knowledge and practice of CP application.[17–21] Noll et al found that only 1.3% of anesthetic physicians and assistants who frequently applied CP could achieve the pressure of 30 Newtons and maintain it during endotracheal intubation.[17] In another study, Koziol et al reported that a large number of their study participants could not identify the cricoid cartilage on a model, only 5% were aware of the correct amount of pressure to be applied, and only 13% of them practically applied the correct amount of pressure.[18] Clark and Trethewy assessed effective CP application in emergency department physicians and nurses by placing a laryngotracheal model on a scale.[19] In their study, only 25% of the participants applied the correct amount of CP. In a questionnaire conducted on French anesthesiologists routinely using CP, only 52% could describe the technique adequately.[20] In another study, 40% of anesthesiologists in Southern Sweden were not aware of the contraindications to CP.[21] Although application of CP is routine practice in most centers, lack of knowledge pertaining to CP and its ineffective application could well be the reason for the reports on lack of trust in the effectiveness of CP in preventing aspiration.[6] In a multicenter study, Birenbaum et al failed to demonstrate the noninferiority of the sham procedure compared with CP in preventing pulmonary aspiration.[22] The authors believe that improvement in practice with better training will restore trust in this procedure.

Significant improvements were observed in both knowledge and skills in our participants immediately following the training workshops. Patten has reported similar findings in his quality improvement program for OR nurses routinely involved in the application of CP.[3] Both didactic and hands-on teaching and training were provided in Patten's study, and pretraining and posttraining assessments were conducted. Patten reported that only 2% of the nurses answered all questions correctly in the pretest compared with 76.5% in the posttest. Similarly, 68.6% of the participants applied correct CP after training compared with 3.9% before training.[3] Owen et al assessed the amount and direction of CP applied by OR clinicians on a life-size mannikin with pressure sensors. Training was then provided to the participants. In the pretraining assessment, only 10% of participants were able to apply the correct amount of CP, whereas 90% applied the correct pressure after training.[12] Kopka and Robinson used a 50-mL syringe to assess and train nurses in the application of CP.[7] They found that only 17% had knowledge about the amount of pressure to be applied. In the group that did not receive training, only 19% were able to apply the correct amount of pressure, whereas 47% of the participants who were trained on the 50-mL syringe applied the correct amount of pressure.[7]

For safe and effective use of CP, one needs to know the anatomy of the neck, the amount of pressure to be applied, and appropriate technique in addition to practice and experience.[23] Our curriculum consists of multiple teaching and learning strategies to cover all of these aspects. Arja and colleagues have concluded that students perform better when a hybrid model of instructions is used in teaching clinical skills,[24] quoting Benjamin Horton "I hear and I forget, I see and I remember, I do and I understand."[25] It is highly likely that both theoretical knowledge and hands-on practice contributed to the improvement in skills demonstrated in this study.

Of the 102 participants in our study, 74 (73.5%) were able to attend the assessment session for retention of skills conducted 2 months after each training session. Compared with the immediate posttraining skills assessment, a 20% decrease in scores was observed in most aspects of CP application when assessed 2 months after the workshop. Previous studies have also reported that staff can readily be trained to apply CP correctly,[4,10] but the performance declined over time.[26–28] Flucker et al have reported that, after a single training episode, performance of CP was well maintained for 1 week, but retention declined in 1 month.[10] In a study by Ashurst et al, improved performance was retained for up to 3 weeks,[26] whereas Herman and colleagues have reported retention of skills for 3 months.[27] In a systematic review of evidence regarding effectiveness of simulation-based training to improve efficacy of CP application,[28] it was found that CP training resulted in a large favorable impact on skills among trainees compared with no intervention. However, 4 studies have reported posttraining retention of skills for CP application for a limited period of less than 4 weeks.[28]

On review of retention of skills after simulation training in other procedures, it was observed that retention of skills for at least 1 year was seen for cricothyroidotomy in consultant anesthesiologists following a single training session using high-fidelity simulation of a cannot intubate, cannot ventilate scenario.[29] A potential explanation for longer retention for cricothyroidotomy could be the near to real life scenario used to train and assess the skill compared with training composed of lectures and static models. It is likely that the close to real life depiction of the scenario and dynamic environment using high-fidelity simulation with alarms from monitors induced a certain level of stress that facilitated memorizing the situation with longer retention of skills than training on the usual static models.[30] Research has shown that training through simulation compared with no training provides a consistent advantage for learning patient-related skills.[31] Beckford et al recommend regular training to sustain the ability of effective CP application.[15] In skills such as CP application, training and practice through high-fidelity simulation with retraining and testing schedules would have clear benefits. However, lack of time is often a barrier to implementing simulation on a regular basis.[32]

Despite having availability of the tracheostomy trainer model, we used 2 other methods for teaching, practicing, and assessing CP application. In low-to-middle-income countries, ideal CP training equipment is unavailable or is expensive to procure. Therefore, we included 2 easily available training tools that would be more practical and affordable options for our regional colleagues, that is, a simple kitchen weighing scale and a 50-mL syringe training aid, which has been used for this purpose by other authors.[7,10] A weighing scale is useful in getting the feel of 3 kg of pressure and is practical for repeated practice. Similarly, a 50-mL syringe is another easily available piece of equipment that has been successfully used for training in effective

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application of CP. We found the 50-mL syringe method to be comparable with the tracheostomy trainer model used by us. Our results showed that 82.4% versus 81.4% of participants applied correct pressure on the syringe and tracheostomy trainer, respectively, immediately after training and practice. Training with feedback has been shown to be effective for the application of CP whether provided on realistic anatomical models or on researcher-made models that mainly measure the pressure applied.[33] Kopka et al have suggested the routine use of a 50-mL syringe for practice by anesthesia assistants to ensure retention of skill.[7]

The lesson learned by the authors from this project is that to make the training activity more practical for all stake holders, we need to identify the educational interventions that would be adequate to produce the intended learning outcome during shorter training sessions. From the experience of 5 workshops, we recommend small group sessions with a 20-minute presentation on the theoretical aspects of CP, followed by a short video and practice on any 1 of the training tools, a 50-mL syringe being a practical, economical, and validated method for this purpose.[7,10] The entire session would take less than 1 hour or up to 90 minutes if pre- and posttest skill assessments are included to demonstrate improvement in skill. To ensure retention of skill, the 50-mL syringe contraption should be placed at a designated area of the workplace for regular on-the-job practice. Our study has some limitations. First, there is a delay in reporting of our data. The data analysis was completed in 2019, and manuscript writing was started with its submission planned for early 2020. However, with the emergence of the coronavirus disease 2019 pandemic, the duty structure and work pattern of the authors changed dramatically, which led to a halt in our research and scholarly activities. This resulted in a backlog of the ongoing projects, causing significant delays. Second, we did not correlate the improved performance following the workshop with an improvement in performance in the clinical setting, which is the ultimate aim of such training sessions. Evidence of improvement in clinical performance would be the indicator of real success of the training workshops. We recommend that future training activity for CP application should be followed by assessment of performance at the workplace. Moreover, a survey on participants' perceptions about improvement in their own performance may also be performed. Another limitation is the low attendance of participants for assessment of retention of skill (73.5%). The reason for this was the difficulty for busy clinical staff to get relieved from their duties for this purpose.

Conclusion

In this pre- and postintervention study, significant improvements were observed in both knowledge and skills immediately following training in effective application of CP. A 20% decrease in scores was observed in the assessment of skills 2 months after the workshops. Improvement of skills after 2 months compared with the pretest is a promising result. However, correlation with performance in the clinical setting is required to strengthen these findings. We recommend formal training and regular practice to enable clinicians to apply CP correctly and effectively. Readily accessible simple equipment, such as a 50-mL syringe, is recommended for regular practice to maintain retention of skills among personnel routinely responsible for CP application.

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Abstract

Background: Cricoid pressure (CP) is applied to occlude the esophagus during endotracheal intubation in patients at an increased risk of aspiration of gastric contents. Evidence shows marked deficiencies in knowledge and skills for CP application among personnel responsible for this task. This study evaluated the effectiveness of CP training in improving knowledge and skills regarding CP application among anesthesiology technicians and critical care nurses and assessed the retention of skills after 2 months.

Methods: Five workshops were conducted on effective application of CP. Indications, relevant anatomy, physiology, and correct technique were taught using interactive sessions and videos and hands-on practice on a weighing scale, 50-mL syringe, and trainer model. Pre- and postworkshop tests were conducted for knowledge and skill. An assessment was repeated after 2 months to assess skill retention.

Results: Five workshops were conducted for 102 participants. Statistically significant improvements were seen in mean scores for knowledge in postworkshop assessments (12.32 ± 2.12 versus 7.12 ± 2.32; $P < .01$). Similarly, posttraining mean scores for skill assessment were significantly higher than pretraining scores (6.31 ± 0.96 versus 2.72 ± 2.00; $P < .0005$), indicating an overall 131% improvement. Seventy-four participants appeared for assessment of the retention of skills. A 20% decrement was observed compared with posttraining scores (5.15 ± 1.71 versus 6.45 ± 0.86; $P < .0005$).

Conclusions: A significant improvement was observed in both knowledge and skills immediately following training. However, this does not ensure long-term retention of clinical skills, as a 20% decrement was observed 2 months after the workshops. Formal training and regular practice are recommended to enable clinicians to perform CP effectively.

Keywords: Cricoid pressure, endotracheal intubation, rapid sequence induction, gastric aspiration

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Figures

Figure 1. *Calibrated kitchen weighing scale used to learn and practice application of cricoid pressure.*

Figure 2. *A tracheostomy trainer model adapted for use for learning and practicing the application of cricoid pressure.*

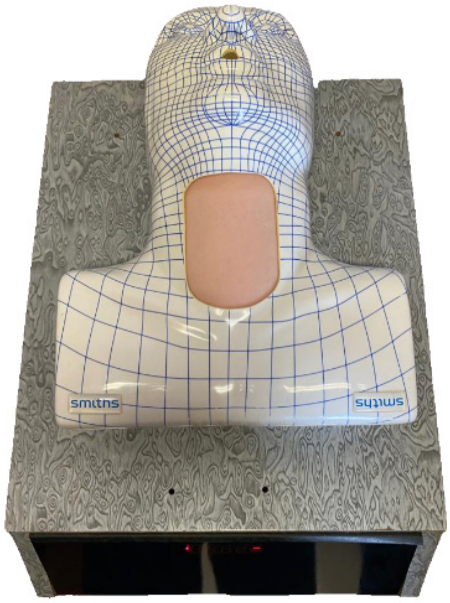

Figure 3. *A 50-mL syringe (BD Luer-Lok) used to learn and practice the application of cricoid pressure.*

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Tables

Table 1. *Comparison of the Results for Individual Questions in the Pre- and Posttests Conducted Before and Immediately After the Workshop, Respectively (n = 102)*

Question No.	MCQ Topic Assessed	Pretest n (%)	Posttest n (%)	*P* Value
1	The reason for applying cricoid pressure during rapid sequence induction	84 (82.4%)	76 (74.5%)	.268
2	Shape of cricoid cartilage	30 (29.4%)	85 (83.3%)	.0005
3	Location of cricoid cartilage	65 (63.7%)	96 (94.1%)	.0005
4	Correct finger placement for application of cricoid pressure	48 (47.1%)	83 (81.4%)	.0005
5	The direction of force applied	45 (44.1%)	79 (77.5%)	.0005
6	The adequate force required in adult patients	59 (57.8%)	84 (82.4%)	.0005
7	When to release cricoid pressure	59 (57.8%)	97 (95.1%)	.0005
8	Comparison of units of pressure	57 (55.9%)	82 (80.4%)	.005
9	Consequence of aspiration of acidic gastric contents	50 (49%)	100 (98%)	.0005
10	Another name for application of cricoid pressure	15 (14.7%)	80 (78.4%)	.0005
11	Incorrect cricoid pressure in patients with a full stomach is likely to lead to	69 (67.6%)	90 (88.2%)	.005
12	Complication caused by excessive pressure (>44 Newton) applied over cricoid cartilage	51 (50%)	74 (72.5%)	.005

Abbreviation: MCQ, multiple-choice question.

Table 2. *Comparison of Pre and Postworkshop Assessments of Skills in Practical Application of Cricoid Pressure (n=102)*

Hands-on Assessment		Pretest	Posttest	*P* Value[a]
Locating the cricoid cartilage	Correct	35 (34.3%)	99 (97.1%)	.0005
Position of fingers	Correct	40 (39.2%)	98 (96.1%)	.0005
Direction of pressure	Correct	52 (51.5%)	95 (94.1%)	.0005
Pressure applied on weighing scale	Correct	47 (46.1%)	83 (81.4%)	.0005
Pressure applied on syringe	Correct	22 (21.6%)	84 (82.4%)	.0005
Pressure applied on manikin	Correct	21 (20.6%)	83 (81.4%)	.0005
Pressure maintained for 1 minute	Yes	60 (58.8%)	100 (98%)	.0005

[a] A McNemar-Bowker test was applied.

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Table 3. *Comparison of Scores for Hands-On Skills in Immediate Postworkshop Assessments and Assessments after 2 Months (n=74)*

Hands-On Workshop		Posttest	Retention of Skills After 2 Months	*P* Value
Method of locating cricoid cartilage	Correct	72 (97.3%)	59 (79.7%)	.0005
Position of fingers	Correct	72 (97.3%)	59 (79.7%)	.0005
Direction of pressure	Correct	70 (94.6%)	68 (91.9%)	.727
Pressure applied at weighing scale station in kg/Newton	Correct	62 (83.8%)	34 (45.9%)	.0005
Pressure applied at syringe station in kg/Newton	Correct	64 (86.4%)	49 (66.2%)	.008
Pressure applied at mannequin station in kg/Newton	Correct	63 (85.1%)	52 (70.3%)	.052
Pressure maintained for 1 minute	Yes	73 (98.6%)	60 (81.1%)	.001

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Appendices

Appendix 1. *Cricoid Pressure Workshop*

Program

Participants: 20

Time: 0900 to 1400 hours

Date: September 6, 2018

Venue: Anatomy Dissection Hall

Serial No.	Activities	Duration (h)	Presenter/coordinator
1	Registration	0845 to 0900	
2	Introduction	0900 to 0910	A.A.
3	Pretest	0910 to 0930	All faculty
	Tea break	0930 to 0940	
4	Hands-on assessment (Pretest)	0940 to 1010	A.A., M.Q.H., F.S.
5	Didactic component		
	i. Anatomy of neck and airway	1010 to 1025	A.S.S.
	ii. Pathophysiology of aspiration	1025 to 1035	A.A.
	iii. Role of cricoid pressure in prevention of aspiration	1035 to 1045	F.S.
	iv. Limitations of cricoid pressure	1045 to 1055	M.Q.H.
	v. Movie on correct application of cricoid pressure/ discussion	1055 to 1110	F.S.
	Questions and answers	1110 to 1125	All faculty
6	Hands-on training and practice on four stations (in groups followed by individual practice)	1125 to 1245	All faculty
	Lunch	1245 to 1315	
7	Posttest	1315 to 1335	All faculty
8	Hands-on reassessment	1335 to 1400	A.A., M.Q.H., F.S., A.S.S.

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Appendices *continued*

Appendix 2. *Objectives of Lectures*

Lecture 1: Anatomy of Neck and Airway

Learning objectives:

- By the end of this lecture, the participants will be able to
- Describe the anatomy of the larynx and trachea
- Describe the relationship between the trachea and esophagus
- Explain the reason for applying pressure at the level of the cricoid ring

Lecture 2: Pathophysiology of Aspiration

Learning objectives:

- By the end of this lecture, the participants will be able to
- Explain the importance of preventing aspiration of gastric contents
- Describe aspiration pneumonia and its consequences
- Enlist the complications related to aspiration pneumonia

Lecture 3: Role of Cricoid Pressure in the Prevention of Aspiration

Learning objectives:

- By the end of this lecture, the participants will be able to
- Enlist the indications for application of cricoid pressure
- Demonstrate the correct method of application of cricoid pressure
- Describe the process of prevention of aspiration by effective cricoid pressure

Lecture 4: Limitations of Cricoid Pressure

Learning objectives:

- By the end of this lecture, the participants will be able to
- Describe the contraindications of cricoid pressure application
- Describe the possible difficulty in intubation with the application of cricoid pressure
- Enlist the limitations of cricoid pressure application

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Appendices *continued*

Appendix 3. *Training in the Correct Application of Cricoid Pressure*

Pretest/Posttest

Name: _____ Date: _____

Circle only one response for each question. ALL questions must be answered.

1. The reason for applying cricoid pressure during rapid sequence induction is to
   A. Enable better view of vocal cords for intubation
   B. Enable easier bag-mask ventilation
   C. Prevent aspiration of gastric contents
   D. Prevent respiratory obstruction during intubation

2. Cricoid cartilage is
   A. A complete tracheal ring
   B. A C-shaped tracheal ring
   C. The midtracheal ring
   D. The last tracheal ring

3. Cricoid cartilage is located
   A. Above the thyroid cartilage
   B. Above the hyoid bone
   C. Below the thyroid cartilage
   D. Below the trachea

4. The correct finger placement for application of cricoid pressure is
   A. Directly on the Adam's apple
   B. Directly on the cricoid cartilage
   C. Immediately superior to the cartilage
   D. On the space below the cricoid cartilage

5. The force applied should be directed
   A. Backward
   B. Caudal
   C. Lateral
   D. Upward

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Appendices *continued*

6. The force required for adequate cricoid pressure is between
   A. 0.3 and 0.4 Newtons
   B. 3 and 4 Newtons
   C. 13 and 14 Newtons
   D. 30 and 40 Newtons

7. The cricoid pressure should be released after
   A. Confirmation of intubation by auscultation
   B. Confirmation of intubation by ETCO2
   C. Inflation of the endotracheal tube cuff
   D. Permission by the person who performed the intubation

8. A pressure of 1 kg is approximately equal to
   A. 2 Newtons
   B. 6 Newtons
   C. 10 Newtons
   D. 30 Newtons

9. Aspiration of acidic gastric contents can lead to a potentially fatal condition called
   A. Addison's syndrome
   B. Cushing's syndrome
   C. Down's syndrome
   D. Mendleson's syndrome

10. Application of cricoid pressure is also called
    A. BURP maneuver
    B. OLEM maneuver
    C. Rapid sequence induction
    D. Sellick's maneuver

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Appendices *continued*

11. Incorrect application of cricoid pressure in patients with a full stomach is likely to lead to
    A. Aspiration
    B. Difficult intubation
    C. Regurgitation
    D. Pain

12. Excessive pressure (>44 Newtons) over cricoid cartilage can cause
    A. Airway obstruction
    B. Easy intubation
    C. Regurgitation
    D. Rupture of cartilage