Developing a Guideline for Endotracheal Suctioning of Adults With Artificial Airways in the Perianesthesia Setting in China

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Purpose: *This study aimed to adapt a guideline for endotracheal suctioning of adults with artificial airways in the perianesthesia setting in China.*
Design: *This study was guided by the ADAPTE framework.*
Methods: *The development process consisted of setup, adaptation, and finalization phases. A heterogeneous consultant panel that included a patient representative was established to contribute guidance and suggestions regarding guideline development. Relevant evidence documents were searched, critically appraised, selected, and synthesized to develop the draft guideline. After revisions, the adapted guideline was evaluated by 20 external reviewers.*
Findings: *A 155-page adapted guideline was developed with 26 key recommendations (including 3 procedure phases and 17 points of care).*
Conclusions: *The adapted guideline provided the best evidence for endotracheal suctioning of adults with artificial airways and supported practitioner decisions about appropriate endotracheal suctioning practices for this population. The study also lays the groundwork for future projects on quality improvement and knowledge translation.*

Keywords: *clinical practice guideline, endotracheal suctioning, evidence-based practice, China.*

IN CHINA, MOST PATIENTS require an artificial airway during perianesthesia care. After surgery, intubated patients are transferred from an operating room to a Phase I postanesthesia care unit (PACU). They are not extubated until they recover from anesthesia. Patients are then transferred to a Phase II PACU. Sometimes intubated patients are transferred to a surgical

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intensive care unit rather than to a PACU if they need an artificial airway or mechanical ventilation for 2 hours or more.

Endotracheal suctioning is one of the most common invasive procedures for patients who have an artificial airway in place. The goal of endotracheal suctioning is to clear respiratory tract secretions and maintain airway and endotracheal tube patency to prevent insufficient ventilation, atelectasis, and pulmonary infections.[1] One study[2] showed that an adult patient with an artificial airway may receive endotracheal suctioning 3 to 25 times every 24 hours.

Endotracheal suctioning is a necessary procedure; however, it is associated with adverse effects such as increased intracranial pressure, alterations in hemodynamic parameters, lesions in the airway mucosa, and cross-infection.[3-5] In addition, endotracheal suctioning leads to distressing experiences and pain for patients.[6,7] Thus, endotracheal suctioning requires best evidence integrated with individual clinical expertise and patient choice.

Although English guidelines or evidence summaries on endotracheal suctioning have been developed and published, recent studies showed that the clinical practices of most health care professionals on endotracheal suctioning varied and were not standardized.[2,8-12] One of the most frequently mentioned reasons for this factor is the lack of appropriate evidence-based guidelines regarding endotracheal suctioning in local areas.[9,12]

In China, no evidence-based guideline exists for endotracheal suctioning. The Ministry of Health of China (Beijing, China) developed an expert consensus-based nursing practice guideline that includes 11 recommendations on endotracheal suctioning of adults with artificial airways.[13] However, limitations in this guideline that impede its use in the clinical setting include unclear process for the development of the recommendations, lack of references supporting the recommendations, numerous missing recommendations on the practices of endotracheal suctioning, and inconsistencies in the recommendations with recent evidence.[5,13,14] Without a high-quality evidence-based guideline for endotracheal suctioning of adult patients with artificial airways, it is difficult for nurses or other health care professionals in the perianesthesia setting to provide appropriate endotracheal suctioning and make decisions integrating the best external evidence with individual clinical expertise and patient choice.[15]

Objectives

This study aimed to adapt a guideline for endotracheal suctioning of adults with artificial airways in the perianesthesia setting in China. The specific objectives were (1) to synthesize and evaluate existing guidelines or other evidence documents on this procedure, (2) to develop an adapted guideline for the perianesthesia setting in China, and (3) to evaluate the quality, acceptability, and applicability of this guideline.

Methods

Research Design

This study was guided by the ADAPTE framework (version 2.0), which aims to standardize and facilitate the process of adapting clinical practice guidelines in a local context.[16-18]

Phase I: Setup

The diversity of participants' education and experience can increase the validity and clinical utility of consensus. Therefore, a heterogeneous consultant panel was established to contribute guidance and suggestions for guideline development (Table 1).[19,20] Four members were health care professionals with graduate degrees with comprehensive training and experience in research methods, literature searching and appraisal, and evidence-based medicine. Moreover, patient representatives and nurses who had experience in receiving endotracheal suctioning were included on the consultant panel. These members brought their perspective as experts from their unique experiences, complementing the scientific knowledge of health care professions, and ensuring that the adapted guideline was relevant to patient concerns.[21]

Table1. Consultant Panel and External Reviewer

Characteristics	Consultant Panel (n = 10)	External Reviewer (n = 20)
Position		
Nursing director	1	1
Clinical manager	1	2
Head nurse	1	2
Nurse researcher	1	1
Nurse educator	1	1
Specialty nurse	1	3*
Bedside nurse	2*	5
Physician	1	3
Patient representative	1	2
Education (excluding patient representatives)		
Doctoral degree	2	5
Master degree	2	4
Bachelor degree	4	6
College diplomat	1	3
Working years (excluding patient representatives)		
4∼10	3	2
11∼20	4	10
>20	2	6

*One of the nurses has the experience of receiving airway suctioning.

Phase II: Adaptation

IDENTIFYING RELEVANT EVIDENCE DOCUMENTS. Using the Population, Intervention, Professionals, Outcomes, Health Care Setting Framework, the research team and the consultant panel determined evidence inclusion criteria, based on the study objectives (Table 2). A search strategy was then established by the research team working with a librarian and tested by a second librarian.[22] The following databases were searched to identify relevant literature: MEDLINE (OVID, New York, NY), Excerpta Medica dataBASE (EMBASE; OVID), Cumulative Index to Nursing and Allied Health Literature (CINAHL; EBSCO, Ipswich, MA), the Joanna Briggs Institute (JBI; Adelaide, Australia), Evidence-based Practice Database (OVID), and Web of Science (Clarivate Analytics, Philadelphia, PA). To supplement the database search, a search was also conducted on web sites of international guideline institutes recommended by the ADAPTE toolkit such as National Guidelines Clearinghouse, Registered Nurses' Association of Ontario, Cochrane Library, National Institute for Clinical Evidence, Guidelines International Network, Institute for Clinical Systems Improvement, and New Zealand Guidelines Group.[16] Key search terms included "suction," "tracheal," "endotracheal," "airway," "air hose," "air duct," "air passage," "air tube," "respiratory tract," "respiratory passage," and "pharynx."

EVIDENCE DOCUMENTS SELECTION. After removing duplicate documents, two reviewers (J.H. and L.Y.) independently screened all the literature through Covidence.[23] If any conflicts existed during the identification of relevant literature, they were discussed and resolved through a consensus process with the other research team members and the consultant panel. At this second step, the reasons for exclusion were documented for all articles excluded from the review. A Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRIMSA) flow diagram was applied to document the process of screening and data selection.[24]

EVIDENCE DOCUMENTS' APPRAISAL. Two reviewers (L.J. and L.Y.) independently evaluated the quality of the evidence documents by using the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument.[25] The six domains and 23 items in the AGREE II Instrument have been illustrated as reliable and valid for assessing the methods for developing clinical practice guidelines.[26,27] All conflicts were discussed and resolved by the research team and the panel. In addition, the final results of the AGREE II appraisal were calculated, based on the manual of the AGREE II instrument, and sent to the panel to provide a sense of the quality of certain aspects of the guideline and how well they were reported.[25]

ADAPTED GUIDELINE CREATION. Recommendations for each included guideline were analyzed and synthesized using a qualitative content analysis method.[28] All recommendations and their supporting evidence and information were extracted and grouped into the relevant category. A draft of the adapted guideline was then produced, based on the standards in the AGREE II instrument.[16]

DECISION AND CUSTOMIZATION. The draft guideline was sent to the panel 2 weeks before the discussion meeting. The chair (J.H.) facilitated the discussion and ensured that all members had an opportunity to present their views. The

Table 2. Evidence Inclusion Criteria

	Criteria
Population	Adults, defined as a person aged 18 y or older, with an artificial airway
Intervention	Endotracheal suctioning
Professionals targeted	Nurses and other health care professionals, especially in perianesthesia settings, operating rooms, and intensive care units
Outcomes	Appropriate practice and procedure
Health care setting	Perianesthesia settings: postanesthesia care units, surgical intensive care units, and operating rooms
Methodology	Clinical practice guideline, evidence-based practice information sheets, and other best evidence summary documents
Language	English

discussion was recorded and any new suggestions were documented and addressed. After the draft guideline was modified, based on the suggestions, the research team and the consultant panel met again to discuss whether further revisions were required, and discussions continued until both groups reached a final decision that no further changes were needed.

Phase III: Finalization

Once the research team and the consultant panel decided on the adaptation of the guideline, the research team held an external review meeting to report the adapted guideline to potential users and obtain their feedback. A convenience and purposive sample was applied to recruit 20 external reviewers at Shanghai Ninth People's Hospital (Shanghai, China), a large academic teaching hospital in China (Table 1).[29] The AGREE II instrument, the Acceptability and Applicability Evaluation Tool, and comments feedback sheets were provided to all external reviewers with the draft guideline.[16,25] The Acceptability and Applicability Evaluation Tool is a five-point Likert-type scale developed using the JBI Feasibility, Appropriateness, Meaningfulness, Effectiveness framework.[30]

Ethical Considerations

This research project was approved by the Research Ethics Board at Ninth People's Hospital, which is affiliated with Jiaotong University (Shanghai, China). All participants (ie, consultants and external reviewers) in this study were provided a consent form that described the study and provided sufficient information for them to make an informed decision about their participation in the study. The anonymity and confidentiality of all participants' information were maintained. Moreover, all participants signed a declaration of conflict of interest form regarding their involvement in the guideline development.

Results

Systematic Search and Selection

The search yielded 799 citations for screening. Of these studies, seven evidence documents were included for quality appraisal and analysis (Figure 1). These seven documents included two clinical practice guidelines, four evidence summaries, and one evidence-based practice information sheet, all of which were published in the JBI or in journals (eg, *Respiratory Care* and *Canadian Respiratory Journal*) from 2000 to 2016 (Table 3). These documents used different grading systems: (1) level of evidence and (2) grades of recommendation. They had high scores (ie, at least greater than 70%) for "scope and purpose," "clarity of presentation," and "editorial independence," but had low scores (19.05% to 59.52%) for "rigor of development" (Table 3). All seven evidence documents were used to develop the adapted clinical practice guideline under the discussion of the research team and the consultant panel.

Adapted Clinical Practice Guideline Revisions

The first draft of the adapted guideline comprised 17 sections that covered four main topics: (1) key recommendations, (2) implementation toolkit, (3)

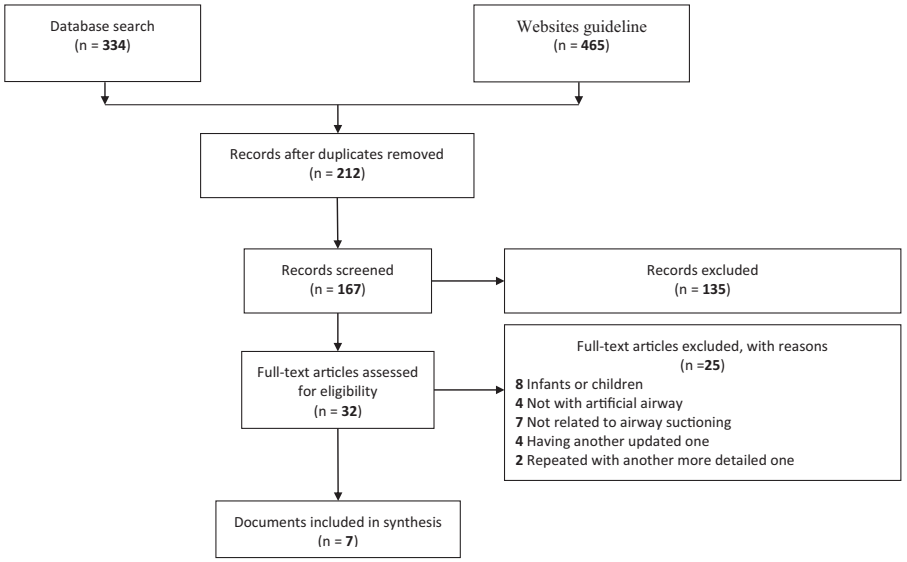

Figure 1. PRISMA flow diagram of screening and selecting literature. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

introduction and background of the guideline, and (4) the adaptation process (Appendix). Eighty-two recommendations (Appendix) were extracted from the included evidence documents to be condensed and categorized into three procedure phases: (1) preparation before endotracheal suctioning (four points of care), (2) procedure during endotracheal suctioning (11 points of care), and (3) evaluation after endotracheal suctioning (two points of care). There were five discussion meetings and 78 revisions in the section of key recommendations (Appendix). After the revisions, 26 key recommendations using the JBI grading system[16,30] were listed in the 155-page adapted guideline and covered three procedure phases and 17 points of care in endotracheal suctioning of adults with artificial airways in the perianesthesia setting in China (Appendix).

External Reviewers' Evaluation

The AGREE II appraisal from external reviewers had a median score of 90.00% and ranged from 81.67% (for domain 5, applicability) to 93.89% (for domain 1, scope and purpose). Acceptability and Applicability Evaluation had a median score of 3.78. Items 2 to 4 had the lowest scores (range, 1.60 to 1.85), and items 5, 6, and 11 had moderate extent of agreement (range, 3.10 to 3.20). Except for these items, the other items had a more than great extent of agreement (range, 4.35 to 4.75). Detailed descriptions of the AGREE II appraisal and Acceptability and Applicability Evaluation are illustrated in Table 4.

Thirty-eight comments were obtained from 20 external reviewers. The most frequent positive comments were that the adapted guideline was understandable, comprehensive, and easy to follow. The most frequent negative comments were that the guideline was too long and they did not know how to begin implementing the guideline in clinical practice. Moreover, most reviewers argued that it was difficult to accept some evidence-based practices in the clinical setting such as only suctioning when needed, not routinely using normal saline, and suctioning for less than 15 seconds. Eighteen suggestions were provided such as having leaders involved in establishing local policies and standards, designing web or mobile applications, incorporating the guideline into health information systems, developing knowledge translation tools (eg, checklists, reminders, user-friendly pictures, and pocket version of the guideline), and enhancing education.

Discussion

In this study, seven evidence documents were selected, evaluated, and synthesized to generate

Table 3. Characteristics of Guidelines and AGREE II Appraisal

	Title	Year	Publisher	Type	AGREE II Appraisal					
					D1 (%)	D2 (%)	D3 (%)	D4 (%)	D5 (%)	D6 (%)
1	Tracheostomy: suctioning	2016	The Joanna Briggs Institute	Evidence summary	97.22	18.75	40.48	100.00	45.83	100.00
2	Tracheostomy and endotracheal tube suctioning	2016	The Joanna Briggs Institute	Evidence summary	94.44	29.17	30.95	94.44	41.67	100.00
3	Endotracheal suctioning: clinician information	2016	The Joanna Briggs Institute	Evidence summary	100.00	29.17	33.33	100.00	37.50	100.00
4	Artificial airway: suctioning	2016	The Joanna Briggs Institute	Evidence summary	94.44	18.75	30.95	94.44	45.83	100.00
5	Endotracheal suctioning of mechanically ventilated patients with artificial airways	2010	Respiratory care	Clinical practice guideline	94.44	66.67	38.10	94.44	85.71	100.00
6	Clinical practice guidelines for suctioning the airway of the intubated and nonintubated patient	2001	Canadian Respiratory Journal	Clinical practice guideline	77.78	75.00	59.52	100.00	33.33	100.00
7	Tracheal suctioning of adults with an artificial airway	2000	The Joanna Briggs Institute	Evidence summary	72.22	18.75	19.05	88.89	29.17	100.00

Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument domains: domain 1, scope and purpose (items 1 to 3); domain 2, stakeholder involvement (items 4 to 6); domain 3, rigor of development (items 7 to 14); domain 4, clarity of presentation (items 15 to 17); domain 5, applicability (items 18 to 21); and domain 6, editorial independence (items 22 to 23). The calculation of the scale domain score was based on the AGREE II instrument manual, which was as follows: (obtained score − minimum possible score)/(maximum possible score − minimum possible score).

Table 4. External Review

Acceptability and Applicability Evaluation Tool	Score [Mean ± SD (Range)]
1. The cost of EBPs is affordable	4.70 ± 0.47 (4-5)
2. The resources for EBPs are available	1.85 ± 0.88 (1-4)
3. There is sufficient competency available for health care providers to implement the EBPs	1.60 ± 0.75 (1-4)
4. The EBPs are culturally acceptable	1.85 ± 0.93 (1-4)
5. The EBPs are applicable to most of my population	3.20 ± 1.15 (1-5)
6. The EBPs are easily adaptable to a variety of circumstances	3.10 ± 1.48 (1-5)
7. Implementing the EBPs is associated with positive experiences for health care providers	4.40 ± 0.50 (4-5)
8. Implementing the EBPs is associated with positive experiences for clients	4.35 ± 0.49 (4-5)
9. There is a beneficial effect when the EBPs are implemented in clinical settings	4.60 ± 0.50 (4-5)
10. Implementing the EBPs is safe	4.75 ± 0.44 (4-5)
11. How confident would you be when using the adapted guideline?	3.10 ± 0.79 (2-4)
12. How comfortable would you be in disseminating the adapted guideline?	4.45 ± 0.51 (4-5)

EPB, evidence-based practice.

the recommendations in the adapted guidelines. Using the AGREE II instrument, these seven evidence documents had low scores for rigor of development. After a discussion with the consultant panel, our research team decided to include all seven evidence documents because these documents provided recent best evidence.[31] Moreover, we used multiple approaches to resolve the issue of rigor of development, which were recommended by the ADAPTE toolkit.[16] We compared recommendations from different guidelines with respect to content, wording, and supporting evidence, and we conducted independent literature searches to confirm the accuracy of evidence supporting the recommendations, and to assess consistency between the supporting evidence and the guideline developers' interpretation of the evidence and consistency between the interpretation of the evidence and the recommendations.

The included seven evidence documents used different grading systems for the level of evidence and grades of recommendation. In addition, some grading systems the documents used were under criticism on account of their superficial nature because they arbitrarily promoted evidence from experimental studies over observational studies and did not necessarily reflect reality.[32] However, it is of the utmost importance for health care providers attempting to implement the adapted guideline to understand the strength of evidence and the grade of recommendation on endotracheal suctioning.[33] Thus, the JBI grading system was used by the consultant panel and the research team to generate the level of evidence and the grade of each recommendation in this adapted guideline.[30]

The AGREE II appraisal of the adapted guideline indicated that the quality of the guideline was beyond the expected standards. With regard to acceptability and applicability, most reviewers were concerned about the length of the guideline, insufficient competency in implementing the recommended practices, the fact that some practices substantially differed from the reviewers' current practices, and lack of leaders' support. These findings corroborated those of a recent study reflecting 32 failure factors in safe and appropriate endotracheal suctioning in the intensive care unit.[34]

The reviewers' comments regarding the length of the guideline and its implementation were expected because the guideline had 155 pages. However, this guideline was well structured so that most reviewers found it was understandable, comprehensive, and easy to follow. It included basic anatomy, physiology, and pathology knowledge related to endotracheal suctioning and a detailed description of evidence to support each recommendation. This information could help clinical facilitators or educators to design education resources and increase nurses' or other health care professionals' competency in implementing the recommended practices of

endotracheal suctioning. Moreover, the detailed process of developing the guideline using the ADAPTE framework was comprehensively reported in the guideline. This factor significantly decreased acceptability and applicability in the clinical setting, but it could increase researchers' or health care professionals' confidence in the quality of the adapted guideline and facilitate the adaptation of this guideline into other languages or other clinical settings.[16,25]

Most reviewers found it difficult to accept some evidence-based practices such as only suctioning when needed, not routinely using normal saline, and suctioning for less than 15 seconds because these practices substantially differed from or contradicted their current practices. This contrast between the evidence-based practices and reviewers' current practices was the most common barrier in knowledge translation.[35] On the basis of this high-quality evidence-based guideline, numerous strategies could be developed such as policies or standards, web or mobile applications, checklists, reminders, user-friendly pictures, and pocket versions of the guideline to facilitate implementing evidence-based practices of endotracheal suctioning in perianesthesia settings.[36] In addition, leaders' support was strongly suggested, which is a critical factor for implementing evidence-based practices in many areas.[37]

Limitations

One strength of this study is that it strictly followed the ADAPTE framework and followed a rigorous guideline adaptation process.[16] However, there are limitations in the study. First, the research team and the adaptation consultant panel were all from Shanghai, which is a large and developed city on the east coast of China. Thus, the context might be different in developing cities in western China and the adapted guideline may not fit with the context in these local areas. Second, the guideline was only evaluated by external reviewers in one hospital. The findings of external review in this study probably cannot represent the acceptability and applicability of the adapted guideline in other hospitals because different hospitals might have different policies, cultures, and administrative structures when implementing new evidence-based practices.

Conclusions

The ADAPTE framework was an efficient, rigorous, and structured approach guiding the cross-contextual adaptation of the guideline for endotracheal suctioning of adults with artificial airways. This guideline could provide the groundwork to develop knowledge translation tools or local standards to facilitate the implementation of the new evidence-based practices of endotracheal suctioning.

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Supplementary Data

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References

1. Bell L. Using endotracheal suctioning for patients. *Am J Crit Care*. 2015;24:326.
2. Leddy R, Wilkinson JM. Endotracheal suctioning practices of nurses and respiratory therapists: How well do they align with clinical practice guidelines? *Can J Respir Ther*. 2015;51:60-64.
3. Favretto DO, Silveira RC, Canini SR, Garbin LM, Martins FT, Dalri MC. Endotracheal suction in intubated critically ill adult patients undergoing mechanical ventilation: A systematic review. *Rev Lat Am Enfermagem*. 2012;20:997-1007.
4. Pedersen CM, Rosendahl-Nielsen M, Hjermind J, Egerod I. Endotracheal suctioning of the adult intubated patient—What is the evidence? *Intensive Crit Care Nurs*. 2009;25:21-30.
5. Sole ML, Bennett M, Ashworth S. Clinical indicators for endotracheal suctioning in adult patients receiving mechanical ventilation. *Am J Crit Care*. 2015;24:318-324; quiz 325.
6. Samuelson KA. Adult intensive care patients' perception of endotracheal tube-related discomforts: A prospective evaluation. *Heart Lung*. 2011;40:49-55.

7. Arroyo-Novoa CM, Figueroa-Ramos MI, Puntillo KA, et al. Pain related to tracheal suctioning in awake acutely and critically ill adults: A descriptive study. *Intensive Crit Care Nurs*. 2008;24:20-27.

8. Bulbul Maras G, Kocacal Guler E, Eser I, Kose S. Knowledge and practice of intensive care nurses for endotracheal suctioning in a teaching hospital in western Turkey. *Intensive Crit Care Nurs*. 2017;39:45-54.

9. Beuret P, Roux C, Constan A, Mercat A, Brochard L. Discrepancy between guidelines and practice of tracheal suctioning in mechanically ventilated patients: A French multicenter observational study. *Intensive Care Med*. 2013;39:1335-1336.

10. Sole ML, Byers JF, Ludy JE, Zhang Y, Banta CM, Brummel K. A multisite survey of suctioning techniques and airway management practices. *Am J Crit Care*. 2003;12:220-230; quiz 231–222.

11. Jansson M, Ala-Kokko T, Ylipalosaari P, Kyngäs H. Evaluation of endotracheal-suctioning practices of critical care nurses—An observational correlation study. *J Nurs Educ Pract*. 2013;3:99-105.

12. Ansari A, Alavi NM, Adib-Hajbagheri M, Afazel M. The gap between knowledge and practice in standard endo-tracheal suctioning of ICU nurses, Shahid Beheshti Hospital. *Iran J Crit Care Nurs*. 2012;5:71-76.

13. People's Republic of China Ministry of Health. Endotracheal Suctioning. Clinical Nursing Practice Guideline. Beijing, China: People's Republic of China Ministry of Health. Available at: http://www.nhfpc.gov.cn/. Accessed June 21, 2016.

14. Wang CH, Tsai JC, Chen SF, et al. Normal saline instillation before suctioning: A meta-analysis of randomized controlled trials. *Aust Crit Care*. 2016;30:260-265.

15. Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: What it is and what it isn't. *BMJ*. 1996;312:71-72.

16. ADAPTE Collaboration. The ADAPTE process: Resource toolkit for guideline adaptation (version 2.0), 2009. Available at: http://www.g-i-n.net/document-store/working-groups-documents/adaptation/adapte-resource-toolkit-guideline-adaptation-2-0.pdf/at_download/file. Accessed July 22, 2016.

17. Ayhan Baser D, Kahveci R, Baydar Artantas A, et al. Exploring guideline adaptation strategy for Turkey: Is "ADAPTE" feasible or does it need adaptation as well? *J Eval Clin Pract*. 2018;24:97-104.

18. Chakraborty SP, Jones KM, Mazza D. Adapting lung cancer symptom investigation and referral guidelines for general practitioners in Australia: Reflections on the utility of the ADAPTE framework. *J Eval Clin Pract*. 2014;20:129-135.

19. Keeney S, Hasson F, McKenna H. Consulting the oracle: Ten lessons from using the Delphi technique in nursing research. *J Adv Nurs*. 2006;53:205-212.

20. Baker J, Lovell K, Harris N. How expert are the experts? An exploration of the concept of "expert" within Delphi panel techniques. *Nurse Res*. 2006;14:59-70.

21. Armstrong MJ, Rueda JD, Gronseth GS, Mullins CD. Framework for enhancing clinical practice guidelines through continuous patient engagement. *Health Expect*. 2017;20:3-10.

22. Sampson M, McGowan J, Cogo E, Grimshaw J, Moher D, Lefebvre C. An evidence-based practice guideline for the peer review of electronic search strategies. *J Clin Epidemiol*. 2009;62:944-952.

23. Cochrane Community. Covidence. Available at: http://community.cochrane.org/tools/review-production-tools/covidence. Accessed June 26, 2016.

24. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *PLoS Med*. 2009;6:e1000100.

25. Brouwers MC, Kho ME, Browman GP, et al. AGREE II: Advancing guideline development, reporting and evaluation in health care. *CMAJ*. 2010;182:E839-E842.

26. Brouwers MC, Kho ME, Browman GP, et al. Development of the AGREE II, part 2: Assessment of validity of items and tools to support application. *CMAJ*. 2010;182:E472-E478.

27. Brouwers MC, Kho ME, Browman GP, et al. Development of the AGREE II, part 1: Performance, usefulness and areas for improvement. *CMAJ*. 2010;182:1045-1052.

28. Vaismoradi M, Turunen H, Bondas T. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nurs Health Sci*. 2013;15:398-405.

29. Speziale HS, Carpenter DR. *Qualitative Research in Nursing: Advancing the Humanistic Imperative*, 4th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2011.

30. Joanna Briggs Institute. *Levels of Evidence and Grades of Recommendation Working Party. Supporting Document for the Joanna Briggs Institute Levels of Evidence and Grades of Recommendation*. Adelaide, Australia: Joanna Briggs Institute; 2014.

31. Padjas A, Kehar R, Aleem S, et al. Methodological rigor and reporting of clinical practice guidelines in patients with allergic rhinitis: QuGAR study. *J Allergy Clin Immunol Pract*. 2014;133:777-783.e774.

32. Hillier S, Grimmer-Somers K, Merlin T, et al. FORM: An Australian method for formulating and grading recommendations in evidence-based clinical guidelines. *BMC Med Res Methodol*. 2011;11:23.

33. Guyatt G, Oxman AD, Akl EA, et al. GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol*. 2011;64:383-394.

34. Vazquez-Valencia A, Santiago-Saez A, Perea-Perez B, Labajo-Gonzalez E, Albarran-Juan ME. Utility of failure mode and effect analysis to improve safety in suctioning by orotracheal tube. *J Perianesth Nurs*. 2017;32:28-37.

35. Graham ID, Logan J. Innovations in knowledge transfer and continuity of care. *Can J Nurs Res*. 2004;36:89-103.

36. Straus S. *Knowledge Translation in Health Care: Moving from Evidence to Practice*, 2nd ed. Chichester, West Sussex: Wiley; 2013.

37. Hu J, Gifford W. Leadership behaviors play a significant role in implementing evidence-based practice. *J Clin Nurs*. 2018;27:e1684-e1685.

Appendix

Guideline for endotracheal suctioning of adults with artificial airways in Chinese perianesthesia settings

Table S1. Table of Contents

Table S2. Extracted Recommendations

Category	G1	G2	G3	G4	G5	G6	G7	Total
Total number of extracted recommendations	22	6	13	8	10	8	15	82
A. Preparation before endotracheal suctioning (19 recommendations)								
(1) Clinical indicators	2	1	0	1	1	0	1	6
(2) Patent communication	0	1	1	0	1	0	1	4
(3) Catheter size	3	1	1	1	1	0	1	8
(4) Knowledge and skills	0	0	0	0	0	0	1	1
B. Procedure during endotracheal suctioning (54 recommendations)								
(5) Suction approach	3	1	0	0	1	0	0	5
(6) Aseptic technique	1	0	0	1	0	0	1	3
(7) Humidification	2	1	2	0	1	0	1	7
(8) Insertion depth	2	0	0	1	1	1	0	5
(9) Suction pressure	2	0	0	1	0	0	0	3
(10) Time length of suction procedure	1	0	1	1	1	0	1	5
(11) Frequency of suction procedure	0	0	2	0	0	0	1	3
(12) Suction intervals	0	0	0	1	0	0	1	2
(13) Hyperinflation	1	0	1	0	0	1	3	6
(14) Preoxygenation	2	0	1	1	1	2	2	9
(15) Ventilation	0	0	2	0	2	1	1	6
C. Evaluation after endotracheal suctioning (9 recommendations)								
(16) Monitoring	2	0	1	0	0	1	0	4
(17) Adverse effects	1	1	1	0	0	2	0	5

Table S3. Sample of Suggestions and Revisions to Adapted Guideline

Issues	Example	Panel Suggestions and Revisions
Repetition	Different guidelines have different statements for the same recommendation "Suctioning should only be done when a thorough assessment of the patient establishes the need for such a procedure and not be dictated by routine."	These recommendations are consistent but repeated, it is suggested to summarize them into one appropriate statement.
Inconsistency	One guideline has the recommendation "Use of shallow suction is always better than deep suction." And the other one recommends Deep suctioning is necessary in patients with large amounts of secretions in the lower airways.	Sufficient and high level of evidence existed to support the recommendation "Deep suctioning is necessary in patients with large amounts of secretions in the lower airways." Also, there is another recommendation in the adapted guideline to illustrate the depth of the catheter insertion, which is "The suction catheter should be inserted to the carina and then retracted 1-2 cm before suctioning is performed, or the length of the suction catheter is estimated by measuring an identical endotracheal tube." Thus, it is suggested to delete the former recommendation and keep the later one.
Update	Before 2016, there was "weak" recommendation and "low level of evidence" on the routine use of normal saline instillation before endotracheal suction.	The routine instillation of normal saline before suctioning is expected to elicit coughing and to liquefy secretions and it is commonly used in clinical practice. However, recent evidence documents after 2016 suggested that routine use of normal saline instillation before endotracheal suction should not be performed. Also, there was a new published systematic review to support this recommendation. Thus, we kept this recommendation.
Low level of evidence	Recommendation: "A curved catheter rather than a straight catheter (in tracheotomized or intubated patients) is more successful in entering the left main bronchus; however, there is no evidence as to whether suctioning the left versus the right bronchus provides an advantage to patient outcome."	There was only one cohort study supporting this recommendation. Also, the study examined the effect of the catheters on mucosal injury based on a subjective outcome measure. As the evidence is not sufficient and in the low level, it was suggested to delete this recommendation.
Other issues	Translation, presentation, lack of references, format, and so forth.	

Table S4. Key Recommendations in Adapted Guideline

A. Preparation before endotracheal suctioning (5 recommendations)

(1) Clinical indicators (1 recommendation)

Recommendation 1: Suctioning should only be done when a thorough assessment of the patient establishes the need for such a procedure and not be dictated by routine. (Level 4, Grade A)

(2) Patent communication (1 recommendation)

Recommendation 2: If patients are able to cough up their own secretions, they should be encouraged to do so. (Level 4, Grade A)

(3) Catheter size (2 recommendations)

Recommendation 3: Suction catheters should be as small as possible, yet large enough to facilitate secretion removal. (Level 4, Grade B)

Recommendation 4: The size of the suction catheter should occlude no more than half of the internal diameter of the artificial airway to avoid greater negative pressures in the airway and to potentially minimize falls in PaO_2. (Level 3, Grade A)

(4) Knowledge and skills (1 recommendation)

Recommendation 5: Because of the potential associated hazards, nurses require procedural skill and gentleness when suctioning. (Level 4, Grade A)

B. Procedure of endotracheal suctioning (19 recommendations)

(5) Suction approach (2 recommendations)

Recommendation 6: The use of a closed suction system is suggested for adults with high Fraction of Inspired Oxygen (FIO_2), or Positive End-Expiratory Pressure (PEEP), or at risk for acute lung injury. (Level 2, Grade A)

Recommendation 7: The closed or open suction system is not superior to the other in terms of oxygen saturation, cardiovascular instability, secretion removal, environmental contamination, and cost. (Level 5, Grade B)

(6) Aseptic technique (1 recommendation)

Recommendation 8: Aseptic technique should be considered an essential component of the suctioning procedure for hospitalized patients with artificial airways, including hand washing and use of gloves, because endotracheal suctioning is an invasive procedure that may lead to contamination of the lower airways. (Level 4, Grade A)

(7) Humidification (2 recommendations)

Recommendation 9: Routine use of normal saline instillation before endotracheal suction should not be performed. (Level 2, Grade B)

Recommendation 10: Ensuring patients are adequately hydrated is the way health care providers can facilitate the removal of respiratory secretions. (Level 1, Grade A)

(8) Insertion depth (2 recommendations)

Recommendation 11: The suction catheter should be inserted to the carina and then retracted 1-2 cm before suctioning is performed, or the length of the suction catheter is estimated by measuring an identical endotracheal tube. (Level 4, Grade B)

Recommendation 12: Deep suctioning is necessary in patients with large amounts of secretions in the lower airways. (Level 1, Grade B)

(9) Suction pressure (1 recommendation)

Recommendation 13: Use the lowest possible suction pressure during endotracheal suctioning, usually 80-120 mm Hg. (Level 1, Grade B)

(10) Time length of suction procedure (1 recommendation)

Recommendation 14: The suctioning procedure should last no longer than 15 seconds. (Level 3, Grade B)

(11) Frequency of suction procedure (1 recommendation)

Recommendation 15: There should not be more than two consecutive suction procedures. (Level 3, Grade A)

(12) Suction intervals (1 recommendation)

Recommendation 16: Perform suctioning at least every 8-h to reduce the risk of partial occlusion of the endotracheal tube and the accumulation of secretions. (Level 4, Grade B)

(13) Hyperinflation (3 recommendations)

Recommendation 17: Using volumes of hyperinflation that are indexed to the size of the patient may assist in minimizing potential difficulties. (Level 3, Grade A)

Recommendation 18: Patients have reported feeling dyspneic during hyperinflation when larger tidal volumes (900 mL) were used. (Level 3, Grade A)

(Continued)

Table S4. Continued

Recommendation 19: If hyperinflation is used in patients before suctioning, caution should be employed because it may be associated with increases in mean arterial blood pressure. (Level 3, Grade B)

(14) Preoxygenation (2 recommendations)

Recommendation 20: Preoxygenation by the delivery of 100% oxygen for at least 30 s before and after the suctioning procedure is recommended to prevent a decrease in oxygen saturation, especially when the patient has a clinically important reduction in oxygen saturation with suctioning. (Level 1, Grade A)

Recommendation 21: Combining hyperoxygenation and hyperinflation before suctioning can minimize suctioning-induced hypoxemia. (Level 1, Grade B)

(15) Ventilation (3 recommendations)

Recommendation 22: A ventilator should be used rather than a manual resuscitation bag to provide hyperventilation/hyperoxygenation before suctioning to reduce hemodynamic alterations. (Level 3, Grade B)

Recommendation 23: Suctioning through an adaptor is preferred to preserve oxygenation in mechanically ventilated patients. (Level 2, Grade B)

Recommendation 24: A washout time of up to 2 min can be required when hyperoxygenation is being delivered via some ventilators to allow time for the increased oxygen percentage to come through the ventilator tubing and reach the patient. (Level 5, Grade B)

C. Evaluation after endotracheal suctioning (2 recommendations)

(16) Monitoring (1 recommendation)

Recommendation 25: The following should be monitored before, during, and after the procedure if indicated and available: breath sounds, oxygen saturation, respiratory rate and pattern, hemodynamic parameters, sputum characteristics, cough characteristics, intracranial pressure, and ventilator parameters. (Level 5, Grade B)

(17) Adverse effects (1 recommendation)

Recommendation 26: Endotracheal suctioning, unless managed appropriately, can lead to various adverse events (tracheal trauma, hypoxemia, hypertension, cardiac arrhythmias, and raised intracranial pressure), and increase mortality and morbidity rates. (Level 1, Grade A)