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Delphi Consensus on American Society of Anesthesiologists' Physical Status Classification in an Asian Tertiary Women's Hospital

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Running title : Consensus Study on ASA Classification

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Abstract

Background: The American Society of Anesthesiologists (ASA) score is generated, based on patients' clinical status. Accurate ASA classification is essential for the communication of perioperative risks and resource planning. The literature suggests that ASA classification can be automated for consistency and time-efficiency. To develop a rule-based algorithm for automated ASA scoring, this study seeks to establish consensus in ASA classification for clinical conditions encountered at a tertiary women's hospital.

Methods: After informed consent, 37 anaesthesia providers rated their agreement (on a Likert scale) to ASA scores assigned to items via the Delphi technique. After Round 1, the group's collective responses and individual item scores were shared with participants to aid their responses for Round 2. Categories of "agree" and "strongly agree" were combined to give the percentage agreement. For each item, percentage agreement, median (IQR) and SD were calculated at the conclusion of Delphi. Consensus for each item is achieved when percentage agreement $\geq 70\%$, IQR ≤ 1.0 and S.D. <1.0.

Results: All participants completed the study with no missing data. Consensus items increased from 25 (51.0%) to 37 (75.5%) after both Delphi rounds, particularly for items assigned ASA III and IV. Nine items did not achieve consensus after two Delphi rounds. They pertain to: alcohol intake, asthma, thyroid disease, limited exercise tolerance and stable angina.

Conclusions: Delphi consensus was attained for 37 out of 49 study items (75.5%), facilitating their incorporation to a rule-based clinical support system designed to automate the prediction of ASA physical status.

Introduction

Preanaesthesia assessment is the process of clinical evaluation that precedes the delivery of anaesthesia care for surgery and non-surgery procedures [1]. Upon completion of assessment, it is standard practice to assign an American Society of Anesthesiologists (ASA) score, based on the patient's clinical status [2]. The ASA classification system is the most widely used component of preanaesthesia assessment for surgical patients that aids in the prediction of complications [3], resource planning [4] and reimbursement of anaesthesia services [5].

Despite its widespread utility, studies suggest that ASA classification is associated with poor inter-rater agreement [6-10]. Interpretation of ASA definitions may be influenced by the patient case-mix [11, 12], rater expertise [9, 11] and healthcare funding model [6]. Yet, consistency in ASA assignment is vital for accurate risk prediction and resource planning. With the establishment of outpatient preanaesthesia evaluation clinics, disagreement in ASA classification between preprocedural and day-of-surgery anaesthesiologists could lead to day-of-surgery cancellations, with decreased operating room efficiency, low staff morale, patient anxiety and increased costs [13, 14].

Traditional models of in-person preanaesthesia assessment have transitioned to digital formats, administered by health care providers or self-administered by patients [15-23]. Electronic preoperative assessment platforms often incorporate clinical decision support systems (CDSS) that improve quality of care through standardization of practice [24, 25]. We previously reported the development and validation of a web-based Pre-AnaesThesia Computerized Health (PATCH) assessment application through a mixed-methods approach [22]. The PATCH application allows patients to self-administer a

preanaesthesia health screening questionnaire on a mobile device at a time, place and pace convenient to them. Patient responses gathered online generate a comprehensive health report that is reliable and accurate, when compared to nurse-led assessment [23]. However, in its current form, the application does not automatically generate the ASA score. We aim to build a clinical decision-making support system for automated ASA prediction for integration into the PATCH application.

As ongoing research to develop a CDSS for automated ASA classification, the present study was undertaken with the aim of establishing Delphi consensus in ASA classification for a spectrum of clinical conditions encountered in our setting of a tertiary women's hospital. As typical of the Delphi technique, the opinion of experts is sought to determine the extent of agreement, with disagreements resolved through a series of anonymized sequential rounds, interspersed with controlled opinion feedback and opportunity for respondents to modify their responses [26]. Items that attain consensus could then be incorporated to build decision rules for the program algorithm to automate ASA scoring.

Materials and Methods

Study Participants

The study was conducted at the Department of Women's Anaesthesia of the KK Women's and Children's Hospital, Singapore from 2 January to 28 February 2021. The 830-bedded hospital provides tertiary care for women and children. Eligible 'experts' for the Delphi study are anaesthesia providers of the department who staff the outpatient preanaesthesia evaluation clinics and operating rooms and have minimum two years' experience in providing supervised or independent anaesthesia care. Purposive sampling was performed to ensure that invited participants met eligibility criteria.

Study Design

The Delphi technique was undertaken through two rounds of structured questionnaires. Questionnaire items in the Delphi study were formulated by three members of the study team (EL, BLS and RD) who each has more than 20 years of clinical experience. Items covered clinical entities commonly encountered in our clinical setting, and included examples adapted from the ASA approved examples [2]. Conditions that are typically classified as ASA V (e.g. moribund patient) and VI (e.g. brain death) were excluded in the study as they are not considered controversial in nature. The first version of the questionnaire of items was evaluated for clarity and relevance by two consultant anaesthesiologists not affiliated with the hospital. No changes were deemed necessary after their review.

Round 1

After written informed consent, participants accessed a web-based questionnaire

(https://form.gov.sg/5fb48cb93a3ec7001128173b) to rate their agreement (on a four-point Likert scale) to ASA scores assigned to 49 items in the ASA framework of questionnaire. Options for free-text comments of individual items were also provided. In addition, participants were asked to provide information on gender and clinical experience.

Participants were instructed to indicate their level of agreement on a four-point Likert scale (strongly disagree "1", disagree "2", agree "3" and strongly agree "4") to ASA scores assigned to 49 items. The "neutral" option was removed to move the group towards consensus [27] and produce stable findings in Delphi [28].

Round 2

Four weeks from the completion of the first Delphi round, participants received via email an individualized questionnaire in Excel format denoting their individual scores, the group median, distribution of responses and free-text comments collected in Round 1. Participants were then asked to reconsider their responses for Round 2, taking into consideration the group's collective responses (i.e. median ASA score for each item) and comments obtained in Round 1. The method of providing feedback along with the distribution of responses per item has been described previously in similar Delphi studies [29]. Round 2 allowed participants to review their ratings and potentially move the group's rating towards a level of consensus. There was no option of free-text comments in Round 2. Figure 1 summarises the method used in this Delphi technique.

We had aimed to conduct two Delphi rounds, making an *a priori* decision to proceed with Round 3 if consensus was not achieved by Round 2. Ethics approval of the study (2017/3002) was provided by the SingHealth Centralised Institutional Review Board D of the Singapore Health Services Private Limited.

Defining Consensus

For the present study, consensus for each item was determined by a combination of percentage agreement, inter quartile range (IQR) and standard deviation (SD). Although the setting of a percentage level based on the majority may be considered subjective [30], the addition of IQR and SD increases the rigor of determining consensus by measuring the stability of responses between rounds and level of convergence in the participants' assessment [31, 32].

To measure consensus in this study, the following criteria were used in combination a priori:

1. percentage agreement of ≥ 70% where ≥ 70% of participants agree/strongly agree (Likert scale ≥3) with an item in Round 2 for inclusion in the framework of the ASA score assignment. This level of agreement has been described in previous Delphi [33].

2. IQR of ≤1.0 (i.e. IQR lies within 1 unit of the median on a 4-point Likert scale) [31].

3. SD of <1.0 to indicate homogeneity of participants' responses [32].

Failure to achieve consensus in Round 2 on all three measures was a reason for exclusion of the item.

Statistical Analysis

Data was analyzed using IBM SPSS Statistics for Windows (IBM Corp., Armonk, N.Y., USA) at the conclusion of each round. Demographic data and Likert item response were analyzed by descriptive statistics. Median (IQR) score was calculated for each Likert item. Categories of 'strongly agree' and

'agree' were combined to compute the percentage agreement of each item. Variability in responses was measured by SD, where a decrease in SD from one round to the next indicates increasing homogeneity of response. Regardless of whether the level of consensus was obtained in Round 1, all items were returned in Round 2 of the Delphi survey to allow every item the same chance to gain the highest rating and level of consensus.

Results

All thirty-seven eligible staff members of the anaesthesia department (excluding the three study team members) consented to the study and completed both Delphi rounds with no missing data (100% response). Table I shows the demographic characteristics of the 37 participants, comprising 15 consultant anaesthesiologists, 2 anaesthesia nurse practitioners, 14 residents and 6 resident physicians. Majority (75.7%) had ≥ 5 years of experience in providing anaesthesia care.

Table II to V shows the Delphi consensus levels of items at the end of two rounds. Number of items that attained consensus increased from 25 (51.0%) in the first round to 37 (75.5%) at the end of round two. The greatest increase in consensus occurred for items assigned ASA III and IV. Consensus was obtained for 77.3% of items assigned ASA III (Table IV) and 100% of items assigned ASA IV (Table V). Three items (age> 75 years, disseminated intravascular coagulation and obstetric haemorrhage with Hb <6 g/dL) did not achieve consensus in one assigned class, but achieved consensus when assigned another ASA class.

Consensus was not achieved for nine items after two Delphi rounds. They pertain to: alcohol intake of 1-2 pints twice a week, asthma with monthly attacks on home therapy, thyroid disease, exercise tolerance of one flight of stairs and stable angina. As consensus was attained for at least 75% of items after round two, it was deemed unnecessary to proceed with another consensus round and the study was terminated.

Discussion

Delphi consensus was attained for 37 out of 49 clinical items (75.5%), facilitating their inclusion in a rule-based clinical support system designed to automate the prediction of ASA physical status. We postulate that the moderate level of consensus obtained could reflect the similarity in training background among anaesthesia providers at our setting of predominantly obstetric and gynecological cases. The literature also suggests an increased inter-rater agreement in ASA classification when raters share common training background and experience [11].

Three clinical items did not achieve consensus in one allocated ASA class but attained consensus in another class. They are: age > 75 years, disseminated intravascular coagulation and obstetric haemorrhage with Hb < 6g/dL.

Age > 75 years

Age alone is not a criterion for ASA classification, although chronic diseases are more prevalent with age. Advanced age is also a risk factor for increased morbidity and mortality. Technically, ASA scoring should be based on the assessment of underlying organ function due to deterioration with age or disease and not simply by an age cut-off. However, anaesthesiologists have been known to score otherwise healthy patients as ASA II, based on an arbitrary age criterion that ranges from 60 to 75 years [34], as shown by participants of this study.

Disseminated intravascular coagulation

Disseminated intravascular coagulation (DIC) is a condition characterized by macro- and microvascular thrombosis and progressive consumption coagulopathy. In pregnancy, it can be triggered by placental abruption, placenta previa, amniotic fluid embolism, intrauterine death, eclampsia and HELLP syndrome. The mortality rate for DIC is reported to be 20% to 50% [35]. Hence, it is not surprising that a consensus rating of ASA IV was attained in this study.

Obstetric haemorrhage with Hb<6g/dL

Obstetric haemorrhage is a leading cause of maternal mortality, accounting for 27% of all maternal deaths [36]. As our institution is an obstetric tertiary referral centre, anaesthesia providers have had first-hand experience managing life-threatening obstetric haemorrhage, including placenta accreta spectrum disorders [37]. We postulate that their clinical experience has likely influenced the group consensus of ASA IV for acute obstetric haemorrhage complicated by severe anaemia.

Nine items did not achieve consensus in ASA rating after both Delphi rounds. They are: alcohol consumption of 1-2 pints twice a week, asthma with monthly attacks managed by home therapy, thyroid disease with and without thyroid storm, exercise tolerance of one flight of stairs and stable angina.

Alcohol intake

Participants could not reach a consensus to assign ASA II or III for the alcoholic consumption of 1-2 pints twice a week. Based on the latest ASA guidelines, 'minimal alcohol intake' is an example of ASA I while 'social drinking' is considered ASA II [2]. The ASA definitions do not define differential volumes and alcoholic concentrations. However, the US Department of Agriculture defines social

drinking as limitation to ≤2 drinks a day in men and ≤1 drink a day in women [38]. Accordingly, the intake of 1-2 pints of alcohol twice a week would be considered minimal and should warrant an ASA I classification. Our results suggest that participants were likely to be up-to-date with current guidelines on alcohol consumption and of the opinion that the consumption of 1-2 pints twice a week warranted ASA I classification.

Asthma

No consensus was achieved for ASA II classification of a case of asthma with monthly attacks that could be controlled by home therapy. Definitions of the ASA have been criticised for their subjective nature [6-9] and this is a case in point. "Asthma with exacerbation," as an approved example for ASA III, is vague and does not quantify frequency and severity, thus posing a challenge to differentiate between ASA II and III. We postulate that participants were probably mixed in their opinion to assign ASA II and III, thereby accounting for the results obtained.

Thyroid disease

The ASA does not provide approved examples of thyroid disease [2]. The item description of "active thyroid disease with abnormal levels of thyroid hormone" is vague as it does not detail the symptomatology or serum thyroid hormone levels. Without the benefit of clinical examination and laboratory thyroid measurements, we postulate that majority of participants had chosen to adopt a more conservative approach in assigning ASA III to a case of active thyroid disease in the absence of thyroid storm. This could account for the lack of consensus to assign ASA II. In the presence of a thyroid storm

– a condition associated with a mortality of 10% [39], ASA IV would be the appropriate option, hence explaining the failure to achieve consensus for ASA III among participants.

Exercise tolerance

Exercise tolerance is an important predictor of cardiovascular complications after non-cardiac surgery [40]. In the preoperative setting, exercise tolerance can be estimated from activities of daily living, using metabolic equivalents (METs), where 1 MET is the resting oxygen consumption of a 40-year-old, 70-kg man [41, 42]. Exercise tolerance for one flight of stairs or ≥4 METs [40] is usually used as a discriminator for further preoperative cardiac testing [41]. In the present study, participants concur that exercise capacity of one flight of stairs constitute ASA III but could not agree that exercise capacity of two flights of stairs constitutes ASA II physical status.

Some authorities have argued that exercise tolerance may be better utilized as an indicator for further cardiac testing [43]. In one study, exercise tolerance <4 METs was used to further stratify a broad category of ASA III vascular patients for more accurate risk prediction [44].

Stable angina

Stable angina is characterized by chest pain that is precipitated by exertion but relieved with rest or medication. In the ASA guidelines and approved examples [2], myocardial infarct is listed as an approved example, with onset of 3 months as a discriminator between ASA III and ASA IV. Besides this temporal relationship, stable and unstable angina were not provided as approved ASA examples.

Hence, participants could have drawn upon their own varied clinical experience for interpretation, resulting in the lack of consensus.

Findings of this study provide a preliminary platform to establish decision 'rules' for the automated prediction of ASA scores, with benefits of improved productivity and consistency in classification. A CDSS can be knowledge-based and implemented as a conditional logic, or non-knowledge-based, using artificial intelligence to derive patterns from clinical data sets [45, 46]. Clinical decision support systems aid clinical decision making [47] and have been implemented for direct patient care [48, 49, 50], or to improve compliance to protocols and quality measures [51, 52]. More recently, CDSSs incorporating the automated prediction of ASA physical status have been reported [24, 53]. In one study, data from a web-based preoperative assessment system was processed using decision logic to provide automated computation of the ASA scores [24]. Except for 159 cases (or 1.1%), the computed ASA scores showed close agreement with ASA scores estimated clinically by a heterogeneous group of anaesthesia providers. Machine learning approaches have also been developed to predict ASA scores [53]. However, quality of the algorithm's output would then be highly dependent on the quality and size of data sets. A simple and basic CDSS based on the "IF THEN" rule could be designed using data from the present study. For example, a patient with age > 75 years would automatically be assigned an ASA score of II based on the consensus attained, unless it is superseded by another condition that warrants a higher ASA score.

There are strengths and limitations in the present study. Although the sample size is only 37, a 100% response rate was obtained in both Delphi rounds. To ensure robustness of Delphi, all items in Round 1 were maintained in Round 2 to allow every item an equal chance of attaining consensus at each round.

The re-circulation of items also allows for comparison of IQR which indicates if consensus had been present throughout or only developed between rounds. The study was conducted at a single institution with its unique case-mix and hence, external validity of results is limited. The level of consensus could vary in another population of anaesthesia providers or if the same population of anaesthesia providers are surveyed at a future date. Controversial items could have been repeated under other ASA classes to give participants the chance to achieve consensus in these ASA classes. To develop an accurate and robust system for automated ASA classification, consensus should ideally be achieved for all items. This may be achieved by training participants in ASA assessment. Future research should also seek to evaluate consensus on a wider range of clinical entities that include clinical and laboratory data to improve internal validity of the system. Consensus could also be evaluated through clinical vignettes oriented to local practice as this has been shown to improve internal consistency of ASA classification [54, 55].

Conclusion

In the present study, Delphi consensus in ASA classification was attained for 37 out of 49 (75.5%) clinical entities commonly encountered at this tertiary women's hospital. This facilitates the development of a rule-based CDSS for the automated prediction of ASA classification in a preanaesthesia health assessment application. Future research should seek consensus in ASA classification on a wider range of clinical conditions and vignettes to improve internal validity.

References

1. Pasternak LR, Arens JF, Caplan RA, Connis RT, Fleisher LA, Flowerdew R, et al. Practice advisory for preanesthesia evaluation: an updated report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. Anesthesiology 2012;116:522-38.

2. American Society of Anesthesiologists' Committee of Oversight: Economics. ASA physical status classification system. [Guidelines, statements, clinical resources on internet]. 2020 Dec 13. Available from www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system.

3. Wolters U, Wolf T, Stutzer H, Schroder T. ASA classification and perioperative variables as predictors of postoperative outcome. Br J Anaesth 1996;77:217-22.

4. Enneking FK, Radhakrishnan NS, Berg K, Patel S, Wishin JM, Vasilopoulos T. Patient-centered anesthesia triage system predicts ASA physical status. Anesth Analg 2017;124:1957-1962.

5. De Cassai A, Boscolo A, Tonetti T, Ban I, Ori C. Assignment of ASA-physical status relates to anesthesiologists' experience: a survey-based national-study. Korean J Anesthesiol 2019;72:53-59.

6. Mak PH, Campbell RC, Irwin MG; American Society of Anesthesiologists. The ASA Physical Status Classification: inter-observer consistency. American Society of Anesthesiologists. Anaesth Intensive Care 2002;30:633-40.

7. Owens WD, Felts JA, Spitznagel EL Jr. ASA physical status classifications: a study of consistency of ratings. Anesthesiology 1978;49:239-43.

8. Haynes SR, Lawler PG. An assessment of the consistency of ASA physical status classification allocation. Anaesthesia 1995;50:195-9.

9. Ranta S, Hynynen M, Tammisto T. A survey of the ASA physical status classification: significant variation in allocation among Finnish anaesthesiologists. Acta Anaesthesiol Scand 1997;41:629-32.

10. Ihejirika RC, Thakore RV, Sathiyakumar V, Ehrenfeld JM, Obremskey WT, Sethi MK. An assessment of the inter-rater reliability of the ASA physical status score in the orthopaedic trauma population. Injury 2015;46:542-6.

11. Kuza CM, Hatzakis G, Nahmias JT. The assignment of American Society of Anesthesiologists physical status classification for adult polytrauma patients: results from a survey and future considerations. Anesth Analg 2017;125:1960-6.

12. Jacqueline R, Malviya S, Burke C, Reynolds P. An assessment of interrater reliability of the ASA physical status classification in pediatric surgical patients. Paediatr Anaesth 2006;16:928-31.

13. Tait AR, Voepel-Lewis T, Munro HM, Gutstein HB, Reynolds PI. Cancellation of pediatric outpatient surgery: economic and emotional implications for patients and their families. J Clin Anesth 1997;9:213-9.

14. Van Klei WA, Moons KGM, Rutten CL, Schuurhuis A, Knape JTA, Kalkman CJ, et al. The effect of outpatient preoperative evaluation of hospital inpatients on cancellation of surgery and length of hospital stay. Anesth Analg 2002;94:644–649.

15. Goodhart IM, Andrzejowski JC, Jones GL, Berthoud M, Dennis A, Mills GH, et al. Patient-completed, preoperative web-based anaesthetic assessment questionnaire (Electronic Personal Assessment Questionnaire PreOperative): Development and validation. Eur J Anaesthesiol 2017;34:221-228.

16. Vitkun SA, Gage JS, Anderson DH 2nd, Williams SA, Halpern-Lewis JG, Poppers PJ. Computerization of the preoperative anesthesia interview. Int J Clin Monit Comput 1995;12:71-6.

17. VanDenKerkhof EG, Goldstein DH, Blaine WC, Rimmer MJ. A comparison of paper with electronic patient-completed questionnaires in a preoperative clinic. Anesth Analg 2005;101:1075-80.

18. Tompkins BM, Tompkins WJ, Loder E, Noonan AF. A computer-assisted preanesthesia interview: value of a computer-generated summary of patient's historical information in the preanesthesia visit. Anesth Analg 1980;59:3-10.

19. Essin DJ, Dishakjian R, deCiutiis VL, Essin CD, Steen SN. Development and assessment of a computer-based preanesthetic patient evaluation system for obstetrical anesthesia. J Clin Monit Comput 1998;14:95-100.

20. Beers RA, O'Leary CE, Franklin PD. Comparing the history-taking methods used during a preanesthesia visit: the HealthQuiz versus the written questionnaire. Anesth Analg 1998;86:134-7.

21. Howell M, Hood AJ, Jayne DG. Use of a patient completed iPad questionnaire to improve pre-operative assessment. J Clin Monit Comput 2017;31:221-225.

22. Osman T, Lew E, Lum EP, van Galen L, Dabas R, Sng BL, et al. PreAnaesThesia computerized health (PATCH) assessment: development and validation. BMC Anesthesiol 2020;20:286.

23. Osman T, Lew E, Lum E, Chew J, Dabas R, Sng BL, et al. Effect of PreAnaesThesia Computerized Health (PATCH) Assessment on duration of nurse-patient consultation and patient experience: a pilot trial. Int J Environ Res Public Health 2020;17:4972.

24. Zuidema X, Tromp Meesters RC, Siccama I, Houweling PL. Computerized model for preoperative risk assessment. Br J Anaesth 2011;107:180-5.

25. Sim EY, Tan DJA, Abdullah HR. The use of computerized physician order entry with clinical decision support reduces practice variance in ordering preoperative investigations: A retrospective cohort study. Int J Med Inform 2017;108:29-35.

26. Jones J, Hunter D. Consensus methods for medical and health services research. BMJ. 1995;311:376-80.

27. McPherson S, Reese C, Wendler MC. Methodology Update: Delphi Studies. Nurs Res. 2018;67:404-410.

28. Vogel C, Zwolinsky S, Griffiths C, Hobbs M, Henderson E, Wilkins E. A Delphi study to build consensus on the definition and use of big data in obesity research. Int J Obes (Lond). 2019;43:2573-2586.

29. MacLennan S, Kirkham J, Lam TBL, Williamson PR. A randomized trial comparing three Delphi feedback strategies found no evidence of a difference in a setting with high initial agreement. J Clin Epidemiol. 2018;93:1-8.

30. Brunt H, Barnes J, Longhurst J, Scally G, Hayes ET. Enhancing local air quality management to maximise public health integration, collaboration and impact in Wales, UK: a Delphi study. Environ Sci Policy 2018;80:105-16.

31. Heiko A, von der Gracht. Consensus measurement in Delphi studies: review and implications for future quality assurance. Technol Forecast Soc Change 2012;79:1525-36.

32. Schmalz U, Spinler S, Ringbeck J. Lessons learned from a two-round Delphi-based scenario study. MethodsX. 2020;8:101179.

33. Hsu C-C, Sandford BA. The Delphi technique: making sense of consensus. Pract Assess Res Eval 2007;12:10.

34. Akhtar S, Barker SJ, Bose R, Botts A, Burstrom RE, Culley DJ, et al. American Society of Anesthesiologists Committee on Geriatric Anesthesia. Frequently asked questions about anesthetic considerations for elderly patients. [Physician series] 2009. Available from www.sagahq.org/images/FAQs.pdf.

35. Gando S, Saitoh D, Ogura H, Mayumi T, Koseki K, Ikeda T, et al; Japanese Association for Acute Medicine Disseminated Intravascular Coagulation (JAAM DIC) Study Group. Natural history of disseminated intravascular coagulation diagnosed based on the newly established diagnostic criteria for critically ill patients: results of a multicenter, prospective survey. Crit Care Med.2008;36:145-50.

36. Say L, Chou D, Gemmill A, Tunçalp Ö, Moller AB, Daniels J, et al. Global causes of maternal death: a WHO systematic analysis. Lancet Glob Health 2014;2:e323-33.

37. Lional KM, Tagore S, Wright AM. Uterine conservation in placenta accrete spectrum (PAS) disorders: a retrospective case series: is expectant management beneficial in reducing maternal morbidity? Eur J Obstet Gynecol Reprod Biol 2020;254:212-217.

38. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2020-2025. 9th Edition. December 2020. Available at DietaryGuidelines.gov.

39. Chiha M, Samarasinghe S, Kabaker AS. Thyroid storm: an updated review. J Intensive Care Med 2015;30:131-40.

40. Fleisher LA, Fleischmann KE, Auerbach AD, Barnason SA, Beckman JA, Bozkurt B, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 2014;130:2215-45.

41. Reilly DF, McNeely MJ, Doerner D, Greenberg DL, Staiger TO, Geist MJ, et al. Self-reported exercise tolerance and the risk of serious perioperative complications. Arch Intern Med 1999;159:2185-92.

42. Fleg JL, Piña IL, Balady GJ, Chaitman BR, Fletcher B, Lavie C, et al. Assessment of functional capacity in clinical and research applications: an advisory from the Committee on Exercise, Rehabilitation, and Prevention, Council on Clinical Cardiology, American Heart Association. Circulation 2000;102:1591-7.

43. Biccard BM. Relationship between the inability to climb two flights of stairs and outcome after major non-cardiac surgery: implications for the pre-operative assessment of functional capacity. Anaesthesia 2005;60:588-93.

44. Dosluoglu HH, Wang J, Defranks-Anain L, Rainstein M, Nader ND. A simple subclassification of American Society of Anesthesiology III patients undergoing peripheral revascularization based on functional capacity. J Vasc Surg 2008;47:766-72.

45. Sutton RT, Pincock D, Baumgart DC, Sadowski DC, Fedorak RN, Kroeker KI. An overview of clinical decision support systems: benefits, risks, and strategies for success. NPJ Digit Med 2020;3:17.

46. Sim I, Gorman P, Greenes RA, Haynes RB, Kaplan B, Lehmann H, et al. Clinical decision support systems for the practice of evidence-based medicine. J Am Med Inform Assoc 2001;8:527-34.

47. Zikos D, DeLellis N. CDSS-RM: a clinical decision support system reference model. BMC Med Res Methodol 2018; 18:137.

48. Eden A, Pizov R, Toderis L, Kantor G, Perel A. The impact of an electronic reminder on the use of alarms after separation from cardiopulmonary bypass. Anesth Analg 2009;108:1203-8.

49. Nair BG, Grunzweig K, Peterson GN, Horibe M, Neradilek MB, Newman SF, et al. Intraoperative blood glucose management: impact of a real-time decision support system on adherence to institutional protocol. J Clin Monit Comput 2016;30:301-12.

50. Kooij FO, Klok T, Hollmann MW, Kal JE. Decision support increases guideline adherence for prescribing postoperative nausea and vomiting prophylaxis. Anesth Analg 2008;106:893-8.

51. McDonald CJ. Protocol-based computer reminders, the quality of care and the non-perfectability of man. N Engl J Med 1976;295:1351-5.

52. Nair BG, Peterson GN, Newman SF, Wu WY, Kolios-Morris V, Schwid HA. Improving documentation of a beta-blocker quality measure through an anesthesia information management system and real-time notification of documentation errors. Jt Comm J Qual Patient Saf 2012;38:283-8.

53. Lazouni, MEA, Daho MEH, Settouti N, Chikh MA, Mahmoudi S. Machine learning tool for automatic ASA detection. In: Modeling Approaches and Algorithms for Advanced Computer Applications. Edited by Amine A, Otmane AM, Bellatreche L: Cham, Springer International Publishing. 2013, pp9-16.

54. Hurwitz EE, Simon M, Vinta SR, Zehm CF, Shabot SM, Minhajuddin A, et al. Adding examples to the ASA-Physical Status classification improves correct assignment to patients. Anesthesiology 2017;126:614-622.

55. Aronson WL, McAuliffe MS, Miller K. Variability in the American Society of Anesthesiologists Physical Status Classification scale. AANA J 2003;71:265-74.

Table I. Demographic characteristics of respondents (n=37)

	Frequency	Percent
Gender		
M / F	17 / 20	45.9 / 54.1
Job position		
Consultants	15	43.2
Non-consultants	22	56.8
Years of experience		
1 to < 5	9	24.3
≥ 5	28	75.7

Table II. Consensus levels achieved for clinical items assigned ASA I

Items	Round 1				Round 2				
ASA I	PA*	Median†	IQR	SD	PA*	Median†	IQR	SD	Outcome‡
Age > 75 years old	59.5	3	1.0	0.90	54.1	3	1.0	0.80	**No**
No or minimal alcohol use	100	4	1.0	0.48	94.6	4	1.0	0.58	Yes
BMI 28	83.8	3	1.0	0.79	70.3	3	1.0	0.82	Yes

* Percentage agreement (% of "agree" and "strongly agree" responses)

† Median Likert score (1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree)

‡ Consensus outcome (No= consensus not achieved, Yes= consensus achieved)

Consensus is said to be achieved if PA ≥ 70%, IQR ≤1.0 and SD <1.0

Table III. Consensus levels achieved for clinical items assigned ASA II

Items	Round 1				Round 2				
ASA II	PA*	Median†	IQR	SD	PA*	Median†	IQR	SD	Outcome‡
Current smoker of 10 pack years	86.5	3	1.0	0.69	81.1	3	1.0	0.70	Yes
Alcohol use of 1-2 pints of drink twice a week	56.8	3	1.0	0.79	62.2	3	1.0	0.62	No
Pregnancy with twins	81.1	3	1.0	0.76	86.5	3	0	0.60	Yes
Obesity with BMI 32	81.1	3	1.0	0.71	78.4	3	0	0.71	Yes
Chronic schizophrenia on medications	89.2	3	1.0	0.65	89.2	3	1.0	0.67	Yes
Diabetes and Hb A1c 6.5%	97.3	3	1.0	0.56	94.6	3	1.0	0.57	Yes
Hypertension and BP readings < 150/90 mmHg	89.2	3	1.0	0.71	94.6	3	1.0	0.57	Yes
Asthma with attacks once a month that are controlled by home therapy	75.7	3	1.5	0.87	73.0	3	1.5	0.83	No
Anaemia with Hb 10 g/dL	97.3	3	1.0	0.51	91.9	3	0.5	0.55	Yes
Age > 75 years	59.5	3	1.0	0.66	75.7	3	0.5	0.55	Yes
Exercise tolerance of 2 flights of stairs	45.9	3	2.0	1.11	21.6	2	0	0.60	No
Obstructive sleep apnoea with STOP BANG 3	78.4	3	0	0.66	81.1	3	0	0.48	Yes
Active thyroid disease with abnormal levels of free thyroxine but not in thyroid storm	45.9	2	1.0	0.87	27.0	2	1.0	0.57	No
Disseminated intravascular coagulation	2.7	1	1.0	0.51	2.7	1	0.5	0.51	No
Obstetric haemorrhage with Hb 6 g/dL	16.2	1	1.0	0.55	2.7	1	1.0	0.55	No

* Percentage agreement (% of "agree" and "strongly agree" responses)

† Median Likert score (1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree)

‡ Consensus outcome (No= consensus not achieved, Yes= consensus achieved)

Consensus is said to be achieved if PA ≥ 70%, IQR ≤1.0 and SD <1.0

Table IV. Consensus levels achieved for clinical items assigned ASA III

Items	Round 1				Round 2				
ASA III	PA#	Median†	IQR	SD	PA#	Median†	IQR	SD	Outcome‡
Poorly controlled diabetes with HbA1c 10%	91.9	3	1.0	0.72	97.3	3	1.0	0.61	Yes
Hypertension and BP readings 160/105 mmHg	91.9	3	1.0	0.72	100	3	1.0	0.45	Yes
Chronic obstructive lung disease with daily exacerbations	62.2	3	2.0	1.10	78.4	3	1.0	0.88	Yes
BMI 42	89.2	4	1.0	0.77	94.6	4	1.0	0.58	Yes
BMI 38	59.5	3	1.5	0.85	75.7	3	0.5	0.72	Yes
Active hepatitis by clinical presentation and investigation results	70.3	3	2.0	0.80	81.1	3	0	0.65	Yes
Effort tolerance of one flight of stairs	64.9	3	1.0	0.69	78.4	3	0	0.42	Yes
Atrial fibrillation, rate 150 bpm	64.9	3	2.0	1.04	75.7	3	0.5	0.85	Yes
Myocardial ejection fraction 40%	83.8	3	1.0	0.71	97.3	3	0	0.46	Yes
End stage renal disease undergoing regularly scheduled peritoneal dialysis	56.5	3	1.0	0.86	94.6	3	0	0.59	Yes
End stage renal disease undergoing regularly scheduled haemodialysis	86.5	3	1.0	0.88	94.6	3	0	0.57	Yes
Myocardial infarct 6 months ago	83.8	3	1.0	0.69	91.9	3	0	0.52	Yes
Cerebrovascular accident or transient ischaemic attack 4 months ago	78.4	3	1.0	0.80	86.5	3	0.5	0.68	Yes
Coronary stenting 6 months ago	86.5	3	1.0	0.63	94.6	3	0	0.46	Yes
Implanted pacemaker	83.8	3	1.0	0.79	97.3	3	0	0.44	Yes
Chest pain exacerbated by exertion and resolved with rest	51.4	3	1.5	0.83	51.4	3	1.0	0.68	**No**
Mitral stenosis with valve area 1.5 cm2	73.0	3	1.0	0.66	81.1	3	0	0.58	Yes
Obstructive sleep apnoea with STOP BANG 5-6	83.8	3	1.0	0.76	86.5	3	0	0.65	Yes
Active thyroid disease with abnormal levels	27.0	2	2.0	1.04	24.3	2	1.5	0.97	**No**

of free thyroxine and in thyroid storm								
Disseminated intravascular coagulation	40.5	2	2.0	1.07	27.0	2	1.5	1.00	**No**
Obstetric haemorrhage with Hb 6 g/dL	35.1	2	1.0	0.96	29.7	2	1.0	0.88	**No**
Alcohol use of > 1-2 pints of drink twice a week (where 1 pint = 500ml)	32.4	2	1.0	0.62	24.3	2	0.5	0.64	**No**

* Percentage agreement (% of "agree" and "strongly agree" responses)

† Median Likert score (1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree)

‡ Consensus outcome (No= consensus not achieved, Yes= consensus achieved)

Consensus is said to be achieved if PA ≥ 70%, IQR ≤1.0 and SD <1.0

Table V. Consensus levels achieved for clinical items assigned ASA IV

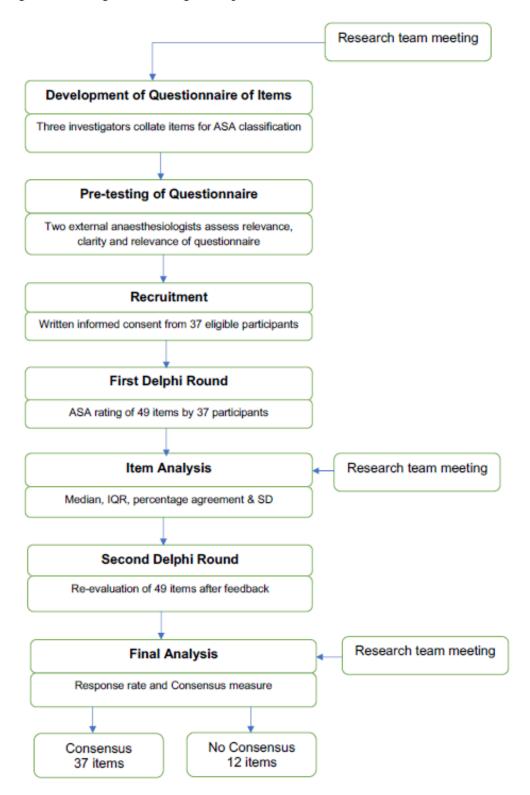| Items	Round 1				Round 2				Outcome‡
ASA IV	PA#	Median†	IQR	SD	PA#	Median†	IQR	SD	
Atrial fibrillation, rate 180 bpm	100	4	1.0	0.48	100	4	0	0.40	Yes
Myocardial infarct 2 months ago	75.7	3	1.5	0.83	89.2	4	1.0	0.65	Yes
Cerebrovascular accident or transient ischaemic attack 3 months ago	64.9	3	2.0	0.91	83.8	3	1.0	0.66	Yes
Coronary stenting 2 months ago	67.6	3	2.0	0.88	81.1	3	0	0.65	Yes
Effort tolerance less than or equal to one flight of stairs	59.5	3	1.0	0.82	70.3	3	1.0	0.65	Yes
Mitral stenosis with valve area 0.8 cm2	81.1	3	1.0	0.79	89.2	3	0	0.57	Yes
Myocardial ejection fraction of 20%	83.8	4	1.0	0.76	91.9	3	1.0	0.63	Yes
Disseminated intravascular coagulation	94.6	4	1.0	0.61	100	4	1.0	0.45	Yes
Obstetric haemorrhage with Hb 6 g/dL	73.0	3	2.0	0.89	84.8	3	1.0	0.99	Yes

* Percentage agreement (% of "agree" and "strongly agree" responses)

† Median Likert score (1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree)

‡ Consensus outcome (No= consensus not achieved, Yes= consensus achieved)

Consensus is said to be achieved if PA ≥ 70%, IQR ≤1.0 and SD <1.0

Figure 1 Flow diagram illustrating the Delphi method used.

Research team meeting

Development of Questionnaire of Items

Three investigators collate items for ASA classification

Pre-testing of Questionnaire

Two external anaesthesiologists assess relevance, clarity and relevance of questionnaire

Recruitment

Written informed consent from 37 eligible participants

First Delphi Round

ASA rating of 49 items by 37 participants

Item Analysis

Median, IQR, percentage agreement & SD

Research team meeting

Second Delphi Round

Re-evaluation of 49 items after feedback

Final Analysis

Response rate and Consensus measure

Research team meeting

Consensus
37 items

No Consensus
12 items