ARTICLE REVIEW

Scoring Systems in Anesthesia

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Abstract: Risk predictors and scoring systems are commonly used in medicine to provide a reliable and objective estimation of disease prognosis, probability of adverse events and outcome. Different scoring systems are available to stratify perioperative risk and adverse events in anesthesia. The most commonly used is the American Society of Anesthesiologists (ASA) score. While it is easy to use, the ASA score has not fulfilled all of the ideals and many other scores have been developed with respect to organ systems e.g. (cardiovascular system, neurological system, liver and hematological diseases). Postoperative recovery is a complex process related to various outcomes. The recovery can be divided into three distinct phases. Early (phase I) recovery is usually achieved by the fast-tracking scoring system. Intermediate (phase II) recovery is usually achieved by using the postanesthesia discharge scoring system (PADSS) and the modified postanesthesia discharge scoring system (MPADSS). Patients are then discharged home to complete full recovery (phase III). The Ramsay Scale continues to be the most widely used scale for monitoring sedation in adults. However, it includes several categories that are not relevant for young infants**.** The Comfort scale is the most practical scoring system for pediatrics. The measurement of satisfaction in anesthesia practice is considered as an important healthcare outcome measure. Various tests have been used to evaluate motor blockade during regional anesthesia. The most widely used, is the Bromage scale**.** Moreover, several scoring systems have been proposed for predicting post-operative nausea and vomiting. The Koivuranta et al or Apfel et al simplified scoring systems are the current preferred in adults, and the Eberhart et al simplified system are the current preferred choice for use in children.

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Background:

Risk predictors and scoring systems are commonly used in medicine to provide a reliable and objective estimation of disease prognosis. They were designed to classify severity of illness and to perform risk stratification for scientific studies in a standardized way. The main improvements in scoring systems have consisted of simplification and, hence, increased user-friendliness, rather than performance enhancement. The simplified scoring systems obviate laborious calculations and may reduce the scope of required detailed history-taking but have demonstrated equivalent or superior discriminating power compared with more complex formulas. In addition they are more workable in clinical practice. (1)

Different scoring systems and classifications are available to stratify perioperative risk and adverse events in anesthesia. Perioperative risk assessment starts by identifying the type of surgery to be performed and the type of patient. These two factors determine the risk of complications. The most commonly used is the American Society of Anesthesiologists (ASA) score. While it is easy to use, the ASA score has not fulfilled all of the ideals and many other scores have been developed with respect to organ systems e.g. (cardiovascular system, neurological system, liver and hematological diseases). Furthermore, there are scoring-systems for special events, such as difficult laryngoscopy, Recovery scores, Satisfaction scores, Regional anesthesia scores and post-operative nausea and vomiting (PONV).

Pre-operative risk scores

ASA physical status classification system

The ASA classification is a system for assessing the fitness of patients before surgery. In 1963, the ASA adopted the five-category physical status classification system and a sixth category was later added (table 1) *[(2).]* If the surgery is an emergency, the physical status classification is followed by “E” (for emergency) for example “3E”. The class 5 is usually an emergency and is therefore usually "5E". The class "6E" does not exist and is simply recorded as class "6", as all organ retrieval in brain-dead patients is done urgently. *[(3).]*

ASA classification is easy to be applied, simple, subjective, used for many years, remains the only score routinely used in most surgical emergency cases and may be applied inconsistently by different anesthetists. It was not designed to predict mortality but it has been shown to give a good estimate of mortality risk [(4)]. It is reported that In ASA class 1, the mortality and morbidity is 0.41/1,000 and this increases in classes IV and V to reach 9.6/1,000 and with emergency surgeries ASA I mortality and morbidity is 1/1,000 and this increases to 26.5/1,000 in classes IV and V. [(5)].

Limitations in the ASA classification has been pronounced as it neither does consider the patient age, sex, weight and pregnancy nor the nature of the planned surgery, the skill of the anesthetist or surgeon, the degree of pre-surgical preparation or the facilities for postoperative care [(6)]. The terms minor, intermediate and major are used to categorize the complexity of surgery. However, the assumption is that these terms are intuitive and self-explanatory [(7)]. The word 'systemic' in ASA classification creates a lot of confusion, (as it means a generalized disorder). For example, myocardial infarction (MI), though grave, is a 'local' disease and is not a 'systemic' disease, yet has poor post-surgery survival rates. Similarly, liver cirrhosis, chronic obstructive pulmonary disease, severe asthma, peri-nephric abscess, badly infected wounds, intestinal perforation, skull fracture, etc [(2)]. Another limitation is the missing class between ASA 2 and ASA 3 for a systemic disease which is of moderate nature. It is also not clear what will be the ASA classification of a patient who is suffering simultaneously from two, three or more systemic diseases (which might be of different severity). [(7)].

Several studies tried to find a modification to improve the ASA classification. ***Barbetio and colleagues*** had suggested the addition of a modifier G for pregnancy. As the pregnant patient presents physiologic disturbances that may increase her anesthetic risk [(8)]. Another study done by ***Tomoaki and Yoshihisa*** reported that the ASA class II is very broad and does not accurately reflect the patients' risk. They assessed 1933 patients scheduled for surgical procedures by ASA protocol dividing classes I and II into *a* and *b*. [(9)].

Class I: I*a*: Normal healthy patient, I*b*: Patient with mild systemic disease or normal healthy patient with anesthetic or operative risk.

Class II: II*a*: Patient with moderate systemic disease or patient with mild systemic disease with anesthetic or operative risk, II*b*: Patient with moderate to severe systemic disease that does not limit activity or patient with moderate systemic disease with anesthetic or operative risk.[(9)]

Cardiovascular system scoring systems

Scoring systems to estimate cardiac Risk in non-cardiac surgery:

Revised Cardiac Risk Index (RCRI)

Goldman monitored 2893 patients undergoing elective major non-cardiac procedures and identified six independent predictors of major cardiac complications (defined as MI, pulmonary edema, ventricular fibrillation or primary cardiac arrest, and complete heart block) [(10)]. The risk of major cardiac complications varied according to the number of risk factors (table 2). The RCRI has better predictive value than the original Goldman index or the Detsky modified risk index. [(11)].

Risk stratification models in cardiac surgery

During the last decades, several risk-scoring systems have been developed as initial Parsonnet, Cleveland Clinic, French, EuroSCORE (European System for Cardiac Operative Risk Evaluation) and Pons and Ontario Province Risk (OPR) scores (data not shown). However, there are significant differences between scores with regard to score design and the initial patient population on which score development was based [(12)]. On comparing the 6 risk scoring models, ***Geissler et al***, found that the Euro score yielded the highest predictive value in patient population undergoing heart surgery with cardiopulmonary bypass [(13)]. While ***Nilsson et al***, found that the Euro score, Cleveland clinic showed superior performance and accuracy in open-heart surgery, and Euro score and Cleveland clinic in CABG-only surgery [(14)].

Limitations of these models, is that the predictive accuracy of all risk-score algorithms is influenced by variable definitions, management of incomplete data field, geographic differences in patient risk factors and surgical procedure selection criteria [(14)]. In addition, accuracy and discriminative power can be fairly independent, as a model that soundly over- or under-estimates the probability of death can be efficient in discriminating patients who will survive from those who will die. [(15)].

Modifications to the previous models try to solve some problems. The original initial Parsonnet's score was modified, including thirty new risk factors. These new risk factors take the place of the 2 imprecise risk factors catastrophic states and other rare circumstances of the initial score, and this new score is referred to as the 'modified Parsonnet's score [(16)]. The original Euro score model are now aging and a new model – Euro score II - was announced. [(17)].

Central nervous system scoring system:

The central nervous system scoring system has been constructed to improve communication among health care personnel and also to standardize examination of the unconscious patient. [(18)].

The Glasgow Coma Scales:

The Glasgow Coma Scale (GCS) (table 3) was created by ***Jennet and Teasdale*** in 1974 to assess the depth and duration of impaired consciousness and coma for a wide range of situations such as trauma, cerebrovascular accidents, infections, and metabolic conditions [(19).] Individual elements as well as the sum of the score are important. Hence, the score is expressed in the form "GCS 9 = E2 V4 M3 at 07:35". This number helps medical practioners categorize the four possible levels for survival, with a lower number indicating a more severe injury and a poorer prognosis [(20).] Generally, comas are classified into (severe, with GCS ≤ 8, moderate GCS from 9 – 12 and minor, GCS ≥ 13). [(21).]

A modified version of the scale (table 3) the Pediatric Glasgow Coma Scale (PGCS) was created for children too young to talk [(22).] The ***interpretation*** of the Modified Glasgow Coma Scale for Infants differs from the adult one. (PGCS) of 12 or more suggests a severe head injury, (PGCS) between 7 and 12 suggests need for intubation and ventilation while (PGCS) 6 or less suggests need for intracranial pressure monitoring. [(23).]

The GCS is simple, has a relatively high degree of reliability and correlates well with outcomes following severe brain injury [(24).] The numeric scoring system is time-efficient and easy to sum. Changes in neurological status can be easily detected because of the range of responses associated with the scoring system. It is also used as a component of several other outcome prediction scores [(25)].

The GCS is not an exact science. It has some ***disadvantages***, as some people with very low scores have gone on to make almost complete recoveries, while those with high scores have suffered from lifelong disabilities. [(26).] If one component of the GCS (eyes, verbal, motor) cannot be assessed, the total score loses its value. The GCS does not account for the inability to test for responses in situations such as an intubated patient, a patient with eyes swollen shut due to maxillofacial fractures, a chemically or functionally paralyzed patient, or a patient who speaks a foreign language [(27).] Another problem with the GCS is that abnormal brainstem reflexes, changing breathing patterns, and the need for mechanical ventilation could reflect severity of coma, which is not included within the scale. [(28).]

Failure of the GCS to incorporate brainstem reflexes, supported the thinking for modification for this scale [(28).] One of the modifications of the GCS is **the Glasgow Liege Scale**. It was developed in 1982 by Liege and combines the Glasgow Scale with a quantified analysis of five brain stem reflexes: fronto-orbicular, vertical oculocephalic, pupillary, horizontal oculocephalic and oculocardiac [(29).] Although the Glasgow–Liege Coma Scale incorporated examination of some brainstem reflexes, these reflexes included rapid neck movements to obtain oculovestibular reflexes and eyeball pressure to obtain oculocardiac reflexes, these reflexes could further jeopardize patients who had additional spinal trauma and hemodynamic instability. [(30).]

The Full Outline of Unresponsiveness (FOUR) coma score

The (FOUR) score is a new coma score that was developed in 2005 by considering the limitations of the GCS. The FOUR score assesses four domains of neurological function: eye responses, motor responses, brainstem reflexes, and breathing pattern (figure 1)[(97)].

There are significant ***advantages*** over the GCS score. The FOUR score remains testable in neurologically critically ill patients who are intubated. Intubation invalidates one of the three components of the GCS. The FOUR score tests essential brainstem reflexes and provides information about stages of brainstem injury that is unavailable with the GCS. The FOUR score also recognizes a locked-in syndrome and a possible vegetative state and signs suggesting uncal herniation. [(98).]

FOUR score did not incorporate the oculovestibular reflexes and oculocardiac reflexes that could further jeopardize patients who had additional spinal trauma and hemodynamic instability [(99)].

Attention to respiratory patterns in the FOUR score not only may indicate a need for respiratory support in stuporous or comatose patients, but also provides information about the presence of a respiratory drive. The FOUR score further characterizes the severity of the comatose state in patients with the lowest GCS score. Finally, the probability of in-hospital mortality was higher for the lowest total FOUR scores when compared with the GCS [(101)].

A major ***disadvantage*** of the FOUR score that it had only been validated at the Mayo Clinic. Bellomo et al 2009 pointed out that caution is warranted for single-center trials. They also recommended that for the FOUR score to compete with the GCS in its widespread use, further work needs to be done regarding the predictive value of the FOUR score [(102)].

Airway scoring systems

Respiratory events are the most common anesthetic related injuries. Many classification systems have been developed in an effort to predict difficulty of tracheal intubation. [(31)]

Mallmpati score

Mallmpati score is used to predict the ease of intubation. It is determined by visibility of the base of uvula, faucial pillars and soft palate. This test is performed with the patient in the sitting position, head in a neutral position, the mouth wide open and the tongue protruding to its maximum. Patient should not be actively encouraged to phonate as it can result in contraction and elevation of the soft palate leading to a spurious picture. To avoid false positive or false negative, this test should be repeated twice. [32] The original Mallampati test used three classes (Class 1 – faucial pillars, soft palate and uvula could be visualized, Class 2 – faucial pillars and soft palate could be visualized but the uvula was masked by the base of the tongue, Class 3 – only soft palate could be visualized). The modification of ***Samsoon and Young***, modified Mallampati test (MMT) describes four classes (figure 2). [33] This score is simple, reproducible, and reliable preanesthetic airway assessment method when performed properly. In addition to difficult tracheal intubation, Mallampati class 3 or 4 is an independent predictor for difficulty of mask ventilation during anesthesia induction and presence of obstructive sleep apnea. [34]

A big ***limitation*** of the MMT is that it requires significant patient cooperation, which is troublesome in patients in the emergency room with altered mental status. [35] The inter-observer reliability of the MMT can be poor and had moderate degree of accuracy. The visibility of the oropharyngeal structures also depends on the patient's position during examination. The classical Mallampati test is done in the sitting patient, with his/her head in the neutral position. However, when performed in the supine position, the test may have a higher positive predictive value and is associated with more true positives than assessment in the sitting position. MMT is also influenced by the patient's ethnic group. The incidence of modified Mallampati Classes 3 and 4 also increases during labor compared with the pre-labor period, and these changes are not fully reversed within 48 hours after delivery. [36]

Respiratory system scoring models

It has been estimated that nearly one fourth of deaths occurring within 6 days of surgery are related to postoperative pulmonary complications. [37] Two prediction models have been developed and validated by **Arozullah** researchers from the National Veterans Affairs Surgical Quality Improvement Program (NSQIP). The first model was designed to predict post-operative respiratory failure (PRF) (the Respiratory Failure Risk Index) and the second model to predict the likelihood of postoperative pneumonia (the Postoperative Pneumonia Risk Index). [38]

Respiratory Failure Risk Index

The Respiratory Failure Risk Index (Table 4) was developed between 1991 and 1993. The model was designed to predict respiratory failure. [39] It provides a useful guide to evaluate preoperative risk for developing PRF. One major ***advantage*** of this model, is that patient characteristics and outcomes were obtained prospectively with a level of clinical detail not found in administrative databases. [39] The respiratory failure risk index is unique in that it includes several patient-specific and operation-specific risk factors simultaneously, allowing for an accurate assessment. [40]

There are several ***limitations*** to this model. Because veterans cared at Veterans Affairs medical centers (VAMCs) have a high level of comorbid conditions, these models may not generalize to other healthier populations. Moreover, women were excluded because of the caseload of the source hospitals. Patient-specific factors such as age and albumin level are likely to be relevant in women, but the associated odds ratios may be different. Another limitation was that other potentially important preoperative risk factors for PRF were not included in the NSQIP as obesity, increased body mass index or impaired pulmonary function test [39].

Postoperative Pneumonia Risk Index (PPRI)

The model was developed between 1997 and 1999. Patients were defined as having postoperative pneumonia if they met the Centers for Disease Control and Prevention definition of nosocomial pneumonia after surgery. [41] PPRI (table 5) may also be useful to clinicians in estimating patient risk for postoperative pneumonia and in targeting perioperative testing and respiratory care to high-risk patients. Other ***advantages*** of the index are that the variables needed to calculate it are readily accessible for almost all patients undergoing major surgery and that it can be calculated at the bedside without expensive preoperative testing. [42]

The PPRI shares the Respiratory Failure Risk Index the same ***limitations***. [43] Another limitation is that bias in determining postoperative pneumonia may have occurred because postoperative chest radiographs and sputum cultures were not performed for all patients and were obtained on the basis of routine clinical care. [43] In addition, the authors described complications associated with pneumonia (for example, respiratory failure, sepsis, and myocardial infarction) but did not tell us how many patients had only pneumonia and, for those with multiple complications, whether or not pneumonia was the index or first complication.[44]

Hepatic dysfunction scoring systems

The reported mortality rates in patients with cirrhosis undergoing various non-transplant surgical procedures are unacceptably high, ranging from 8.3% to 25%, in comparison to 1.1% in non-cirrhotic patients. So, risk stratification models are necessary to predict and improve postoperative outcomes of patients with cirrhosis. [45]

Child-Turcotte classification of liver disease:

Child and Turcotte in 1964 designed their classification (table 6) to predict mortality in cirrhotic patients. Patients were classified according to increasing severity from class A to class C. Although this classification is simple and easy but the ***limitation*** was that 3 of the elements (ascites, encephalopathy and nutrition) are very subjective. [46] **Pugh et al** in 1973, published a modification of the original Child-Turcotte classification (table 6). This classification allowed better grading of ascites and encephalopathy and substituted prothrombin time (PT) in place of the nutritional status. To determine surgical risk, each parameter in class A, B and C was assigned 1, 2 and 3 scoring points respectively. Total points of 5-6, 7-9 and 10-15 were denoted good, moderate and poor surgical risk respectively. [47] Although mortality increases through the grades, the ability of the Child-Pugh score to predict those likely to die was not satisfactory since many patients died in grades A and B. [48] The main ***application*** of Child–Pugh score has been to select patients for prognostic analyses, for retrospective assessment of non-randomly administered therapy or for randomized clinical trials. Contrasting with its wide validation as a prognostic index, Child–Pugh score is seldom incorporated into algorithms for the management of individual patients, with the exception of patient selection for surgical resection of hepatocellular carcinoma. [49]

A first ***limitation*** of these scores is related to the fact that the five basic components of Child–Pugh score have been selected empirically, however, studies reported thereafter, have shown that these variables have a statistically significant impact on the outcome. [50] A second ***limitation*** comes from the arbitrary use of cut-off values for the quantitative variables. [51] A third ***limitation*** is that each variable is given the same weight which may results in overestimating or underestimating their real impact. [52] A fourth ***limitation*** is due to the fact that important prognostic factors are not taken into account as creatinine and markers of portal hypertension [53] ***Lastly***, it does not take into account the cause of cirrhosis, the possible coexistence of several causal factors, and the persistence of a damaging process such as persistent alcohol abuse, ongoing viral hepatitis or autoimmune hepatitis. [54]

Scoring systems in hematology

Disseminated intravascular coagulation (DIC) Scoring system

DIC isn't an illness on its own but rather a complication or a progression of other illnesses. [55] DIC exists in both acute and chronic forms. The International Society on Thrombosis and Haemostasis (ISTH) proposes a definition and a diagnostic scoring system for a stressed but decompensated hemostatic system (overt DIC). In addition, a template for a similar scoring system for a stressed, but compensated hemostatic system (non-overt DIC) is formulated. [56].

Overt DIC score

The ISTH and the Japanese Association for Acute Medicine (JAAM) DIC study group announced DIC diagnostic criteria (table 7). Both systems have been prospectively validated and have a high diagnostic rate; they used simple laboratory tests that are available in almost all hospital laboratories. However, the JAAM criteria seem to have an advantage for selection of patients with early DIC. [57]

Non-overt DIC score

The subcommittee proposes a framework for a scoring system for non-overt DIC (table 7). [56] However, diagnosing the presence and severity of non-overt DIC using the ISTH scoring system can be complicated. For example, utilization of negative scores does not accurately reflect parametric changes, and does not display significant differences in sensitivity and specificity calculations for mortality. Therefore, in the ISTH modified criteria, negative scores were rejected. The modified ISTH criteria can be used for the early detection of non-overt DIC, and may be useful for the improvement of outcomes of non-overt DIC patients. [58].

Recovery scores

Postoperative recovery is a complex process related to various outcomes, such as physiological end-points, incidence of adverse events, and change in psychological status. The recovery process may last many days and can be divided into three distinct phases. *Early (phase I) recovery* lasts from discontinuation of anesthesia until patients awaken and regain their vital protective reflexes and motor functions. This is usually achieved by using the fast-tracking scoring system. *Intermediate (phase II) recovery* denotes immediate clinical recovery as coordination and ambulation allowing home-readiness. This is usually achieved by using the postanesthesia discharge scoring system (PADSS) and the modified postanesthesia discharge scoring system (MPADSS). Patients are then discharged home to complete full recovery including its psychological component, a stage termed late *(phase III) recovery*. [59]

The fast-tracking scoring system

Newer anesthetics and techniques may allow more rapid awakening and phase I early recovery may be completed in the operating room. Then, patients are transferred directly to the ampulatory surgical unit, bypassing the PACU, a process known as fast-tracking. [60] The proposed fast-tracking scoring system (table 8) takes in consideration pain and emetic symptoms, added to the modified Aldrete five parameters completing 14 scoring points. A minimal score of 12 would be required for a patient to bypass the PACU. [61] Its main ***advantage***, is that it takes in consideration pain and emetic symptoms. Also using these fast-track criteria could limit the number of additional nursing interventions required in the phase II area. In addition, fast-tracking children by using these criteria are feasible and beneficial leading to high parent satisfaction. [62]

The postanesthesia discharge scoring system (PADSS)

Chung 1993, designed his early version of PADSS including 10 points and patients with scores of ≥9 are considered fit for home discharge (table 9). In this way patient discharge is addressed in a simple, clear and reproducible manner. Nurses are able to evaluate the postoperative course of the patient in a systematic way. [63] PADSS had a lot of ***Advantages***; it is simple, practical, easy to apply and to remember. In addition to permitting a uniform assessment of home readiness for patients, PADSS establishes a pattern of routine, repetitive evaluation of patients' home readiness that is likely to contribute to improved patient outcome. In this way, PADSS also may have added medicolegal value. [64] Inspite of its advantages it had some ***Limitations;*** it has been observed that the early version of the PADSS for safe patient discharge required that patients should have taken oral fluids or passed urine before deciding home-readiness. However, Chung found that 20% of outpatients could have been discharged earlier by excluding drinking and urine voiding. [65]

The modified postanesthesia discharge scoring system (MPADSS)

Chung has modified the early version of the PADSS into the modified postanesthesia discharge scoring system (MPADSS) (table 9), removing the requirements to drink and to void and separating the postoperative nausea and vomiting (PONV) and pain elements, The MPADSS is based on five criteria each of these items is assessed independently and assigned a numerical score of 0-2, with a maximal score of 10. Patients are fit for discharge when their score is ≥9. The MPADSS is a simple way to establish a routine of repeated re-evaluation which may result in improved patient supervision. [66]

Sedation and satisfaction scoring systems

Sedation scoring systems

The inherent problem with all sedation scoring systems is the subjective nature of the measurements. A tool that could objectively measure level of sedation has theoretical appeal. [67]

Adults Sedation scoring systems

The Ramsay Sedation Scale (RSS)

This scoring system was described by ***Ramsay et al*** in 1974 (table 10). It continues to be the most widely used scale historically for monitoring sedation in daily practice, as well as in clinical research. [68] The RSS was not originally intended to be used as a tool for clinical monitoring and has not been rigorously tested for reliability and validity. It also lacks enough information on behaviors to guide medication administration. Numerous shortcomings of the RSS are also present, including unclear definition of the sedation levels and the lack of sufficient measure of agitation and the psychometric properties. It is considered more a scale of consciousness than a tool for measurement of sedation. [69] Its **advantages** appear to be familiarity to staff and simplicity. It also exhibits a satisfactory inter-rater reliability. [70]

Pediatric Sedation scoring systems

Several sedation scoring scales have been described for children the Comfort scale seems to be the most practical scoring system for pediatrics. [71]

Comfort Scale

The Comfort scale (table 11) was developed by **Ambuel** in 1992 for children 0-18 years. [72] It has been demonstrated to be reliable and has been validated as a descriptor of behavioral and physiologic distress in critically ill even ventilated children. It also exhibited a good inter-rater reliability. [73] The application of this scale is not easy because of the great number of variables (eight), thus rendering it not very practical. In addition, its applicability is questionable when used in a routine manner. Another point of criticism regarding the Comfort score is that physiological parameters such as haemodynamic indices and heart rate, which contribute to the score, can be influenced by ICU therapy. [73]

Satisfaction Scales

The measurement of satisfaction in anesthesia practice is quite difficult as subjective indicators depend on different civilizations, cultures, and backgrounds. [74]

Patient Satisfaction

Patient satisfaction is an important measure of quality of healthcare, the most popular instrument is the Iowa Satisfaction in Anesthesia Scale (ISAS). It intended to measure the satisfaction in Monitored Anesthesia Care (MAC). [75]

Iowa Satisfaction with Anesthesia Scale (ISAS)

The ISAS (table 12) is a questionnaire that measures patient satisfaction with MAC. It consists of 11 questions, each statement describes a feeling that patient may have had during anesthesia. For each item patient marks the answer that best shows how he felt. [76] The ISAS questionnaire is a feasible, reliable, and valid tool to measure patient satisfaction. It offers one of the best psychometric approaches for collection of patient satisfaction data and contains all of the psychometric properties necessary for useful measurement. The ISAS has sufficient reliability to allow comparisons between different anesthetic agents. It provides interesting insight into the quality of care at the hospitals. [77] One of the important ***limitations*** of the ISAS is that it was not appropriate for the Arabic speaking patient. Also it is limited to MAC only. [78]

Modified Iowa Satisfaction with Anesthesia Scale

Baroudi et al had modified the original ISAS to avoid these limitations by addition of two important elements: comprehensibility by Arabic speaker patient and expanding the questionnaire to include the preoperative and postoperative anesthesia care. They removed two questions related to the post anesthesia visit as it is not a standard of practice in several anesthesia departments. They integrated some questions related to some minor complications in recovery room into one question. The final questionnaire consisted of 13 questions. [78]

Surgeon Satisfaction

Since surgeons are coworkers and important clients of anesthesiologists, the level of satisfaction of surgeons with anesthesia services should be explored to optimize quality. [79]

The Surgeon Satisfaction with Anesthesia Services (SSAS) scale:

The SSAS scale (table 12) was developed as a means for anesthesiologists to offer a better service to their customer. The scale was composed of 17 questions with four levels (Strongly disagree, Disagree, Agree, Strongly agree) and four open-ended questions. 7 factor analyses clearly identified two factors (clinical expertise and attitudes & behaviour). [80]

Scores in regional anesthesia

It is important to assess motor block after local anesthesia to determine the amount of motor function, to prevent pressure areas, to ensure the patient is safe to ambulate (if allowed) and to detect the onset of complications e.g. epidural hematoma or abscess. [81] The most widely used method is the Bromage scale (table 13).

Bromage Scale

In this scale, the intensity of motor block is assessed by the patient's ability to move their lower extremities. The degree of motor blockage varies depending on the clinical circumstances, and may differ from side to side. When using the Bromage scale for research in labour analgesia, it is important to measure motor block intermittently throughout labour, as the degree of block will change. It is also important to measure motor block in both legs, since the block may be asymmetrical. [82] A Bromage score of 3 or full block is desirable during surgery under a spinal anesthetic. Immediately following surgery, and for the first few hours postoperatively, a Bromage score of 2 may be observed in patients who have had a spinal or epidural anesthetic. Six hours after a spinal anesthetic, a Bromage score of 1 is desirable. [83]

The Bromage scale is quick and clinically applicable. It provides information of the onset of blockade, rate of development, and maximum intensity of motor blockade. However, this scale is qualitative and limited to motor blockade of the lower limbs. [84] The most significant ***shortcoming*** in studies of labour analgesia is that it was designed to measure differences in surgical blocks, and is somewhat irrelevant to measuring motor block due to dilute local anesthetic solutions for labour analgesia. Another problem is that a woman does not push a baby through her pelvis with her legs. [85] Several modifications of the Bromage scale have been described, including the use of more gradations of motor block. For example, ***Breen et al***. used a six-point scale to assess motor block (table 13). The value of this modification is in the differentiation of patients in the Bromage score IV category. [86]

Postoperative nausea and vomiting scoring system

Although PONV is almost always self-limiting and non-fatal, it can cause significant morbidity. [87] The Koivuranta et al simplified scoring systems are the current preferred choice for use in adults, and the Eberhart et al simplified system are the current preferred choice for use in children, especially inpatients. However, it should be noted that these scoring systems are only moderately accurate in predictive ability. [88]

Koivuranta et al's scoring system

Koivuranta et al.'s scoring system was simplified (table 14) to a five-item risk score, defined as the number of predictors present. [88] Nausea and vomiting were assessed for the intervals 0–2 h and 2–24 h after surgery, with nausea rated on an 11-point numeric scale (0–10).

Eberhart et al scoring system

Eberhart et al developed a simplified risk scoring system (table 14) for assessment of PV in pediatrics**.** One major ***limitation*** is that the underlying population does not represent all potential heterogeneity of clinical practice seen in anesthesia as well as in all surgical specialties. Another problem is that even variables that seem to be perfectly defined are not homogenous. For example, “strabismus surgery” summarizes different surgical approaches that might all have different emetogenic potential. Another potential criticism might be the preprocessing of the data before entering the logistic regression analysis. [89]

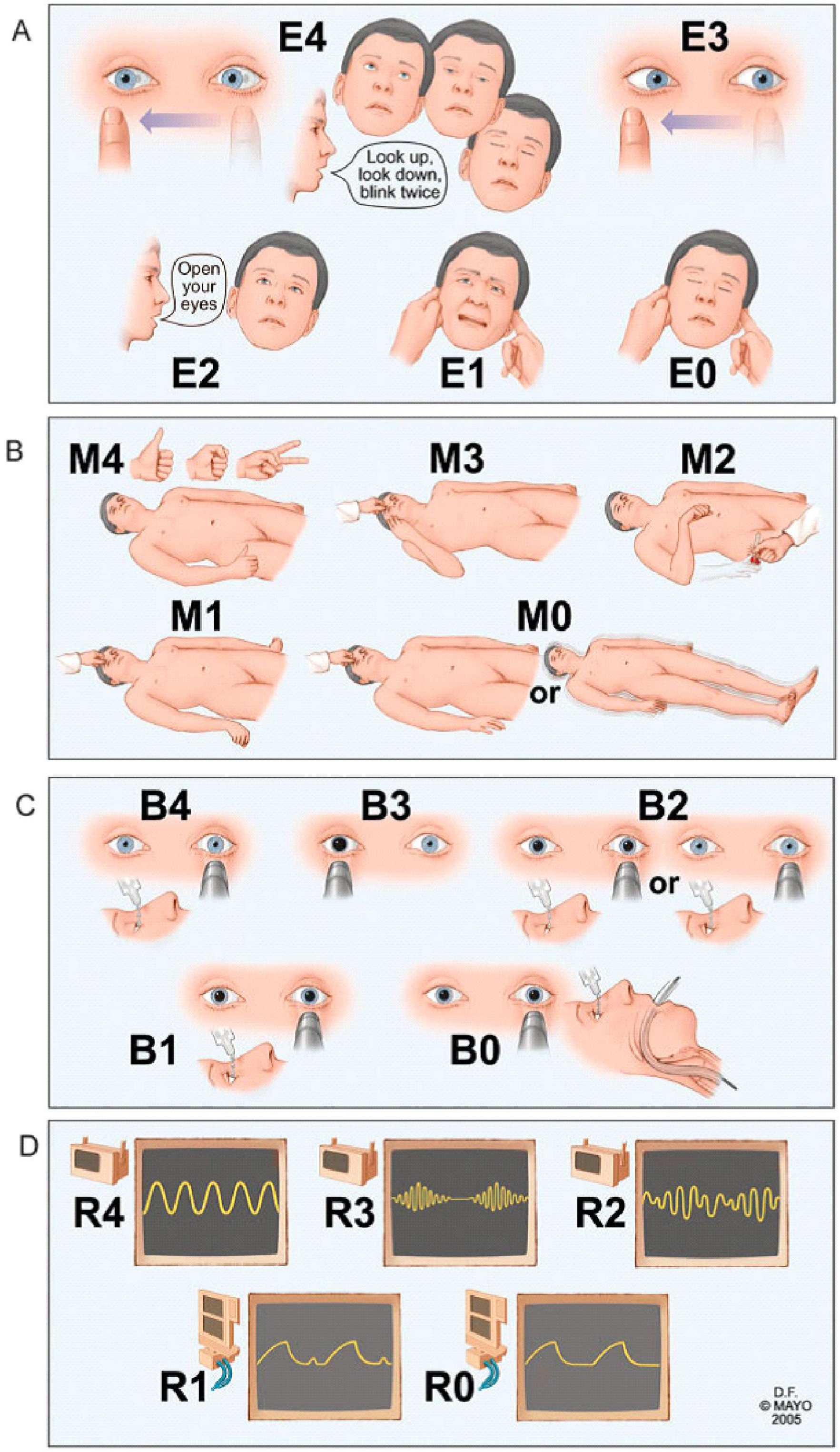


Fig.2: illustration of the eye responses, motor responses, brainstem reflexes, and breathing pattern of the FOUR coma score [(100)].

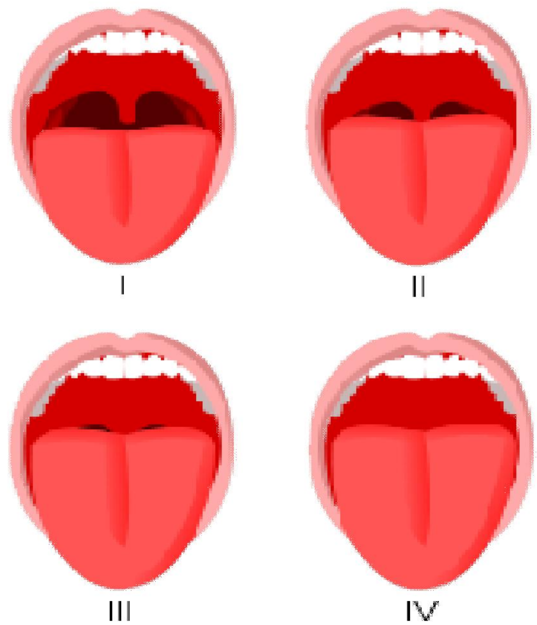
Visible structures	Predicted intubation
	Easy
	Difficult

Fig.2: Modified Mallampati test [90]

Table (1): ASA classification system [91]

Classification	The criteria
ASA I	A normal healthy patient.
ASA II	A patient with mild systemic disease.
ASA III	A patient with severe systemic disease.
ASA IV	A patient with severe systemic disease that is a constant threat to life.
ASA V	A moribund patient who is not expected to survive without the operation.
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes.

Table (2): Revised cardiac risk index [10]

Revised Cardiac Risk Index				
Risk factors		**interpretation**		
Finding	**Points**	**Class**	**Point**	**Risk**
High Risk Surgery	1	I	0	Very low risk (0.4% complications)
Coronary Artery Disease	1	II	1	Low risk (0.9% complications)
Congestive Heart Failure	1	III	2	Moderate risk (6.6% complications)
Cerebrovascular Disease	1			
Diabetes Mellitus on Insulin	1	IV	3	High risk (>11% complications)
Serum Creatinine >2 mg/dl	1			

Table (3): Glasgow Coma Scale and Modified Glasgow Coma Scale for Infants [20,22]

Glasgow Coma Scale	**Modified Glasgow Coma Scale for Infants**		**Score**
Adult	**Child**	**Infant**	
Eye Opening			
Spontaneous	Spontaneous	Spontaneous	4
To speech	To verbal stimuli	To verbal stimuli	3
To pain	To pain only	To pain only	2
None	No response	No response	1

Verbal Response			
Oriented	Oriented, appropriate	Coos and babbles	5
Confused	Confused	Irritable cries	4
Inappropriate words	Inappropriate words	Cries to pain	3
Incomprehensible sounds	Incomprehensible words, or non specific sounds	Moans to pain	2
None	No response	No response	1
Motor Response*			
Obeys	Obeys commands	Moves spontaneously and purposefully	6
Localizes	Localizes to pain	Withdraws to touch	5
Withdraws	Withdraws in response to pain	Withdraws in response to pain	4
Abnormal flexion	Flexion to pain	Decorticate posturing (abnormal flexion) in response to pain	3
Extensor response	Extension to pain	Decerebrate posturing (abnormal extension) in response to pain	2
None	No response	No response	1

Table (4): Respiratory Failure Risk Index [39]

Preoperative Predictor		**Point Value**
Type of operation		
Abdominal aortic aneurysm		27
Thoracic		21
Neurosurgery, upper abdominal, peripheral vascular		14
Neck		11
Emergency surgery		11
Albumin <3 g/dL		9
Blood urea nitrogen (BUN) >30 mg/dL		8
Partially or fully dependent functional status		7
History of chronic obstructive pulmonary disease		6
Age		
≥70 years		6
60–69 years		4
Respiratory Risk Index Scores		
Class	**Point Total**	**Predicted Probability of Postoperative Respiratory Failure (%)**
1	≤10	0.5
2	11–19	2.2
3	20–27	5.0
4	28–40	11.6
5	>40	30.5

Table (5) Postoperative Pneumonia Risk Index [41]

Preoperative Risk Factor	**Point Value**
Type of surgery	
Abdominal aortic aneurysm repair	15
Thoracic	14
Upper abdominal	10
Neck	8
Neurosurgery	8
Vascular	3
Age	
≥80 y	17
70–79 y	13
60–69 y	9

50–59 y	4
Functional status Totally dependent Partially dependent	 10 6
Weight loss 10% in past 6 months	7
History of chronic obstructive pulmonary disease	5
General anesthesia	4
Impaired sensorium	4
History of cerebrovascular accident	4
BUN level <2.86 mmol/L (<8 mg/dL) 7.85–10.7 mmol/L (22–30 mg/dL) ≥10.7 mmol/L (≥30 mg/dL)	 4 2 3
Transfusion 4 units	3
Emergency surgery	3
Steroid use for chronic condition	3
Current smoker within 1 year	3
Alcohol intake 2 drinks/d in past 2 weeks	2

Definition of Postoperative Pneumonia:
Patient met one of the following two criteria postoperatively:
1. Rales or dullness to percussion on physical examination of chest AND any of the following:
New onset of purulent sputum or change in character of sputum
Isolation of organism from blood culture
Isolation of pathogen from specimen obtained by transtracheal aspirate, bronchial brushing, or biopsy
2. Chest radiography showing new or progressive infiltrate, consolidation, cavitation, or pleural effusion AND any of the following:
New onset of purulent sputum or change in character of sputum.
Isolation of organism from blood culture.
Isolation of pathogen from specimen obtained by transtracheal aspirate, bronchial brushing, or biopsy
Isolation of virus or detection of viral antigen in respiratory secretions
Diagnostic single antibody titer (IgM) or fourfold increase in paired serum samples (IgG) for pathogen

Table (6): Child-Turcotte and Child-Pugh modified classification of liver disease [48,92]

Variables	**Child-Turcotte classes**		
	A	B	C
Bilirubin (mmol/L)	<35	35-50	>50
Albumin (g/L)	>38	38-30	<30
Ascites	absent	controlled	poor control
Encephalopathy	absent	moderate	coma
Nutrition	excellent	good	poor
Variables	**Child-Pugh class**		
	A	B	C
Bilirubin (mmol/L)	<40	40-50	>50
Albumin (g/L)	>35	35-28	<28
Ascites	none	mild	moderate, severe
Encephalopathy (grade)	0	I, II	III, IV
PT prolonged (s)	0	<2.5	>2.5
Surgical risk	good	moderate	poor

Table (7): DIC Scoring systems [93,56,58]

Scoring system for DIC established by the JAAM	
Criteria	**Score**
Systemic inflammatory response syndrome criteria	
≥3	1
0-2	0

Platelet counts (10^9/L) <80 or more than 50% decrease within 24 hours ≥80 <120 or more than 30% decrease within 24 hours ≥120		 3 1 0
Prothrombin time (value of patient/normal value) ≥1.2 <1.2		 1 0
Fibrin/fibrinogen degradation products (mg/L) ≥25 10- 25 <10		 3 1 0
Diagnosis 4 points or more		DIC
Criteria for systemic inflammatory response syndrome •Temperature >38 °C or <36 °C •Heart rate >90 beats/min •Respiratory rate >20 breath /min or PaCO2<32 torr (<4.3 kPa) •White cell blood counts >12,000/mm3, <4,000cells/mm3, or 10% immature (band) forms.		
Scoring system for overt DIC established by the ISTH		
Criteria		**Score**
Platelet count (x109/L) >100 50-100 <50		 0 1 2
PT prolongation (seconds) <3 >3 but <6 ≥6		 0 1 2
Fibrinogen (g/L) >1 <1		 0 1
Fibrin-related markers (increase) No increase moderate increase strong increase Cutoffs for scoring fibrin-related markers must be established for the specific assay		0 2 3
Total If ≥5, compatible with overt DIC – repeat scoring daily If <5, suggestive of non-overt DIC – repeat scoring after 1-2 days		
Diagnostic criteria for non-overt DIC by ISTH		
Criteria	**By original TSIH criteria**	**By original TSIH criteria**
Platelet count	Increase: -1 point Decrease: 1 point	Only decrease: 1 point (< 100,000/ul)
PT prolongation (seconds)	Not prolonged: -1 point Prolonged: 1 point	Only Prolonged: 1 point (> 3 sec)
Fibrinogen D-dimer	Not Increased: -1 point increased: 1 point	Always increased: 1 point (≥0.5 g/L)
Protein C activity	Normal: -1 point Decrease: 1 point	Decrease: 1 point (‹70%)
Antithrombin III	Normal: -1 point Decrease: 1 point	Decrease: 1 point (‹80%)
Underlying disorder associated with DIC	Not present: 0 Present: 2	Present: 2
Total: ≥5 = non-overt DIC		

Table (8): Criteria for fast-tracking after outpatient anesthesia [61]

Level of consciousness	**Score**
Awake and oriented	2
Arousable with minimal stimulation	1
Responsive only to tactile stimulation	0
Physical activity	
Able to move all extremities on command	2
Some weakness in movement of extremities	1
Unable to voluntarily move extremities	0
Haemodynamic stability	
BP < 15% of baseline mean arterial pressure (MAP) value	2
BP 15-30% of baseline MAP value	1
BP > 30% of baseline MAP value	0
Respiratory stability	
Able to breath deeply	2
Tachypnea with good cough	1
Dyspneic with weak cough	0
Oxygen saturation status	
Maintains value > 90% on room air	2
Requires supplemental oxygen (nasal prongs)	1
Saturation < 90% with supplemental oxygen	0
Postoperative pain assessment	
Non or mild discomfort	2
Moderate to severe pain controlled with iv analgesics	1
Persistent severe pain	0
Postoperative emetic symptoms	
None or mild nausea with no active vomiting	2
Transient vomiting or retching	1
Persistent moderate to severe nausea and vomiting	0
Total score	14

Table (9): Postanesthesia discharge scoring system [63]

Postanesthesia discharge scoring system	
Vital signs	**Score**
Within 20% of preoperative value	2
20% - 40% of preoperative value	1
< 40% of preoperative value	0
Activity, mental status	
Oriented and steady gait	2
Oriented or steady gait	1
Neither	0
Pain, nausea, vomiting	
Minimal	2
Moderate	1
Severe	0
Surgical bleeding	
Minimal	2
Moderate	1
Severe	0
Intake, output	
Has had postoperative fluids and voided	2
Has had postoperative fluids or voided	1
Neither	0

Total score	10
the Modified postanesthesia discharge scoring system	
Vital signs Vital signs must be stable and consistent with age and preoperative baseline. BP and pulse within 20% of preoperative baseline BP and pulse within 20%-40% of preoperative baseline BP and pulse > 40% of preoperative baseline	**Score** 2 1 0
Activity level Patient must be able to ambulate at preoperative level. Steady gait, no dizziness, or meets preoperative level Requires assistance Unable to ambulate	 2 1 0
Nausea and vomiting Patient should have minimal nausea and vomiting before discharge. Minimal: successfully treated with oral medication Moderate: successfully treated with intramuscular (IM) medication Severe: continues after repeated treatment	 2 1 0
Pain Patient should have minimal or no pain before discharge. The level of pain should be accepted to the patient. Pain should be controllable by oral analgesics. The location, type, and intensity of pain should be consistent with anticipated postoperative discomfort. Acceptability: Yes No	 2 1
Surgical bleeding Postoperative bleeding should be consistent with expected blood loss for the procedure. Minimal: does not require dressing change Moderate: up to two dressing changes required Severe: three or more dressing changes required	 2 1 0
Total score	10

Table (10): Ramsay Scale [94]

	Score
Awake levels: patient anxious or agitated or both patient co-operative, orientated and tranquil patient responds to commands only	 1 2 3
Asleep levels: a brisk response to a light glabellar tap a sluggish response to a light glabellar tap no response	 4 5 6

Table (11): Comfort Scale [95]

Variable	**Score**
Alertness: Deeply asleep Lightly asleep Drowsy Fully awake and alert Hyper-alert	 1 2 3 4 5

Calmness/Agitation:	
Calm	1
Slightly anxious	2
Anxious	3
Very anxious	4
Panicky	5
Respiratory response:	
No coughing and no spontaneous respiration	1
Spontaneous respiration with little or no response to ventilation	2
Occasional cough or resistance to ventilator	3
Actively breathes against ventilator or coughs regularly	4
Fights ventilator; coughing or choking	5
Physical movement:	
No movement	1
Occasional, slight movement	2
Frequent, slight movement	3
Vigorous movement limited to extremities	4
Vigorous movement including torso and head	5
BP:	
BP below baseline	1
BP consistently at baseline	2
Infrequent elevations of 15%or more (1±3 episodes)	3
Frequent elevations of 15%or more (more than 3 episodes)	4
Sustained elevationL15%	5
Heart rate (HR):	
HR below baseline	1
HR consistently at baseline	2
Infrequent elevations of 15%or more (1±3 episodes)	3
Frequent elevations of 15%or more (more than 3 episodes)	4
Sustained elevationL15%	5
Muscle tone:	
Muscle totally relaxed	1
Reduced muscle tone	2
Normal muscle tone	3
Increased muscle tone and flexion of fingers and toes	4
Extreme muscle rigidity and flexion of fingers and toes	5
Facial tension:	
Facial muscles totally relaxed	1
Facial muscle tone normal; no facial muscle tension evident	2
Tension evident in some facial muscles	3
Tension evident throughout facial muscles	4
Facial muscles contorted and grimacing	5
Scoring: 8–16 corresponds to deep sedation, 17–26 indicates light sedation and 27–40 indicates inadequate sedation.	

Table (12): Satisfaction Scales [76]

Iowa Satisfaction with Anesthesia Scale	
Iowa Satisfaction with Anesthesia Scale's Questions	**Iowa Satisfaction with Anesthesia Scale's Response Choices**
• I threw up or felt that	• Disagree very much
• I would want to have the same anesthetic again	• Disagree moderately
• I itched	• Disagree slightly
• I felt safe	• Agree slightly
• I was too cold or hot	

• I was satisfied with my anesthetic care • I felt pain during surgery • I felt good • I hurt	• Agree moderately • Agree very much
The Surgeon Satisfaction with Anesthesia Services scale	
1) Maintain patients hemodynamically stable during surgery 2) Communicate with surgeons during surgery 3) Are open to criticism and constructive comments 4) Position patients and induce anesthesia rapidly 5) Encroach on my field of expertise 6) Consider my professional opinion 7) Remain calm during emergencies 8) Show a passive and indifferent attitude while discussing with surgeons 9) Control patients postoperative pain effectively 10) Control mechanical ventilation effectively in the postoperative period 11) Remain sufficiently present in the operating room during surgery to supervise the patient's condition and the devices installed 12) Neglect to update their clinical knowledge/skills 13) Show a defensive attitude during discussions 14) Act effectively during emergencies 15) Ask too many unnecessary preoperative tests 16) Are punctual 17) Are not very likely to adjust their availability according to the surgeon's or patient's needs • Questions 12 and 15 obtained low variance on both factors and will be deleted from the next version of the SSAS scale. • Questions 1,2,7,9,10,11,14 are related to clinical expertise (Factor 1) • Questions 3,4,5,6,8, 13,16,17,12,15 are related to attitudes & behaviour (Factor 2)	

Table (13): The Bromage score [82]

The Bromage score		
Score	**Criteria**	**Degree of block**
0	Free movement of legs and feet	Nil (0%)
1	Just able to flex knees with free movement of feet	Partial (33%)
2	Unable to flex knees, but with free movement of feet	Almost complete (66%)
3	Unable to move legs or feet	Complete (100%)
Modified Bromage score		
Score	**Criteria**	
1	Complete block (unable to move feet or knees)	
2	Almost complete block (able to move feet only)	
3	Partial block (just able to move knees)	
4	Detectable weakness of hip flexion while supine (full flexion of knees)	
5	No detectable weakness of hip flexion while supine	
6	Able to perform partial knee bend	

Table (14): PONV scoring systems [96,89]

Simplified Koivuranta Score to Predict PONV				
Risk factor	Score		Risk of PO nausea	Risk of PO vomiting
	0	1	0------- 17%	0---------- 7%
gender	male	female	1------- 18%	1-----------7%
history of PONV	no	Yes	2------ 42%	2---------17%
smoking status	no	Yes	3------- 54%	3 --------25%
duration of surgery ≥60 min	no	Yes	4------- 47%	4-------- 38%
history of motion sickness	no	Yes	5------- 87%	5-------- 61%
Eberhart et al PV score in pediatrics				

Risk factor	**score**		**Risk of PV by score**
	0	**1**	
duration of surgery ≥30 min	no	Yes	0-------- 9% 1------- 10% 2--------30% 3--------55% 4------- 70%
age ≥3 yr	no	Yes	
strabismus surgery	no	Yes	
(history of PV in child or of PV/ PONV in a parent or sibling)	no	yes	

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