Risk of unanticipated intraoperative events in patients assessed at a preanaesthetic clinic

Anna Lee MPH,
Martin E. Lum FANZCA MBChB,
Mary Perry RN,
Sean J. Beehan FANZCA MBChB,
Ken M. Hillman FANZCA FRCA,
Adrian Bauman PhD FAFPHM*

Purpose: To determine the risk of unanticipated intraoperative events (UIE) in patients assessed at a preanaesthetic clinic compared with those not assessed at the clinic.

Methods: Preoperative and intraoperative data were collected on 6130 elective surgical patients by procedural anaesthetists over a 12-month period at an Australian tertiary referral hospital. The procedural anaesthetists rated the level of preparation and identified predefined unanticipated intraoperative events. A logistic regression model was used to identify significant risk factors of UIE and was further validated on another sample of 482 patients (one month) by a goodness-of-fit test.

Results: Of the 6130 elective surgical patients, 2000 (33%) had been assessed at the preanaesthetic clinic. There was a greater proportion of ASA II to IV patients seen at the clinic than patients not assessed at the clinic (χ^2_3=689.92, $P < 0.001$). Nonclinic patients were more likely to be inadequately prepared than clinic patients ($RR_{unadjusted}$=1.61, 95%CI: 1.25 to 2.04, $P < 0.001$). The overall incidence of intraoperative events was 4.14% (95%CI: 3.64% to 4.64%). Despite adjusting for the preparation level, type of anaesthesia, admission category, ASA physical status and duration of anaesthesia, clinic patients were 1.94 (95%CI: 1.42 to 2.64) times more likely to experience an UIE than nonclinic patients ($P < 0.001$).

Conclusion: Although clinic patients were more often optimally prepared, their adjusted risk of UIE was higher than nonclinic patients. The procedural anaesthetist needs to be vigilant with these high risk patients, even if they have been assessed at a preanaesthetic clinic.

Objectif : Préciser le risque d'incidents peropératoires imprévus chez les patients évalués en clinique préanesthésique comparativement à ceux qui n'y sont pas évalués.

Méthodes : Les données préopératoires et peropératoires de 6 130 cas électifs ont été recueillies par des anesthésistes sur une période de 12 mois dans un hôpital australien spécialisé en soins tertiaires. Les anesthésistes ont évalué le degré de préparation et ont identifié des incidents peropératoire imprévus prédéfinis. Un modèle de régression logique a été utilisé pour identifier les facteurs importants de risque d'incidents imprévisibles et a été validé ultérieurement avec un autre échantillon de 482 patients (un mois) grâce à un test de corrélation.

Résultats : Deux mille des 6 130 patients électifs avaient été évalués à la clinique préanesthésique dont une proportion plus élevée de patients ASA II-IV (χ^2_3=689,92, $P < 0,001$). Le manque de préparation survenait plus souvent chez les patients non évalués en clinique ($RR_{non\ ajusté}$ = 1,61, 95% IC : 1,25 à 2,04, $P < 0,001$). L'incidence globale des incidents peropératoires était de 4,14% (95% IC : 3,64% à 4,64%). En dépit des ajustements accordés pour le degré de préparation, le type d'anesthésie, la catégorie d'admission, l'état physique ASA et la durée de l'anesthésie, les patients vus en cliniques étaient 1,94 (95% IC :1,42 à 2,64) fois plus sujets à subir un accident imprévu que les autres ($P < 0,001$).

Conclusion : Bien que les patients vus en clinique aient reçu plus souvent une préparation optimale, ils encouraient un risque plus élevé d'incidents imprévus que ceux qui n'y avaient pas été vus. L'anesthésiste se doit d'être vigilant devant ces patients à haut risque, même s'ils ont subi une évaluation dans une clinique préanesthésique.

From the Critical Care Research Unit, Department of Anaesthetics and Intensive Care and Epidemiology Unit,* Liverpool Hospital, Liverpool. NSW. Australia. This study was supported, in part, by the Australian and New Zealand College of Anaesthetists Research Grant, Short Stay Surgery Research Institute and the Department of Anaesthetics, Liverpool Hospital.

Address correspondence to: Ms Anna Lee, Critical Care Research Unit, Department of Anaesthetics and Intensive Care, Liverpool Hospital, PO Box 103, Liverpool. NSW. 2170. Australia.

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PREANAESTHETIC assessment is an essential component of safe anaesthetic practice. In health systems driven by cost rationalisation and with expectations of increased efficiency, the fast tracking of patients admitted for surgery is a well-established concept. However, with an increasing number of patients being admitted for Day Only and on the Day of Surgery, many patients may present for surgery without a systematic preoperative anaesthetic assessment. In response to this, anaesthetists have developed preanaesthetic clinics to manage elective surgical patients more effectively.[1-5]

There is accumulating evidence to suggest that preanaesthetic clinics are associated with decreased length of hospital stay,[2,4] lower hospital costs,[4,5] decrease in laboratory tests performed,[1] reduction in the number of cancellations on the day of surgery[1-3,5] and improved operating theatre efficiency.[1-3] However, the outcomes of patients assessed at a preanaesthetic clinic, such as perioperative events, have not been examined.

The aim of this study was to determine the risk of intraoperative events in patients assessed at a preanaesthetic clinic compared with those not assessed at the clinic.

Methods

This study was approved by the hospital ethics committee. The study was a cohort of elective surgical patients admitted to a 470-bed tertiary referral hospital in Sydney, Australia. At the time of conducting the study, cardiothoracic surgical services were not available. The study was conducted during the period June 1995 to June 1996 (12 months for developing the risk model and one month for model validation).

Perioperative system

The Perioperative System is a coordinated approach to managing all elective surgical patients from the time an admission is booked to hospital discharge.[2,6] Integral to the Perioperative System is the referral of high risk patients according to predefined criteria[2] to a preanaesthetic clinic (Perioperative Clinic). In this system, the preanaesthetic clinic is complementary to and does not replace the traditional preoperative visit done by the procedural anaesthetist. The goal of the clinic assessment is to ensure that the procedural anaesthetist is presented with the patient who is optimally prepared for surgery. The clinic anaesthetist may not be the same anaesthetist taking care of the patient on the day of the procedure.

At the time of surgical consultation, patients are given a health questionnaire to complete. Information from the health questionnaire assists in identifying particular conditions that may affect perioperative management, selecting patients who require an assessment at the clinic and planning patient management during the perioperative period and at discharge. The questionnaire is screened by trained Perioperative clerks and nurses using predetermined criteria and sorted into three categories:

(A) no further review required and patient is booked for surgery

(B) requiring Perioperative clinic review

(C) questionnaire needs to be reviewed by an anaesthetist and recategorised into A or B.

The patient's medical history on the questionnaire is also checked by the anaesthetist at the clinic or at the preoperative visit.

Patients are referred to the clinic using four general criteria:

(1) mandatory attendance for major operations such as cholecystectomies, hysterectomies, transurethral resection of the prostate, major orthopaedic surgery and most thoracic, vascular or neurosurgery. Patients undergoing cataract surgery are referred to the clinic because they do not often have an adequate medical workup and usually have comorbidities.

(2) review of the questionnaire identifies a problem

(3) surgeon's request for clinic review

(4) patient's request for clinic review.

Patients attend the Perioperative Clinic about two weeks preoperatively. At present, the clinic runs four half-day sessions per week in the hospital's outpatient area. All patients are seen by either a specialist anaesthetist or a supervised anaesthetic trainee, and by a Perioperative nurse. While most clinic patients require an anaesthetic review, some patients attend the clinic primarily for nursing review, complex instructions about preparation for their surgery, or for routine tests. Therefore, a range of American Society of Anesthesiologist physical status (ASA I to IV) patients are seen at the clinic. Where appropriate, a review by other staff, such as physiotherapists and junior members of the surgical team is also undertaken at this time. At the end of the Clinic, patients are categorised as Day Only, Day of Surgery Admission, Inpatient or Pending case. Patients who are classified as "pending" are not booked for admission until tests results are available, medical review completed or coexisting disease has been stabilized.

Data collection

Preoperative and intraoperative data were collected on elective surgical patients by procedural anaesthetists using a standardised data collection form. The compliance rate of anaesthetists in the study was over 90%. The preoperative data collected included ASA physical status, level of perioperative preparation, preanaesthetic clinic assessment and admission category (Day Only, Day of Surgery Admission or Inpatient). The intraoperative data collected included the duration of anaesthesia (time of arrival at the Recovery Room–induction time), type of anaesthesia and any of the 33 listed unanticipated intraoperative events (UIE) [Appendix 1]. Anaesthetists were protected from subpoena and confidentiality for information when reporting unanticipated events under the Australian Health Insurance (Quality Assurance Confidentiality) Amendment Act 1992. Obstetric patients were excluded from this study.

Definitions of elective surgery, inadequate perioperative preparation of patients, unanticipated intraoperative events and unplanned admissions to critical care units were predetermined. Elective surgical procedures were defined as procedures planned at least 24 hr before hospital admission. Inadequate preparation was determined by procedural anaesthetists, who subjectively rated the patient as "suboptimally prepared" or "poorly prepared" at the induction time. The anaesthetists were not required to give a reason for inadequate preparation in this study, but nevertheless, it was often documented on the data collection form. Intraoperative events were defined as any unanticipated, undesirable and possibly anaesthetic related episode requiring intervention, which did or could cause mortality or at least morbidity during the intraoperative period. Unanticipated intraoperative events (UIE) were determined by the procedural anaesthetist and was a clinical and subjective assessment at the time of UIE occurrence. An unplanned admission to critical care units was defined when the patient was admitted to an intensive care or a high dependency unit that was unanticipated preoperatively.

Data analysis

Ninety five percent confidence interval (95%CI) using the Poisson distribution[7] was estimated around the incidence of specific intraoperative events. The perioperative differences between clinic and nonclinc patients were assessed using the appropriate univariate test (Welch test,[8] Mann Whitney U test, χ^2 test, Fisher's exact test, Mantel-Haenszel test for linear association). The risk of intraoperative events is presented as relative risk (RR) and 95% confidence intervals (95%CI). Multivariate (forced entry) logistic regression[9] modelling was used to produce estimates of relative risks while adjusting for significant patient, anaesthetic and surgical characteristics in the data sample from June 95 to May 1996 (12 months). Subjects with missing data in any of the variables included in the final logistic regression model were excluded during the modelling process. Interactions were sought and were not significant. The level of significance was set at $P < 0.05$. All statistical analyses were done on SPSS Windows 6.1 software.

Validation of the logistic model was done on the June 1996 (n=482) sample. The Hosmer Lemeshow goodness-of-fit statistic was estimated to assess the model fit.[10] Two receiver operating characteristic curves[10] were constructed from the patients' predicted score or the ASA physical status and the observed occurrence of an intraoperative event on the June 1996 sample. The patient's predicted score of an UIE was calculated by multiplying the relative risk of each independent risk factor from the logistic regression model by 10. A plot was made of the true positive rate (sensitivity) against false positive rate (1- specificity) at different cutoff scores. Another plot was made for different ASA physical status grades. The areas under the curves and standard error were calculated by a methodology outlined by Hanley and McNeil.[11] The area under the curve (θ) is a measure of the overall discriminatory power of the model. A value of 0.5 represents random prediction and a value of 1.0 indicates perfect discrimination.[11]

Results

Over the 12-month period, there were 6130 elective surgical patients in this study. There were more women (58%) than men undergoing elective surgery. The mean age was 45 ± 22(sd) yr. The distribution of ASA physical status gradings were ASA I (51%), ASA II (34%), ASA III (14%) and ASA IV (1%). There were Day Only (49%), Day of Surgery Admission (37%) and Inpatients (14%).

The median duration from admission booking date to hospital admission for surgery was 30 days (range 1 to 364). The types of surgical procedures were general (40%), gynaecological (15%), ophthalomogical (9%), ear/nose/throat (7%), orthopaedic (7%), plastic (6%), urology (5%) and vascular (5%). The median duration of anaesthesia and postanaesthesia care unit stay were 50 min (range 5 to 470) and 60 min (range 5 to 355) respectively. Planned and unplanned admissions to an intensive care unit/high dependency unit directly from the operating suite/Recovery room occurred in 139 (2.3%) and 34 (0.6%) patients respectively.

Of the 6130 patients, the procedural anaesthetist subjectively rated the patient's level of preparation in

5 552 (91%) cases. Inadequate preparation occurred in 4.6% of patients (219 "suboptimal" and 36 "poor"). There was a linear association between inadequate preparation and the ASA physical status (Mantel-Haenszel χ^2=31.79, $P < 0.001$). The rate of inadequate preparation increased from 3.3% (ASA I patients) to 9.9% (ASA IV patients). Some of the reasons for inadequate preparation documented by the procedural anaesthetists included: results of investigations not available at the time of anaesthetic review, clinical history not fully documented, miscommunication between staff, noncompliance of preoperative instructions by the patient or ward staff and limited availability of interpreters for NonEnglish speaking patients.

Clinic

Of the 6 130 elective surgical patients, 2 000 (33%) had been assessed at the preanaesthetic clinic. There were differences between the clinic and nonclinic patients in age, sex ratio, patient admission categories, various types of surgery, duration of surgery and type of anaesthesia (Table I). There was a greater proportion of ASA II to IV patients seen at the clinic than patients not assessed at the clinic (χ^2_3=689.92, $P < 0.001$). However, 19% of ASA III/IV patients who were admitted as Day of Surgery Admission patients were not assessed at the clinic. Of the 76 ASA IV patients, 58 (76%) were admitted as inpatients with or without clinic assessment. Seven ASA IV patients were admitted as

TABLE I Perioperative differences between clinic and nonclinic patients (N=6130)

	Clinic (n=2000)	*Nonclinic (n=4130)*	*Significance*
Mean age (yr)	58 (16)	40 (22)	$t_{5091.61}$=−35.65, $P < 0.001$
Sex, M/F	676/1324	1913/2217	χ^2_1=86.57, $P < 0.001$
*ASA Status**			
I	498 (27%)	2402 (63%)	χ^2_3=689.92, $P < 0.001$
II	890 (47%)	1022 (27%)	
III	460 (25%)	357 (9%)	
IV	29 (2%)	47 (1%)	
Patient admisison			
Inpatient	318 (16%)	543 (13%)	χ^2_2=891.88, $P < 0.001$
Day Only	453 (23%)	2536 (61%)	
Day of Surgery	1229 (61%)	1051 (25%)	
Type of surgery			
General	842 (42%)	1586 (38%)	χ^2_1=7.70, $P < 0.01$
Gynaecological	292 (15%)	644 (16%)	χ^2_1=1.03, $P = 0.31$
Opthalmological	376 (19%)	156 (4%)	χ^2_1=383.70, $P < 0.001$
Ear/Nose/Throat	68 (3%)	386 (9%)	χ^2_1=69.47, $P < 0.001$
Orthopaedics	122 (6%)	290 (7%)	χ^2_1=1.83, $P = 0.18$
Plastics	77 (4%)	274 (7%)	χ^2_1=19.35, $P < 0.001$
Urological	118 (6%)	172 (4%)	χ^2_1=9.00, $P < 0.01$
Vascular	54 (3%)	255 (6%)	χ^2_1=33.98, $P < 0.001$
Median duration of anaesthesia (range)	80 min (5–470)	40 min (5–440)	z=−25.63, $P < 0.001$
Type of anaesthesia			
General	1140 (57%)	2643 (64%)	χ^2_1=27.91, $P < 0.001$
Regional	18 (0.9%)	17 (0.4%)	χ^2_1=5.66, $P = 0.02$
Combined	41 (2%)	133 (3%)	χ^2_1=6.69, $P = 0.01$
*Level of preparation**			
Inadequate	52 (3%)	203 (5%)	χ^2_1=16.85, $P < 0.001$
Intraoperative events	128 (6%)	126 (3%)	χ^2_1=38.05, $P < 0.001$
Difficult intubation	22 (1%)	19 (0.5%)	χ^2_1=8.31, $P < 0.01$
Larynogospasm	7 (0.4%)	20 (0.5%)	χ^2_1=0.55, $P = 0.46$
SpO_2<85%	6 (0.3%)	21 (0.5%)	χ^2_1=1.34, $P = 0.25$
Systolic BP>180 mmHg	21 (1%)	7 (0.2%)	χ^2_1=22.98, $P < 0.001$
Systolic BP<80 mmHg	40 (2%)	35 (0.8%)	χ^2_1=14.81, $P < 0.001$
Heart rate<40 bpm	12 (0.6%)	7 (0.2%)	χ^2_1=8.08, $P < 0.01$
Heart rate>120 bpm (adults)	4 (0.2%)	6 (0.1%)	FE 2-tailed† $P = 0.74$

*some patients with missing data

†Fisher's Exact test

Day Only admissions for minor surgery (Hickman's line insertion, colonoscopy and dental extraction).

Nonclinic patients were more likely to be inadequately prepared than clinic patients ($RR_{unadjusted}$=1.61, 95%CI: 1.25 to 2.04, $P < 0.001$). The incidence of inadequate preparation varied between admission categories and clinic intervention (Figure 1).

Unanticipated intraoperative events (UIE)

There were 254 UIE, an overall incidence of 4.14% (95%CI: 3.64% to 4.64%). The incidence of specific intraoperative events (Table II) makes up 80% of all UIE recorded. Most were cardiorespiratory problems, with hypotension the most frequent. There were higher incidences of difficult intubation, hypertension, hypotension and bradycardia in clinic patients than in nonclinic patients (Table I). Nineteen patients were inadequately prepared and had intraoperative events. Inadequately prepared patients were more likely to experience intraoperative events than those adequately prepared ($RR_{unadjusted}$=1.81, 95%CI: 1.15 to 2.84, $P < 0.01$).

There were six independent risk factors of UIE (Table III). From the logistic regression model, clinic patients were 1.94 (95%CI: 1.42 to 2.64, $P < 0.001$) times more likely to experience an UIE than nonclinic patients even after adjusting for the perioperative preparation level, type of anaesthesia, admission category, ASA physical status grade and duration of anaes-

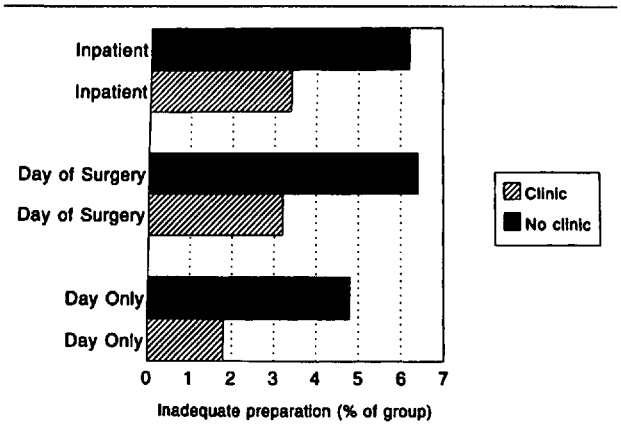

FIGURE 1 Incidence of inadequate preparation among admission groups, stratified by clinic intervention

TABLE II Incidence and 95% confidence intervals (95%CI) of specific unanticipated intraoperative events

Intraoperative event	*Incidence (%)*	*95% CI*
Difficult intubation	0.67	0.48 to 0.91
Laryngospasm	0.44	0.29 to 0.64
SpO_2 <85%	0.44	0.29 to 0.64
Systolic BP >180 mmHg	0.46	0.30 to 0.66
Systolic BP <80 mmHg	1.22	0.98 to 1.53
Heart rate <40 bpm	0.31	0.19 to 0.48
Heart rate >120 bpm (adults)	0.16	0.08 to 0.30

TABLE III Logistic regression model of intraoperative events (n=5139)

Factor	*Relative risk*	*95%CI*	*Significance*
Clinic intervention			
No clinic	1.00		
Clinic	1.94	1.42 to 2.64	$P < 0.001$
Patient admission category			
Inpatient	1.00		
Day only (*vs* inpatient)	0.77	0.48 to 1.21	$P = 0.25$
Day of Surgery Admission (*vs* inpatient)	0.56	0.38 to 0.82	$P = 0.003$
Level of perioperative preparation			
Adequate	1.00		
Inadequate	2.34	1.40 to 3.90	$P = 0.001$
Type of anaesthesia			
Sedation/Regional	1.00		
General anaesthesia	4.61	2.77 to 7.65	$P < 0.001$
ASA physical status			
ASA I	1.00		
ASA II	1.29	0.92 to 1.81	$P = 0.13$
ASA III, IV	2.22	1.47 to 3.35	$P < 0.001$
Anaesthesia duration			
<1 hr	1.00		
1–2hr	2.11	1.45 to 3.08	$P < 0.001$
>2hr	2.25	1.44 to 3.53	$P < 0.001$

thesia. Also, the risk of UIE increased as the ASA physical status increased (Table III). The adjusted relative risk of UIE in a ASA III/IV patients was 2.22 (95%CI: 1.47 to 3.35, $P < 0.001$) times that of an ASA I patient. The Hosmer Lemeshow goodness-of-fit test, estimated by fitting the logistic model on 482 (June 1996) patients, showed an adequate fit between observed and expected UIE ($\chi^2_8 = 10.13$, $P = 0.26$).

To extend the use of the multivariate risk analysis concept, the impact of more than one variable was assessed by using the method outlined by Wolters and coworkers,[12] together with estimated regression coefficients derived from the above logistic regression analysis. The relative risk of an UIE in a Day of Surgery patient who is adequately prepared with a clinic assessment, is 0.46 times that of an inadequately prepared traditional inpatient (no clinic), assuming all other risk factors are identical.

Two receiver operating characteristic curves were constructed (Figure 2). There was improved discrimination in the multivariate risk model ($\theta = 0.72 \pm 0.05$) compared with using only the ASA physical status ($\theta = 0.57 \pm 0.07$). Therefore, the risk of UIE is better estimated using several factors: preparation level, type of anaesthesia, admission category, duration of anaesthesia, clinic intervention and ASA physical status than using the ASA physical status variable alone.

Discussion

This study has highlighted the association between a preanaesthetic clinic and anaesthetic related events during the intraoperative period. While these clinic patients were more adequately prepared, they had a higher risk of intraoperative events than nonclinic patients, despite adjusting for other risk factors. One implication of these results is that anaesthetists still need to be vigilant, even after a patient has been assessed at a preanaesthetic clinic. Irrespective of whether all patients or some patients are assessed at a preanaesthetic clinic, clear and timely communication to procedural anaesthetists is vital to reducing the number of unexpected problems on the day of the procedure.

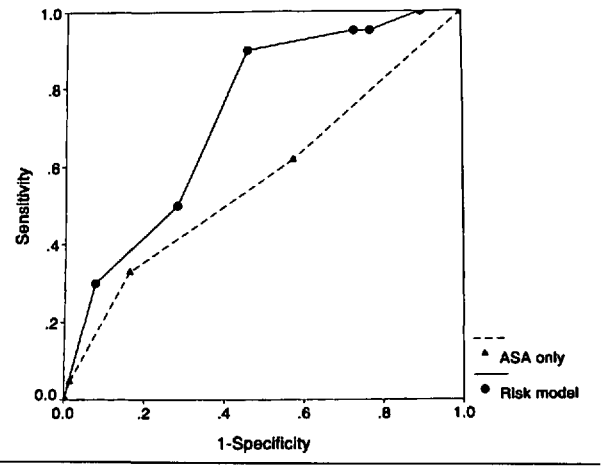

FIGURE 2 Receiver operating characteristic curves of multivariate risk model and ASA physical status

Although the preparation level was subjectively rated by anaesthetists, we found that patients attending the clinic were more adequately prepared than patients not assessed at the clinic. While there was an association between inadequate preparation and ASA physical status, other factors in the Perioperative System may be related to the occurence of inadequate preparation, as higlighted by the reasons given by anaesthetists for inadequate preparation. In our Perioperative System, the clinic assessment of the patient takes place approximately two weeks before surgery. This allows time for the anaesthetist to determine the level of intervention required, plan and review pathology results and collate information from specialist's reviews. This timeframe also allows the patient to read the information brochures, consider the anaesthetic advice given at the clinic and raise any specific questions about their anaesthesia with the procedural anaesthetists upon admission. Therefore, most problems are sorted out before the patient is admitted to the hospital. Also, the patient may be more informed about the process and risks associated with surgery and anaesthesia.

One goal of the Perioperative System is to identify "high risk patients" for clinic assessment. This study used the ASA physical status as a measure of patient acuity. It is a simple classification familiar to all anaesthetists, but may lack sufficient sensitivity and reliability to stratify group differences in risk outcome. While the original aim of the ASA physical status was not to be used as an estimate of "operative risk,"[13] the ASA physical status classification may be a reliable independent predictor of intraoperative events.[14,15] In more recent studies, the ASA physical status may be a predictor of postoperative outcomes.[12,16] However, it is important to remember that the ASA physical status assignment does not allow for the age and the complexity of operation, and there is no differentiation between a systemic disease that leads to operation and one that is an incidental chronic finding.[12]

Two studies have concluded that there is insufficient consistency among anaesthetists in ASA rating to place complete reliance upon it if used as the sole indicator of the patient's condition.[17,18] Findings from this study show that other factors, such as clinic atten-

dance, the level of patient preparation, admission category, duration of anaesthesia, type of anaesthesia, and the ASA physical status, need to be considered when intraoperative risks are estimated. For example, the intraoperative risk may be different when an ASA IV patient undergoes a colonoscopy from that when an ASA IV patient undergoes a cholecystectomy.

Our intraoperative risk model has more discriminating properties than using solely the ASA physical status in predicting UIE. However, it is less than ideal and should only be used in predicting the occurrence of UIE at a population level, such as for quality assessment and resource allocation. Nevertheless, it remains important for anaesthetists to identify patient's risk factors reliably so that appropriate treatment options can be offered. A better assessment of risk factors could contribute to the improvement in safety of anaesthesia.[19]

The type of patient admission category was associated with the occurrence of intraoperative events. Although inpatients are generally not seen at the clinic, 37% of elective inpatients were admitted as inpatients after clinic attendance. Often, the severity of their illness was not known until a physical assessment was performed by the anaesthetist. Thus, the clinic may serve as an important role in ensuring appropriate admissions to hospital.

After adjusting for other UIE risk factors, Day only and Day of Surgery Admission patients had lower risks of an UIE than the traditional inpatient group. Findings from an earlier study[2] and this study suggest that our patients admitted as Day only or Day of Surgery may have lower intraoperative risks, fewer cancellations on the day of the procedure (due to inadequate preparation) and reduced length of stay in the hospital than in the traditional inpatient group. Some of these associated benefits are consistent with the findings from other studies.[1,3–5]

Of the patients who were admitted as ASA III/IV Day of Surgery Admission patients, one in five was not assessed at the clinic. This proportion was higher than expected and may be partly due to some patients who had been assessed at the clinic for a recent previous anaesthetic. Three out of four ASA IV patients were admitted as inpatients with or without preanaesthetic clinic review. The remaining proportion of ASA IV patients underwent minor procedures, usually of not more than one hour duration and were suitable for admission as an outpatient or on the day of the procedure. However, we acknowledge that there is a need to review the screening process and/or clinic referral criteria for these patients. This issue is currently being addressed in our department by employing another nurse to review questionnaires of nonclinic patients after the initial screening process. This extra step in the screening process may increase the number of appropriate clinic referrals.

In this study, the incidence of unplanned admissions related to UIE to critical care units was low (<1%). A limitation in previous studies of unplanned admissions to critical care units includes the lack of reporting separate incidence rates for emergency and elective surgery. The incidence of unplanned admissions to intensive care units ranges from 0.04%[20] to 0.42%.[21] These incidence rates are not directly comparable because of the variations in patient and surgical casemix, use of invasive procedures, proportion of emergency and elective procedures and the skills of medical and nursing personnel.[21]

Study limitations

As high risk patients are selectively assessed at the clinic, one would expect an increase in the risk of UIE, rather than an expected decrease, and thus even if the clinic intervention was beneficial, it might appear to be harmful. This is known as confounding by indication.[22] In this study, this methodological issue was addressed by using multivariate statistical modelling. The referral of patients to a clinic is a multifactorial decision, with the main factors considered being the type of surgery and patient's comorbidity.[6] It is also possible that other unmeasured factors may exist, and this may affect the overall association between clinic patients and an UIE. While this study has focused on the clinical outcomes of patients attending a preanaesthetic clinic, other outcome measures, such as patient satisfaction should be measured in evaluating the efficiency and effectiveness of preanaesthetic clinics.

Another limitation of this study may include the underreporting of UIE by procedural anaesthetists. The extent of the severity of an UIE was not examined in this study. In future studies, we plan to use automated anaesthetic records systems to minimise the subjective reporting bias by anaesthetists. Sanborn and coworkers showed that the use of an anaesthesia information management system facilitated the analysis of intraoperative physiological data and identified certain intraoperative incidents with high sensitivity and specificity.[23] However, in the current study, the extent of the reporting bias may not have been a large problem because (1) a comparison of data collected from the standardised forms and the corresponding anaesthetic record showed a high level of agreement (Kappa=0.92) (2) the incidence of intraoperative events in this study is comparable to the incidence of "severe outcomes" reported by Forrest and coworkers.[24] (3) the study was part of an ongoing departmen-

tal anaesthetic audit, which had appropriate legal protection for anaesthetists from public disclosure of adverse events.

In summary, the findings from this study show that while clinic patients are more optimally prepared, their risk of an UIE remains higher than nonclinic patients. The procedural anaesthetist needs to be vigilant with patients who have been assessed at the clinic. Clear and timely communication to the procedural anaesthetist is vital if patients are to receive quality, safe and cost-effective anaesthetic care.

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APPENDIX 1 Definitions for outcomes used in the study

Unintentional Intraoperative events	
Difficult intubation:	Grade III or IV Cormack and Lehane classification*
Oesophageal intubation:	Endotracheal tube misplaced in the oesophagus
Lip damage:	Trauma to the lips
Chipped or extracted tooth:	Dental trauma
Bronchospasm:	Audible wheezing on auscultation
Laryngospasm:	Transient upper airwary obstruction
Vomiting/regurgitation:	Active expulsion of gastric contents
Aspiration:	Inhalation following vomiting or regurgitation
Ventilation abnormality:	End tidal carbon dioxide less than 25 units or greater than 50 units on intermittent positive pressure ventilation
Desaturation:	Arterial oxygenation less than 85%
Hypertension:	Systolic blood pressure greater than 180 mmHg
Hypotension:	Systolic blood pressure less than 80 mmHg
Bradycardia:	Heart rate less than 40 beats per minute
Tachycardia (adults):	Heart rate greater than 120 beats per minute
Myocardial ischaemia	ST segment change
New ventricular arrhythmia:	Rhythm differing from preoperative status
New atrial arrhythmia:	Rhythm differing from preoperative status
Cardiac arrest:	No cardiac output requiring cardiac massage
Excess blood loss:	Greater than half of the blood volume
Oliguria:	Urine output less than 0.5 ml per kilogram per hour
Patient moved:	Inadequate general anaesthesia or neuromuscular blockade
Hypothermia:	Temperature less than 35.5°C
Unintentional injection:	Unintentional drug injection
Circuit failure:	Circuit disconnection greater than 20 seconds
Death:	Intraoperative mortality
Local anaesthesia (LA) events	
Failed LA:	Three or more attempts (needle withdrawn from skin and reinserted)
Planned LA abandoned:	LA technique planned but not used
Dural tap:	Dural puncture with an epidural
Patchy block:	Incomplete block with epidural
Unable to pass catheter:	Failure to place epidural catheter in epidural space
High block with hypoventilation:	Spinal anaesthesia higher than T5 with respiratory compromise
Accidental spinal block:	Unexpected subarachnoid block with LA
Systemic toxicity of LA:	Signs or symptoms of LA toxicity reported

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