The Canadian four-centre study of anaesthetic outcomes: III. Are anaesthetic complications predictable in day surgical practice?

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To understand better the factors important to the safety of anaesthesia provided for day surgical procedures, we analyzed the intraoperative and immediate postoperative course of patients at four Canadian teaching hospitals' day treatment centres. After excluding those who received only monitored anaesthesia care, there were 6,914 adult (non-obstetrical) patients seen over a twelve-month period in 1988-89. The rate of adverse outcome consequent to their care was identified by a comprehensive surveillance system which included review of anaesthetic records (four hospitals) and follow-up telephone calls (two hospitals). The relationship between adverse events and preoperative factors was determined by using a multiple logistic regression analysis that included age, sex, duration of the procedure and the hospital care. There were no deaths during the study period and major morbid events were infre-

quent. Patient preoperative disease was predictive of some intraoperative events relating to the same organ system, but not to events in the PACU. Some unexpected relationships emerged including preoperative hypertension being related to a greater risk of difficult intubation, and neurological disease to perioperative cardiac abnormalities. Patients judged obese, or inadequately fasted, were found to experience a greater rate of recovery problems as well as discomfort. While the low response rate (36%) to the telephone interviews created a sampling bias, the high rate of patient dissatisfaction among those reached is disconcerting. We conclude that day surgical patients with preoperative medical conditions, even when optimally managed, are at higher risk for adverse events in the perioperative period.

Key words

ANAESTHESIA: epidemiology, morbidity, outcome, outpatient;

COMPLICATIONS: morbidity;

EPIDEMIOLOGY: anaesthesia.

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Afin de mieux comprendre les facteurs importants pour la sécurité de l'anesthésie prodiguée en chirurgie ambulatoire, nous avons analysé le dérouls intra-opératoire en post-opératoire immédiat chez les patients des centres de chirurgie ambulatoire de quatre hôpitaux d'enseignement canadiens. Après exclusion des cas n'ayant nécessité qu'une surveillance anesthésique, il y avait 6914 patients adultes (non obstétricaux) pour une période de douze mois en 1988-89. Le taux d'issues défavorables secondaires aux soins a été identifié par un système de surveillance d'ensemble qui incluait la révision des dossiers anesthésiques (quatre hôpitaux) et des appels téléphoniques pour assurer le suivi (deux hôpitaux). La relation entre les événements défavorables et les facteurs pré-opératoires était déterminée par une analyse de régression logistique multiple qui incluait l'âge, le sexe, la durée de l'intervention et l'hôpital ayant fourni les soins. Il n'y a pas eu de décès durant la période de l'étude et les événements morbides majeurs ont été peu fréquents. La maladie du patient en pré-opératoire était un facteur de prédiction de quelques événements intra-opératoires reliés au même système d'organes, mais ne l'était pas pour les événements survenus en salle de réveil. Quelques relations imprévues ont émergées dont la

relation entre l'hypertension artérielle pré-opératoire et un plus grand risque d'intubation difficile, et la relation entre une maladie neurologique et les anomalies cardiaques en péri-opératoire. Les patients considérés obèses, ou sans jeûne adéquat, ont présentés un plus haut taux de problèmes au réveil et un plus grand inconfort. Bien que le faible taux de réponse (36%) aux entrevues téléphoniques a créé un biais d'échantillonnage, le haut taux d'insatisfaction des patients parmi ceux qui furent rejoints est déconcertant. En conclusion, les patients de chirurgie ambulatoire qui présentent des problèmes médicaux pré-opératoires, même lorsque traités de façon optimale, sont à plus haut risque de présenter des événements défavorables en période péri-opératoire.

The use of day surgery is increasing such that it has been estimated that between 40 to 50% of all surgical procedures could be performed without overnight postoperative hospitalization.¹ Combining anticipated cost savings inherent in the provision of ambulatory surgery with the safety with which care can be provided in modern outpatient facilities has contributed to this popularity.² However, while the operative procedure is commonly used to define which subjects are acceptable candidates,³ there has been little critical evaluation of patient factors important to outpatient anaesthetic practice.

This paper outlines the characteristics of day surgical patients served in four Canadian teaching hospitals during a one-year period of in-depth evaluation of outcome of anaesthetic care. Variables of interest included preexisting patient illnesses, the anaesthetic deployed, the operative procedure and the occurrence of adverse outcome. The purpose of this paper was to determine if the preoperative evaluation of the patient allowed the practising anaesthetist to predict the safety with which a day surgical procedure may be performed.

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Methods

During a 12-month period (1988–89), for each adult, non-obstetrical patient undergoing a surgical procedure at one of four teaching hospitals in Canada, anaesthetists completed a modified anaesthesia data sheet in a check-off format. Included was information about the patient, the surgical procedure and the anaesthetic provided. Each patient was classified according to the American Society of Anesthesiologists' physical status score⁴ and the presence or absence of preexisting medical conditions was documented as either diagnosed only, diagnosed and treated or diagnosed and not controlled despite treatment.

During the surgical procedure, the anaesthetist documented the patient's course and anaesthetic used, as well as any adverse events that may have occurred. Following the procedure, the form accompanied the patient to the Postanaesthetic Care Unit (PACU) where the nursing staff recorded any untoward events on the same form. For all patients, within 72 hr of the procedure, a trained anaesthesia research nurse reviewed the anaesthesia record to ensure completeness of the information.⁵ At one hospital, in addition to the above, all outpatient charts were reviewed; day surgery charts were not accessible at the other three hospitals. At two hospitals, day surgery patients were telephoned within 72 hr of the operation to determine if there were specific postoperative problems. The phone interview was conducted with either the patient or with a proxy. Patients undergoing operations of a sensitive nature (e.g., therapeutic D&C) were not contacted. Research nurses were instructed to telephone each patient up to three times in order to receive a response. Long distance calls outside adjacent neighbouring provinces were not attempted.

The patient questionnaire was developed at the coordinating centre and tested by two pairs of nurses visiting the same 75 patients. The interrater reliability was over 95% between the pairs of nurses. During the interview, patients were asked if they had any of a list of problems (non lifethreatening minor events of a troublesome nature to patients), and if the problem was present, patients were asked to grade the severity of the problem using a five-point scale⁶ ranging from mild to excruciating. In addition, patients were asked how satisfied they were with their anaesthetic experience (very satisfied, satisfied, somewhat satisfied, not satisfied and very unsatisfied).

The term "outpatient or day surgery" referred to those patients who did not have a postoperative overnight stay in hospital. At three hospitals, a small percentage of patients did have one overnight preoperative stay prior to the surgical procedure. In all four hospitals the surgical and PACU facilities were located in the main hospital buildings; these were not free-standing day service facilities. There was no attempt by the investigators to control the

Any OR	Any operating room complications
Any RR	Any recovery room complication
Any BP	Intraoperative hypertension or hypotension, recovery room hypertension or hypotension
Any cardiac	OR arrhythmia, heart block, cardiac arrest, RR cardiac arrest, other cardiac event
Diff intub	Difficult intubation
Any resp	Upper respiratory events, laryngospasm, aspiration (OR)
Any low resp	Bronchospasm, lower respiratory, other respiratory (OR or RR)
N & V	Nausea or vomiting
Other OR	Dental, anaphylaxis, drug incident, malignant hyperthermia, neurological
Other RR	Neurological, renal, metabolic, musculoskeletal, psychological
Any fail	Mechanical or equipment failures, failed regional
Any bleed	Excess blood loss (OR or RR), other surgical event, ICU admission

FIGURE Outcome grouping categories

assignment of patients to inpatient or outpatient care, the choice being made by the surgeon, the patient and the availability of inpatient beds. Some patients were seen in anaesthesia clinics before the operation but these data were not captured in the study.

Preliminary data analysis was performed by examining the patient and surgical case mix across the four hospitals ($n = 10,157$). This identified variations between institutions with respect to procedures done and anaesthetic techniques used. The most important difference was that in hospital A, 70% of the cases were gynaecological procedures performed using monitored anaesthesia care. Since this skewed case-mix would prevent meaningful comparisons between institutions and detract from the role of anaesthetic technique in the genesis of postoperative adverse events, all cases of monitored anaesthesia care were excluded from subsequent analysis ($n = 3243$, 91% from hospital A) leaving 6,914 patients in the study.

The rate of patient and surgical case-mix variables across the four hospitals was determined for the remaining patients. The patient and surgical case-mix across the four institutions was now very similar and therefore the remaining analyses were performed using combined data from the four hospitals. The crude rate of adverse events per 1000 anaesthetics was computed for events occurring in the operating room, in the PACU, and for the patient interviews (two hospitals only). Since many of the adverse events were extremely rare, complications were grouped according to time of appearance and by organ system involved (Figure). Unplanned admission to hospital was a variable which had not been included in the protocol.

In order to determine the relationship between adverse perioperative events and preoperative medical conditions

and factors affecting the administration of the anaesthetic, relative risks were calculated for each variable and each (grouped) outcome. For example, the risk of having a postoperative cardiac complication was computed for patients having a preoperative myocardial infarction compared with patients without a preoperative myocardial infarction. Finally, we adjusted the relative risk estimates for patient casemix using a multiple logistic regression and 99% confidence intervals. Included in the model were age, sex, length of anaesthesia (an approximation of surgical severity) and hospital. A variable was considered to be statistically significant if the confidence intervals around its relative risk estimate did not include unity. Statistical significance was considered at the more conservative value of $P < 0.01$ to rule out spurious results due to multiple comparisons.

Results

Characteristics of the patients, the surgical procedures and the anaesthetic techniques are presented in Tables I to III. The main features include:

Patient characteristics

Most of the patients undergoing day surgery in the four hospitals were young, with 84.2% of cases less than 50 yr of age. On the other hand, 3.1% of anaesthetics were administered to persons over 70 and 0.8% to patients over 80 years of age. The majority of ambulatory surgery cases were healthy women of physical status I or II; about 3% of subjects were physical status III. Over 75% of the patients did not have any notable preexisting medical diseases; those that did were not severe. For example, only two patients had had a myocardial infarction in the six months before operation.

Surgical factors

Most cases were classified as elective, but 2.7% of procedures were deemed to be emergencies. This classification cannot however be used to draw implications as to the adequacy of patient preparation, for only the timing of the procedure is implicated in the emergency classification. The duration of anaesthesia was related to the time of the surgical procedure with only 3.4% lasting more than two hours. Female genital, orthopaedic and ophthalmological procedures dominated but there were considerable variations across the hospitals with respect to the procedures performed.

Anaesthetic factors

The majority of patients did not present complicating factors to the anaesthetist. However, 49 patients (0.7%) gave a history of previous anaesthetic problems, either a personal or family history or a history of malignant

TABLE I Characteristics of day surgery patients by hospital

	<i>Hospital</i>							
	<i>A</i>		<i>B</i>		<i>C</i>		<i>D</i>	
	<i>n = 2096</i>		<i>n = 1652</i>		<i>n = 1325</i>		<i>n = 1841</i>	
<i>Age</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>
<20	206	9.8	209	12.7	156	11.8	153	8.3
20–29	751	35.8	555	33.6	421	31.8	594	32.2
30–39	588	28.1	419	25.4	357	26.9	589	32.0
40–49	244	11.6	217	13.1	136	10.3	230	12.5
50–59	146	7.0	136	8.2	118	8.9	147	8.0
60–69	90	4.3	74	4.5	69	5.2	92	5.0
70–79	49	2.3	31	1.9	47	3.6	32	1.7
80+	22	1.0	11	0.7	21	1.6	4	0.2
<i>Sex</i>								
Female	1513	72.2	1280	77.5	851	64.2	1169	63.5
<i>Physical status</i>								
1	1456	69.5	1061	64.2	911	68.8	1305	70.9
2	590	28.1	545	33.0	349	26.3	491	26.7
3	50	2.4	46	2.8	55	4.2	43	2.3
4	0	0	0	0	1	0.1	2	0.1
<i>Pre-existing medical condition</i>								
None	1589	75.8	1188	72	1027	78	1387	75
Asthma	56	2.7	44	2.7	30	2.3	56	3.1
COPD	47	2.3	44	2.7	53	4.0	19	1.0
Other respiratory	111	5.3	136	8.2	51	3.9	29	1.6
MI < 6 mo	1	0.1	0	0	1	0.1	0	0
MI > 6 mo	10	0.5	9	0.5	10	0.8	12	0.7
Hypertension	93	4.4	72	4.4	64	4.8	92	4.9
Arrhythmia	14	0.7	14	0.9	15	1.1	11	0.6
Congestive heart failure	2	0.1	1	0.1	8	0.6	2	0.1
Other cardiovascular	57	2.7	44	2.7	23	1.7	35	1.9
Cerebrovascular	10	0.5	8	0.5	2	0.2	2	0.1
Renal	16	0.8	4	0.2	9	0.7	5	0.3
Neurological	36	1.7	34	2.1	48	3.6	21	1.1
Hepatic	6	0.3	5	0.3	7	0.5	2	0.1
Diabetes	31	1.5	13	0.8	18	1.4	13	0.7
<i>Patient type</i>								
One preop night	165	7.9	173	10.5	96	7.2	*	

*Not recorded.

hyperthermia. Eighty-nine patients posed an airway difficulty, and inadequate fasting (as judged by the attending anaesthetist) was present in 2.1% of cases. No standardized definition of obesity was used in the study, but was subjectively assigned to 7.4% of cases while 22.6% were acknowledged smokers.

In the time frame of the study, inhalation techniques were widely used, while regional procedures were uncommon. There were wide variations between institutions as to drugs used. While most patients received at least some narcotic and nitrous oxide was used in 80–90% of cases, the favoured volatile anaesthetic varied with the hospital.

(It is noted that not all hospitals had introduced short-acting intravenous anaesthetics into their formularies at the time of the study.)

Basic monitoring (ECG, blood pressure, FiO_2) was universal in the four hospitals, but there was considerable variation in the use of other monitors especially pulse oximetry and capnography. These monitors were being purchased at the time of the study and were therefore not available for each case.

Teaching status

Of the 6914 cases, 1707 (24.7%) were attended by an

TABLE II Characteristics of the surgical procedure by hospital

	<i>Hospital</i>							
	<i>A</i>		<i>B</i>		<i>C</i>		<i>D</i>	
	<i>n = 2096</i>		<i>n = 1652</i>		<i>n = 1325</i>		<i>n = 1841</i>	
	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>
<i>Emergency</i>	53	2.5	87	5.3	35	2.6	15	0.8
<i>Duration of anaesthesia</i>								
<30 min	316	15.1	256	15.5	39	2.9	207	11.2
30–59 min	962	45.9	1047	63.4	573	43.2	945	51.3
60–119 min	746	35.6	322	19.5	649	49.0	619	33.6
120 + min	72	3.4	27	1.6	64	4.8	70	3.8
<i>Surgical procedure</i>								
Nervous system	34	1.6	29	1.8	76	5.7	90	4.9
EENT	148	7.1	44	2.7	143	10.8	83	4.5
Dental	230	10.9	431	26.1	33	2.5	128	7.1
Digestive	319	15.2	199	12.0	169	12.8	231	12.6
Urinary	95	4.5	39	2.4	43	3.3	28	1.5
Female genital	783	37.4	569	34.4	356	26.9	391	21.4
Musculoskeletal	366	17.5	164	9.9	380	28.7	678	36.8
Integumentary	40	1.9	134	8.1	70	5.3	151	8.2
Other	79	3.8	39	2.4	53	4.0	60	3.3

anaesthesia resident as well as a staff anaesthetist. The use of an outpatient facility for educational purposes varied considerably across the four hospitals with as few as 13% of cases having a resident at hospital A to 54% at hospital C.

The next series of Tables show the rates of adverse events per 1000 anaesthetics (data from the four hospitals combined).

Intraoperative events (Table IV)

The majority of patients had an uneventful course, but some developed cardiovascular or respiratory problems. One hundred twelve patients (1.6%) experienced significant swings in blood pressure, while 74 had some notable albeit transient arrhythmia. Difficulty with intubation occurred in 35 subjects (0.5%), while other respiratory related events were encountered in 87 (1.3%). In 21 instances, failure of the intended anaesthetic necessitated changing from one technique to another. Mechanical or equipment problems occurred during six cases, and drug incidents occurred in four subjects. Three patients were admitted to the intensive care unit. Overall the rate of intraoperative events was 50 per 1000 anaesthetics.

PACU (Table IV)

The most common event was nausea and/or vomiting with an overall rate of 72.6 per 1000. There were, in addition, 23 patients who suffered considerable variations in blood

pressure, and 30 who had a respiratory related event recognized by the PACU staff.

Postoperative interviews (Table V)

Only 25% of patients were contacted at Hospital A compared with 67% at Hospital C. The reader is cautioned that these event frequencies may not be representative of the overall surgical population due to the low response rate. It would appear however, that the rates of nausea, vomiting, sore throat, headache and muscle pain were high.

Multivariate analysis

Table VI shows the adjusted relative odds for a perioperative complication for each preoperative medical condition. As would be expected, patients with preoperative respiratory problems such as asthma or chronic obstructive pulmonary disease were at higher risk for intraoperative complications, especially lower respiratory events. Similarly, those with preoperative hypertensive disease were more likely to run into difficulties with blood pressure control. However, there were a number of other relationships which were not expected. Patients with preoperative hypertension were more likely to experience a difficult intubation and patients with preoperative neurological diseases were at risk for cardiac events. Patients with preoperative respiratory problems or hypertension were at higher risk for cardiac events and diabetics had four times the risk of blood pressure abnormalities.

TABLE III Characteristics of the anaesthetic for day surgery patients by hospital

	<i>Hospital</i>							
	<i>A</i>		<i>B</i>		<i>C</i>		<i>D</i>	
	<i>n = 2096</i>		<i>n = 1652</i>		<i>n = 1325</i>		<i>n = 1841</i>	
	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>
<i>Factors affecting the administration of anaesthesia</i>								
Previous anaesthetic problem	10	0.5	12	0.7	14	1.1	13	0.7
Difficult airway	38	1.8	21	1.3	15	1.1	15	0.8
Full stomach	28	1.3	93	5.6	23	1.7	4	0.2
Obesity	156	7.4	163	9.9	166	12.5	27	1.5
Smoker	475	22.7	298	18.0	425	32.1	364	19.8
<i>Primary anaesthetic technique</i>								
Inhalation	1757	83.8	1479	89.5	1000	75.5	1756	95.4
Narcotic	236	11.3	77	4.7	65	4.9	11	0.6
Plexus block	32	1.5	8	0.5	46	3.5	41	2.2
Spinal	14	0.7	12	0.7	20	1.5	8	0.4
Epidural	13	0.6	4	0.2	14	1.1	4	0.2
Other	52	2.5	85	5.1	185	14.0	33	1.8
<i>Monitors</i>								
Neuromuscular	603	28.8	417	25.2	548	41.4	274	14.9
Pulse oximeter	534	25.5	1540	93.2	1169	88.2	1101	59.8
Precordial/oesophageal stethoscope	162	7.7	94	5.7	450	34.0	207	11.2
Temperature	84	4.0	203	12.3	401	30.3	311	16.9
End tidal CO ₂	29	1.4	31	1.9	917	69.2	966	52.5
Urinary catheter	20	1.0	7	0.4	4	0.3	1	0.1
<i>Drugs/gases</i>								
Nitrous oxide	1796	85.7	1481	89.6	1021	77.1	1690	91.8
Halothane	290	13.8	134	8.1	385	29.2	234	12.7
Isoflurane	832	39.7		4.5	586	44.2	1251	68.0
Enflurane	562	26.8		6.3	8	0.6	250	13.6
Fentanyl	1120	53.4		4.5	*		940	51.1
Sufentanil	396	18.9		5.4	*		26	1.4
Alfentanil	181	8.6		5.2	*		142	7.7
Any narcotic	1766	84.3		5.1	995	75.1	1100	59.8
<i>Resident in attendance</i>	264	12.6		6.3	718	54.2	290	15.8

*Not recorded.

Table VII shows the adjusted relative odds for perioperative events by preoperative anaesthetic factors. It is of some interest that a history of previous anaesthetic problems was not associated with any incremental risks while a history of cigarette smoking was only found to be a risk factor for lower respiratory events. Cases with inadequate fasting were at higher risk for problems with blood pressure control while cases where a difficult airway was anticipated were, as expected, at higher risk for difficult intubation and respiratory related events. Patients judged obese were at higher risk for a number of problems. An unusual finding which requires further follow-up is the decreased risk of nausea or vomiting by those who smoked.

Discussion

In spite of the widespread development of ambulatory surgery, there has been relatively little critical evaluation of the outcome of this service. Randomization of subjects between inpatient and outpatient facilities has essentially not occurred. The only referenced randomized trial of day surgical care⁷ included only 28% of eligible subjects, limiting the generalizability of the results. Descriptive studies have covered a prolonged time when many changes occurred in anaesthetic and in surgical technique as well as patients accepted for day surgery. Large series of cases from both Canada^{8,9} and the United States¹⁰⁻¹² point to the safety of the provision of care on an ambulatory basis. However, the enthusiasm to reduce

TABLE IV Observations during the intraoperative and PACU time periods

	<i>All 4 hospitals combined</i>	
	<i>n</i>	<i>Rate /1000</i>
<i>Intraoperative</i>		
Hypotension	47	6.7
Hypertension	65	9.4
Cardiac arrest	0	0
Supraventricular arrhythmia	26	3.8
Ventricular arrhythmia	42	6.1
Heart block	6	0.9
Difficult intubation	35	5.1
Upper respiratory	15	2.2
Aspiration/regurgitation	7	1.0
Laryngospasm	28	4.0
Bronchospasm	28	4.0
Other lower respiratory	9	1.3
Failed technique	21	3.0
Mechanical/equipment	6	0.9
Excessive blood loss	1	0.1
Other surgical	2	0.3
Anaphylactoid	0	0
Drug incident	4	0.6
Admitted to ICU	3	0.4
Deaths	0	0
<i>PACU</i>		
Nausea/vomiting	502	72.6
Hypothermia	8	1.2
Cardiac arrest	0	0
Hypotension	16	2.3
Hypertension	7	1.0
Respiratory	30	4.3
Renal/metabolic	2	0.3
Musculoskeletal	1	0.1
Burns/skin damage	1	0.1
Psychological	3	0.4

hospital costs has resulted in the extension of the service for patients sicker than those evaluated in early published studies.^{13,14} It is therefore important to establish which patients possess an increased risk for an adverse outcome after a day surgical procedure.

A commonly used measure of outcome of day surgical practice is to determine the number and rate of unscheduled admissions to hospital. Unfortunately this information was not a part of the present study. The frequency with which this occurs has been reported to vary from 1% for children⁹ to 0.28–2.44% for adults;^{8,10} the latter ten-fold variation in complications was most likely related to patient selection and year of service. The usual reasons for unscheduled admissions were persistent pain, nausea and/or vomiting, syncope, or surgical bleeding. Mortality related to anaesthesia or surgery is distinctly unusual, with emergency or life-threatening complications estimated to occur in less than 0.007% of cases.¹⁰ With respect to morbidity necessitating admission, it has been suggested

TABLE V Results of patient interviews

	<i>Hospital A (n = 524)</i>		<i>Hospital C (n = 886)</i>	
	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>
Nausea	131	25.1	112	12.6
Vomiting	91	17.3	64	7.2
Sore throat	202	38.5	206	23.2
Eye problem	3	0.6	1	0.1
Tingling	5	1.0	2	0.2
Muscle pain	65	12.4	61	6.9
Headache	81	15.5	55	6.2
Backache	27	5.2	11	1.2
Awareness	2	0.4	2	0.2
Excessive drowsiness	15	2.9	*	
Unsatisfied or very unsatisfied	68	13.0	68	7.7

*Not sampled.

that the surgical procedure is most often a concern; in the large series from Vancouver, admissions relating to surgical reasons occurred in 0.22%, while admissions relating to anaesthesia were 0.07%.⁸ Not to be forgotten, patient-related factors may also be a direct cause, for lack of a supportive social environment may necessitate hospitalization and may be perceived as a failure of the day surgical system.

The design of the present study enabled the identification of those patients who experienced adverse outcomes as a consequence of their day surgical anaesthetics, and identified factors placing patients at higher risk for such events. The use of four separate institutions generated considerable variation in the patient case-mix and in the anaesthetic management, but allowed a large study population to be amassed during a stable time frame to medical advances. It should be noted that the assignment of patients to ambulatory surgery was as generally practised,¹⁵ with the patients treated as outpatients in these four centres being typical of most programs in that they tended to be young and of fit physical status. However, our data suggest that the elderly and those of physical status III can be safely treated as day surgery cases. This stands in contrast to the reduced utilization of day facilities by the elderly as reported by Lagoe.¹⁶ The procedures reported in that study were generally minor, and most operations were of relatively short duration.

There were few major adverse events among this essentially healthy population, and no deaths related to their care. Three patients were admitted to an intensive care unit for monitoring, but there were no permanent sequelae in any patient. The grouping of complications was necessary in view of the very low rate of individual adverse events. If the data are used to indicate which patients are likely to experience an intraoperative compli-

TABLE VI Adjusted† relative risks for perioperative events by preoperative medical conditions

Preoperative condition	Perioperative event											
	Any OR	Any RR	Any BP	Any cardiac	Diff intub	Any resp	Any low resp	N+V	Other OR	Any fail	Any bleed	Other RR
Asthma	2.0*	1.4	0.6	3.4*	–	2.6	7.2*	1.4	0.9	1.3	–	1.5
COPD	2.3*	0.9	2.6*	1.6	1.8	0.7	10.1*	0.6	–	0.8	–	0.6
Other respiratory	2.0*	0.9	1.2	3.2*	1.0	2.1	5.6*	1.0	2.9	–	–	2.1
MI < 6 mo	–	–	–	–	–	–	–	–	–	–	–	–
MI > 6 mo	1.7	1.9	3.0	–	–	–	–	1.6	2.8	–	–	–
Hypertension	2.3*	1.4	4.0*	0.8	4.3*	0.4	1.9	1.0	0.6	1.5	–	1.4
Arrhythmia	1.3	0.7	1.1	6.2*	–	9.6*	–	0.8	–	–	–	–
Congestive heart failure	2.4	1.2	5.6	–	–	–	–	–	–	–	–	7.1
Other cardiovascular	1.3	1.1	2.0	1.2	–	2.1	1.1	0.9	–	2.6	–	0.9
Cerebrovascular	0.5	2.2	1.1	–	–	–	–	2.5	–	–	–	–
Gastrointestinal	2.5*	1.2	2.1	1.3	2.5	1.3	4.3	1.4	3.0	1.8	–	–
Renal	0.4	2.4	1.7	–	–	–	–	2.4	–	–	–	2.8
Neurological	1.6	1.2	0.8	3.7*	–	0.9	1.4	1.4	–	1.2	–	–
Diabetes	1.8	1.1	4.0*	1.2	2.0	1.9	–	1.0	–	–	–	1.5
Hepatic	–	1.1	–	–	–	–	–	1.8	–	–	–	–

* $P \leq 0.01$.

†Adjusted for age, gender, length of anaesthesia and hospital.

– Number of events too small to calculate relative odds.

TABLE VII Adjusted† relative risks for perioperative events by preoperative anaesthetic risk factors

Factor	Any OR	Any RR	Any BP	Any cardiac	Diff intub	Any resp	Any low resp	N+V	Other OR	Any fail	Any bleed	Other RR
Previous anaesthetic problem	2.1	1.7	2.0	–	4.2	6.6	–	1.4	–	4.0	–	5.0
Anticipated difficult airway	3.4*	1.7	1.7	1.0	16.9*	10.2*	4.3	1.3	5.4*	–	–	1.3
Full stomach	1.7	1.3	3.2*	1.1	1.0	1.0	3.0	1.0	0.8	–	–	1.0
Obesity	1.9*	1.4*	1.8	1.0	1.8	2.3	5.4*	1.6*	2.9*	0.3	–	0.9
Smoker	1.2	0.7*	1.0	1.4	0.3	1.0	7.4*	0.6*	0.8	0.7	–	1.0

* $P \leq 0.01$.

†Adjusted for age, gender, length of anaesthesia and hospital.

– Number of events too small to calculate relative odds.

cation, even when optimally prepared for surgery, preexisting medical conditions were found to place patients at increased risk for poorer intraoperative outcome. Complications experienced in the PACU were not as predictable based upon the patient's medical history, with no identified illness statistically related to an increased risk of problems. In contrast, those who were judged obese or inadequately fasted continued to experience difficulties during the recovery phase.

In the study only two hospitals had sufficient follow-up nursing staff to phone outpatient cases after discharge. In one hospital, the rate of successful interviews was 25% and in the second 67%. It is clear that the success of telephone follow-up is dependent upon effort and is difficult to achieve. Patel and Hannallah¹² reported a 50% telephone interview rate for parents of children undergoing ambulatory surgery. In another study using a computerized

system to improve telephone follow-up, 64% of cases were successfully contacted.¹⁷ Such a low response rate introduces a marked bias in that it is likely that those patients who were reached had more postoperative problems (and were forced to stay home) than those who were not reached as they had resumed normal activities. However, even with the limitations of the telephone survey, it is disturbing that so many patients reported sore throat, nausea, headache and backache. A more intensive study of post-discharge ambulatory surgery is clearly needed.

The relationship between patient illness and adverse outcome, even when the condition is deemed to be under sufficient control to allow for day surgery, was found in this study as was found in an earlier study of inpatients.¹⁸ We again found that cardiovascular disease was associated with increased risk of cardiac events and swings in blood pressure. However, not all associations were predictable.

For example, the presence of preoperative hypertension was associated with a greater chance of difficult intubation, a relationship not previously described. The relationship between neurological problems and cardiac events was similarly unexpected. The more conservative *P* value of 0.01 was used in this study, so it is unlikely that these observations were due only to chance. However, these relationships, while of some concern, require further confirmation and investigation in future studies.

Despite the trend towards an increase in the provision of operative services on a day basis,¹⁹ only one of these teaching hospitals had a majority of its cases attended by a resident. While the assumption may be that these cases are "routine" or "uninteresting" for students, it is unfortunate that residents are not more frequently exposed to situations representative of their future practice of anaesthesia.

In summary, in a cohort of almost 7000 patients provided general anaesthesia on an outpatient basis in four university centres in Canada, we have defined the frequency of adverse events. While the selection of cases according to general health and the proposed surgical procedure appears to have resulted in a low rate of events, we have been able to identify specific preoperative risks associated with hypertension, diabetes, and diseases of the gastrointestinal tract. Further critical evaluation of patients with well-managed and stable disease will be necessary to establish a better understanding of these complications and the clinical significance of our observations. We conclude that the majority of younger, healthy patients are at very low risk of adverse events following day surgery. However, patients with preoperative medical conditions, even when optimally managed, are more prone to adverse perioperative events.

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