Anaesthetic Morbidity at the University Hospital of the West Indies

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ABSTRACT

Objective: *There is little information on adverse anaesthetic outcomes from the Caribbean. The aim of this study was to investigate the occurrence of anaesthetic morbidity and mortality at the University Hospital of the West Indies (UHWI) and to identify possible risk factors.*

Methods: *All anaesthetic procedures at the UHWI were monitored for adverse events and patient outcomes for the 12-month period from March 2004 to February 2005. Possible risk factors for these adverse events were assessed using logistic regression.*

Results: *Of 3185 anaesthetic proceduress, the incidence of intra-operative events was 201 per 1000 (95% CI 187, 215); 151 per 1000 being cardiovascular and 26 per 1000 respiratory. Others included excess blood loss and equipment failure, hyperglycaemia, nausea and vomiting. Patients with intra-operative complications were three times more likely to have complications during recovery (OR = 3.35; 95% CI 2.59, 4.33,* $p < 0.001$*). The incidence of complications among paediatric patients was 139 per 1000 (95% CI 104, 174) intra-operatively and 58 per 1000 (95% CI 34, 81) during recovery.*

Risk factors for developing complications ($p < 0.05$*) included age > 50 years, ASA status ≥ II, prolonged anaesthesia, high surgical risk, general or combined anaesthetic techniques, senior anaesthetist, intubated patients and co-morbidities. There were 14 operative mortalities, none of which was anaesthesia-related.*

Conclusion: *Anaesthetic complication rates at the UHWI are comparable to those in developed countries, except for higher paediatric complication rates and ICU admissions and lower rates of postoperative nausea and vomiting.*

Morbilidad Anestésica en el Hospital Universitario de West Indies: un Estudio Transversal Prospectivo

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RESUMEN

Objetivo: *Existe poca información sobre resultados anestésicos adversos en el Caribe. El propósito del presente estudio fue investigar la manifestación de la morbilidad y la mortalidad anestésicas en el Hospital Universitario de West Indies (UHWI) e identificar los posibles factores de riesgo.*

Métodos: *Todos los procedimientos anestésicos en el UHWI fueron monitoreados en busca de eventos adversos y resultados con los pacientes, durante un período de 12 meses a partir de marzo del 2004. Los posibles factores de riesgo para estos eventos adversos fueron evaluados mediante regresión logística.*

Resultados: *De 3185 procedimientos anestésicos, la incidencia de eventos intraoperatorios fue de 201 por 1000 (95% CI 187, 215); siendo 151 por 1000 cardiovasculares y 26 por 1000 respiratorios. Otros incluyeron exceso en pérdida de sangre y fallo de equipos, hiperglicemia, náusea, y vómitos. Los pacientes con complicaciones intraoperatorias presentaron una probabilidad de complicaciones tres veces mayor en la fase de recuperación (OR = 3.35; 95% CI 2.59, 4.33,* $p < 0.001$*). La incidencia de complicaciones entre pacientes pediátricos fue 139 por 1000 (95% CI 104, 174) intraoperatoriamente*

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*y 58 por 1000 (95% CI 34, 81) durante la recuperación. Entre los factores de riesgo que desarrollaban complicaciones (*p < *0.05) se hallaban: la edad > 50 años, estatus de ASA ≥ II, anestesia prolongada, alto riesgo quirúrgico, técnicas anestésicas combinadas o generales, anestesiólogos de la tercera edad, pacientes entubados, y comorbilidades. Se produjeron 14 mortalidades operatorias, ninguna de las cuales guardó relación con la anestesia.*

Conclusión: *Las tasas de complicación anestésica en UHWI son comparables a las que se producen en países desarrollados, excepto por las tasas de complicación pediátrica más altas, mayor número de ingresos a las UCIs, y tasas más bajas de náuseas y vómitos postoperatorios.*

West Indian Med J 2009; 58 (5): 453

INTRODUCTION

Anaesthetic morbidity has been defined as "the occurrence of an unanticipated complication during or following anaesthesia that may be attributable to an anaesthetic (1)" or "any anaesthetic-related complication associated with patient discomfort, compromise or a prolonged hospital stay" (2)." It is a measure of standard of care, and morbidity data are useful in designing and assessing strategies to improve patient safety. Predictors include the American Society of Anaesthesiologists' (ASA) score, age, chronic illnesses, obesity, major abdominal surgery and length of anaesthesia (1, 2).

Anaesthetic mortality represents the worst possible outcome, but has declined considerably in many countries. This has been attributed to improvements in equipment, monitoring, anaesthetic training and peri-operative care (1). Mortality rates range between 0.55 [United States of America (USA)] (3) and 1.0 (United Kingdom (UK)] (4) per 10 000 anaesthetic procedures in developed countries. Countries with limited resources, however, have much poorer outcomes and rates as low as 1 per 133 anaesthetic procedures (Togo) have been documented (5).

The objectives of this study were to investigate the occurrence of intra-operative and recovery room anaesthetic complications and subsequent patient outcomes at the UHWI and to determine predictors of anaesthetic morbidity.

SUBJECTS AND METHODS

This prospective, cross-sectional study was conducted among patients who received an anaesthetic between March 1, 2004 and February 28, 2005 in the main operating suite at the UHWI, excluding obstetric and private patients. Data were available on 3185 anaesthetic procedures that satisfied the inclusion criteria. Ethical approval was obtained from the Ethics Committee of the Faculty of Medical Sciences, The University of the West Indies/University Hospital of the West Indies UWI Faculty of Medical Sciences Ethics Committee.

Data collected included patient demographics, ASA status, chronic illnesses, anaesthetic technique, monitors and the primary anaesthetist's level of training. The perceived surgical risk (Table 1), urgency (elective or emergency), time and length of surgery were also recorded. Adverse anaesthetic "events" were considered complications if they required intervention by the anaesthetist, such as vasoconstrictors or anti-arrhythmics (6, 7). Definitions of each complication adapted from the Canadian study of anaesthetic outcomes by Cohen *et al's* (6) were made available to all anaesthetists to act as guidelines to ensure uniformity of the data collected, and to enable comparison of our results to those from Cohen's study. Complications were documented intra-operatively by the responsible anaesthetist and in the recovery room by the nurses. Patient outcomes, including prolonged recovery (over six hours), Intensive Care Unit (ICU) admission or death were recorded. All forms were reviewed by the research team for completeness, and missing data added from the anaesthetic charts, where available.

Table 1: Perceived surgical risk and associated procedures

Surgical Risk	Examples of Procedures
High risk	Intracranial, open heart, major thoracic, major vascular, major faciomaxillary reconstructive surgeries, spine surgery, procedures with anticipated major blood loss
Medium risk	Intra-abdominal, *eg* cholecystectomy, hemicolectomy; Gynaecological, *eg* total abdominal hysterectomy, salpingo-oophrectomy; Urological, *eg* nephrectomy, perurethral resection of prostate, ureteroscopy; Orthopaedic *eg* open reduction and fixation of fractures
Low risk	Breast lumps, lipomas, inguinal and umbilical hernia repair, appendectomy, circumcision, cystoscopy

Possible risk factors for adverse outcomes were assessed using odds ratios, calculated using logistic regression pre-adjusted for age. The uncertainty associated with results was summarized using 95% confidence intervals. A *p*-value of less than 0.05 was considered statistically significant, and exact *p*-values were presented at all times to clarify the strength of statistical relationships. Analyses were performed using the Stata statistical software (Release 10, StataCorp, College Station, Texas).

RESULTS

Patient Demographics

The mean age of the study group was 39.8 ± 22 years (range 1 day – 99 years) [Fig. 1]. Twelve per cent (12% of patients were under 12 years of age, with a mean age of 5.2 ± 3.9

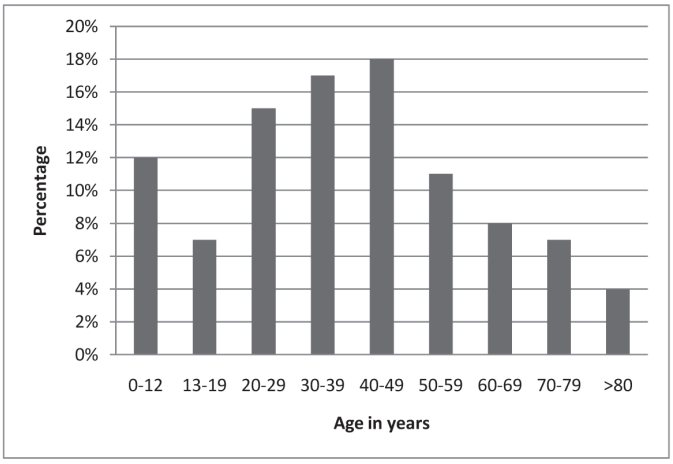

Fig. 1: Age distribution

years. Females comprised (54.5%). American Society of Anaesthesiologists' status was distributed as follows: 55.5% ASA I, 35.2% ASA II, 7.8% ASA III and 1.5% ASA IV. Most procedures were performed by general surgery (33.4%), orthopaedics (17.9%) and gynaecology (16.1%) [Fig. 2].

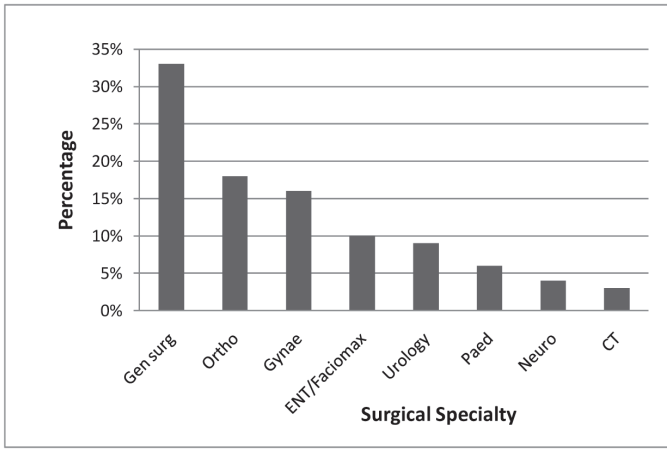

Fig. 2: Distribution by surgical specialty

Emergency surgery was performed in 38.5% of cases. Most operations (67.4%) were done during the day (between 08:00 and 15:59 hours), 14.6% between 16:00 and 19:59 hours and 18.0% between 20:00 and 07.59 hours. A general anaesthetic technique was used in 85.1% of cases. Central neuraxial regional procedures accounted for 9.6% of cases and 2.4% had a peripheral nerve block. The remainder (2.9%) had a combined technique (general and regional or nerve block). Invasive monitoring (arterial line and/or central venous pressure monitoring) was utilized in 4.1% of patients. Only 27% of patients were monitored with capnography.

Anaesthetic Complications

The likelihood of any intra-operative event was 201 per 1000 (95% CI 187, 215). Cardiovascular complications were most common (151 per 1000, 95% CI 139, 163) and included: hypotension (99 per 1000), bradycardia (30 per 1000), and hypertension (23 per 1000) [Table 2]. Two patients had non-fatal cardiac arrests (0.6 per 1000). The incidence of respiratory complications was 26 per 1000 (95% CI 21, 32) and laryngospasm was most common (12 per 1000). Difficult intubation (7 per 1000), bronchospasm (5 per 1000) and aspiration of gastric contents (2 per 1000) were infrequent. Excessive blood loss (> 20% of estimated blood volume) occurred in 31 per 1000 patients (Table 3). During recovery, the complication rate was 93 per 1000 (95% CI 83, 103) and included hyperglycaemia (19 per 1000), nausea (18 per 1000), vomiting (16 per 1000) and bronchospasm (16 per 1000) [Table 4]. Patients with intra-operative complications were over three times more likely to have recovery complications (Odds ratio = 3.35, 95% CI 2.59, 4.33, $p < 0.001$).

The paediatric group had complication rates of 139 per 1000 (95% CI 104, 174) intra-operatively and 58 per 1000 (95% CI 34, 81) during recovery. Respiratory events were more frequent, with laryngospasm (45 per 1000) being the most common intra-operatively, and bronchospasm (29 per 1000) during recovery. These differed from older patients (≥ 13 years) whose major intra-operative events were hypotension (110 per 1000) and excess blood loss (34 per 1000), and in recovery were hyperglycaemia (22 per 1000), nausea (20 per 1000) and vomiting (18 per 1000) [Tables 3, 4].

Predictors of Complications

Predictors of anaesthetic complications are presented in Tables 5 and 6. Risk factors included age, ASA status, anaesthetic duration, anaesthetic technique, surgical risk, anaesthetists' experience, intubated patients and the presence of co-morbid illnesses. Patients over 50 years were three times more likely to have complications ($p < 0.001$). American Society of Anaesthesiologists'ASA III patients had an almost three times greater risk than ASA I, and ASA IV patients' risk was increased over 13-fold ($p < 0.001$). Complication risk also increased with each additional hour of anaesthetic time (OR = 1.28, 95% CI 1.21, 1.34, $p < 0.001$). High risk surgery had a threefold greater complication risk (OR = 3.24, 95% CI 2.38, 4.40, $p < 0.001$). Senior residents and consultants attended cases with two times more complications than other levels of staff ($p < 0.001$). The use of general anaesthesia was associated with a slightly increased risk (OR 1.14, 95% CI 0.85, 1.52) and a combined technique with an even higher risk (OR 2.48, 95% CI 1.23, 5.00) [$p = 0.04$]. Intubated patients ($p < 0.001$) and those with co-morbid illnesses ($p < 0.001$) had increased risk (OR = 1.57, 95% CI 1.31, 1.89 and 1.77, 95% CI 1.48, 2.11 respectively). Paediatric patients had greater risks associated

Table 2: Incidence of intra-operative and recovery room anaesthetic complications per 1000 patients

Complication	Children (0 – 12 years)	Adolescents and adults (13 years and older)	All
Intra-operative events			
Cardiovascular	76.1 (49.4 – 102.8)	161.2 (147.6 – 174.9)	151.0 (138.6 – 163.5)
Respiratory	65.6 (40.7 – 90.5)	20.8 (15.5 – 26.1)	26.1 (20.5 – 31.6)
Other[1]	21.0 (6.6 – 35.4)	53.0 (44.7 – 61.3)	49.0 (41.5 – 56.5)
Any intra-operative event	139.1 (104.3 – 173.9)	210.0 (194.8 – 225.1)	201.3 (187.3 – 215.2)
Recovery events			
Cardiovascular	2.6 (0 – 7.8)	33.3 (26.7 – 40.0)	29.5 (23.6 – 35.4)
Respiratory	49.9 (28.0 – 71.8)	24.7 (19.0 – 30.5)	27.6 (21.9 – 33.3)
Neurological	–	0.4 (0 – 1.1)	0.3 (0 – 0.9)
Renal/metabolic	5.2 (0 – 12.5)	34.0 (27.3 – 40.8)	30.5 (24.5 – 36.4)
Gastrointestinal	5.2 (0 – 12.5)	22.2 (16.7 – 27.7)	20.1 (15.2 – 25.0)
Skin/eye	–	0.4 (0 – 1.1)	0.3 (0 – 0.9)
Any recovery room event	57.7 (34.3 – 81.2)	98.2 (87.1 – 109.2)	92.9 (82.8 – 103.0)

Other intra-operative complications include: excess blood loss, failed technique, oliguria, equipment failure, anaphylaxis/anaphylactoid reactions and tooth injury.

Table 3: Incidence of individual intra-operative complications per 1000 patients

Complication	Children (0 – 12 years)	Adolescents and adults (13 years and older)	All
Cardiovascular			
Ventricular arrhythmia	23.6 (8.3 – 38.9)	9.0 (5.5 – 12.5)	10.7 (7.1 – 14.2)
Hypotension	18.3 (4.9 – 31.9)	109.6 (98.0 – 121.2)	98.6 (88.2 – 108.9)
Hypertension	2.6 (0 – 7.8)	25.4 (19.6 – 31.2)	22.9 (17.7 – 28.1)
Supraventricular arrhythmia	7.9 (0 – 16.8)	12.2 (8.1 – 16.3)	11.6 (7.9 – 15.3)
Cardiac arrest	–	0.6	0.6
Bradycardia	28.9 (12.0 – 45.7)	29.7 (23.4 – 36.0)	29.5 (23.6 – 35.4)
Respiratory			
Difficult intubation	2.6 (0 – 7.8)	7.9 (4.6 – 11.1)	7.2 (4.3 – 10.2)
Laryngospasm	44.6 (23.9 – 65.4)	7.5 (4.3 – 10.7)	11.9 (8.2 – 15.7)
Difficult mask	–	1.4 (0 – 2.8)	1.3 (0 – 2.5)
Bronchospasm	21.0 (6.6 – 35.4)	2.9 (0.9 – 4.9)	5.0 (2.6 – 7.5)
Aspiration	5.2 (0 – 12.5)	1.1 (0 – 2.3)	1.6 (0.2 – 2.9)
Other			
Tooth extraction/injury	2.6 (0 – 7.8)	0.7 (0 – 1.7)	0.9 (0 – 2.0)
Anaphylaxis	5.2 (0 – 12.5)	2.1 (0.4 – 3.9)	2.5 (0.8 – 4.3)
Drug incident	–	1.1 (0 – 2.3)	0.9 (0 – 2.0)
Equipment failure	5.2 (0 – 12.5)	2.5 (0.7 – 4.4)	2.8 (1.0 – 4.7)
Excess blood loss	10.5 (0.2 – 20.8)	33.7 (27.0 – 40.4)	30.8 (24.8 – 36.8)

with intubation than older patients (OR 2.55, 95% CI 1.43, 4.55 *vs* 1.49, 95% CI 1.22, 1.81, $p < 0.001$).

Postoperative Outcomes

The incidence of prolonged recovery was 43 per 1000 (95% CI 36, 50) usually for closer monitoring, fluid management or pain control. The ICU admission rate was 23 per 1000 (95% CI 17, 28). Patients were almost five times more likely to enter ICU after emergency compared to elective surgery (OR = 4.94, 95% CI 2.95, 8.28, $p < 0.001$) [Table 7]. Fourteen patients died intra-operatively (4 per 1000) [Table 8], ten from major trauma and massive haemorrhage. None of the deaths were attributable to anaesthesia; however,

Table 4: Incidence of individual recovery room complications per 1000 patients

Complication	Children (0 – 12 years)	Adolescents and adults (13 years and older)	All
Cardiovascular			
Hypotension	–	12.9 (8.7 – 17.1)	11.3 (7.6 – 15.0)
Hypertension	–	14.0 (9.6 – 18.3)	12.2 (8.4 – 16.1)
Dysrhythmias	2.6 (0 – 7.8)	9.7 (6.0 – 13.3)	8.8 (5.5 – 12.0)
Respiratory			
Laryngospasm	18.4 (4.9 – 31.9)	2.1 (0.4 – 3.9)	4.1 (1.9 – 6.3)
Hypoventilation	2.6 (0 – 7.8)	5.7 (2.9 – 8.5)	5.3 (2.8 – 7.9)
Bronchospasm	28.9 (12.0 – 45.7)	14.7 (10.2 – 19.2)	16.3 (11.9 – 20.7)
Pulmonary oedema	5.2 (0 – 12.5)	2.9 (0.9 – 4.9)	3.1 (1.2 – 5.1)
Respiratory arrest	–	0.4 (0 – 1.1)	0.3 (0 – 0.9)
Re-intubation	–	3.6 (1.4 – 5.8)	3.1 (1.2 – 5.1)
Neurological			
Sensory deficit	–	0.4 (0 – 1.1)	0.3 (0 – 0.9)
Renal / Metabolic			
Oliguria	2.6 (0 – 7.8)	11.5 (7.5 – 15.4)	10.4 (6.8 – 13.9)
Hyperglycaemia	2.6 (0 – 7.8)	21.9 (16.4 – 27.3)	19.5 (14.7 – 24.3)
Gastrointestinal			
Nausea	2.6 (0 – 7.8)	20.1 (14.9 – 25.3)	17.9 (13.3 – 22.5)
Vomiting	5.2 (0 – 12.5)	17.9 (13.0 – 22.8)	16.3 (11.9 – 20.7)

Table 5: Risk of intra-operative or recovery room anaesthetic complications

Characteristic	n	% with complications	Odds Ratio[1]	95% confidence interval	*p*-value
age (*vs.* 0–12)	381	17.3	1	–	< 0.001
13 – 19	233	15.0	0.84	0.54 – 1.32	
20 – 29	464	18.8	1.10	0.77 – 1.57	
30 – 39	534	22.7	1.40	1.00 – 1.95	
40 – 49	573	20.8	1.25	0.90 – 1.75	
50 – 59	356	34.8	2.55	1.81 – 3.60	
60 – 69	266	39.9	3.16	2.20 – 4.54	
70 – 79	228	39.0	3.06	2.10 – 4.45	
80+	137	40.9	3.30	2.14 – 5.08	
ASA status (*vs.* I)	1769	17.2	1	–	< 0.001
II	1121	31.4	1.80	1.49 – 2.18	
III	248	44.8	2.89	2.14 – 3.89	
IV	47	78.2	13.48	6.56 – 27.71	
Urgency (*vs.* elective)	2122	25.2	1	–	0.50
Emergency	1063	25.4	1.06	0.89 – 1.27	
Surgery time (*vs.* day)	2143	26.6	1	–	0.11
Evening	464	22.0	0.78	0.61 – 1.00	
Night	571	23.3	0.88	0.71 – 1.10	
Surgery length (in hours)	3181	25.3	1.28	1.21 – 1.34	< 0.001
Pre-defined surgery risk					
(*vss.* low risk)	1279	17.8	1	–	< 0.001
medium risk	1674	28.5	1.77	1.47 – 2.13	
high risk	232	43.1	3.23	2.38 – 4.39	
Anaesthetist type					
(*vs*. nurse anaesthetist)	348	14.4	1	–	< 0.001
junior resident	458	23.4	1.72	1.18 – 2.51	
resident	969	26.1	1.94	1.38 – 2.71	
senior resident	576	27.6	2.16	1.51 – 3.09	
consultant	806	28.4	2.37	1.68 – 3.34	
Anaesthetic type (*vs.* regional)	267	30.7	1	–	0.04
General	2848	24.4	1.14	0.85 – 1.52	
regional + general	39	46.2	2.47	1.22 – 4.99	
Intubated (*vs.* no)[1]	1028	21.0	1	–	< 0.001
Yes	2157	27.3	1.58	1.31 – 1.90	

[1]Risk of complications among intubated patients (*vs* no intubation) in children (age 12 and less) (OR = 2.55, 95% CI 1.43-4.55, $p = 0.001$). In adolescents/adults (OR = 1.49, 95% CI 1.22-1.81, $p < 0.001$)

Table 6: Risk of anaesthetic complications by co-morbid conditions

Premorbid conditions	n (%)	% with complications	Odds Ratio[1]	95% confidence interval	*p*-value
Hypertension	673 (21)	40.4	1.73	1.40 – 2.13	< 0.001
Diabetes mellitus	356 (11)	41.3	1.57	1.23 – 2.01	< 0.001
Ischaemic heart disease	25 (0.8)	52.0	1.98	0.89 – 4.42	0.09
Chronic smoker	165 (5)	20.6	0.75	0.51 – 1.12	0.16
Sickle cell disease	46 (1)	15.2	0.72	0.32 – 1.64	0.44
Stroke	22 (0.7)	45.5	1.30	0.56 – 3.06	0.54
Congestive cardiac failure	16 (0.5)	25.0	0.68	0.21 – 2.19	0.52
Atrial fibrillation	7 (0.2)	42.9	1.12	0.25 – 5.11	0.88
Asthma	276 (9)	30.4	1.46	1.11 – 1.93	0.01
Renal disease	36 (1)	52.8	2.89	1.47 – 5.67	0.002
Seizure disorder	43 (1)	34.9	2.00	1.05 – 3.81	0.04
Systemic lupus erythematosus	14 (0.4)	57.1	4.35	1.48 – 12.77	0.01
Thyroid disease	35 (1)	34.3	1.47	0.71 – 3.05	0.29
Congenital heart disease	15 (0.5)	40.0	3.31	1.16 – 9.47	0.03
Valvular heart disease	12 (0.4)	75.0	9.74	2.58 – 36.72	0.001
HIV/AIDS (**3**)	17 (0.5)	–	–	–	–
Any co-morbid condition	**1322 (42)**	**34.3**	**1.77**	**1.48 – 2.11**	**< 0.001**

1. Each adverse event risk factor adjusted for age
2. No HIV positive patients experienced anaesthetic complications
3. COPD patients (n = 10) not included in table

Table 7: Post-operative outcomes per 1000 patients undergoing operative procedures

Outcome	Incidence	95% Confidence interval
Normal recovery	931	898 – 965
Prolonged recovery	43	36 – 50
ICU admission (all)	23	17 – 28
ICU (elective)	11	6 – 15
ICU (emergency)	46	33 – 59
Death	4	2 – 7

there were not enough patients in the study to allow for proper assessment of anaesthetic mortality at the UHWI.

DISCUSSION

There are few data on adverse anaesthetic outcomes from the Caribbean. However, this study's findings regarding intra and postoperative complications (201 per 1000 or 20.1% and 93 per 1000 or 9.3% respectively) are comparable to studies done in developed countries. Jenkins *et al* (9) reviewed 14 studies from Canada, USA, Europe and Australia. Intra-

Table 8: Mortality by diagnosis and causes

Patient	Sex	Age	Diagnosis	Cause of death
1	Male	34	Massive upper GI bleed, chronic renal failure	Massive haemorrhage
2	Male	48	Multiple stab wounds to chest	Massive haemorrhage
3	Male	19	Coarctation of the aorta	Massive haemorrhage
4	Male	18 days	Coarctation of the aorta and patent ductus arteriosus (PDA)	Postmortem showed hypoplastic left heart syndrome (not diagnosed pre-operatively)
5	Male	26	Gunshot wounds to chest and abdomen	Massive haemorrhage
6	Male	21	Gunshot wound to chest	Massive haemorrhage
7	Male	21	Multiple gunshot wounds	Massive haemorrhage
8	Male	20	Stab wound to chest	Major vessel injury and massive blood loss
9	Male	Unknown	Gunshot wounds to chest and neck	Massive haemorrhage
10	Male	20	Multiple gunshot wounds	Massive haemorrhage
11	Male	30	Multiple gunshot wounds to chest	Massive haemorrhage
12	Female	36	Gunshot wound	Internal iliac vessel injury and massive blood loss
13	Female	64	Dissecting thoracic aneurysm	Massive haemorrhage
14	Male	60	Gunshot wound to abdomen	Major vessel injury and massive haemorrhage

operative events ranged between 2.3% and 27.9%, and recovery events between 3.1 and 47.4%.

Cohen et al (6) reviewed 27 184 inpatients from four Canadian hospitals. The intra-operative complications reported were hypotension (58.5 – 125.4 per 1000), compared to an incidence of 99 per 1000 in the present study, hypertension (17.1 – 41.6 per 1000) compared to 23 per 1000, and ventricular arrhythmias (4.6 – 11.6 per 1000 *versus* 11 per 1000). Cardiac arrest occurred in 0.4 – 2.6 per 1000 (our incidence was 0.6 per 1000) and difficult intubation was 7.3 – 12.1 per 1000 (our rate: 7 per 1000). The comparability of these findings is reinforced by the fact that we used the same definitions used by Cohen *et al*.

The findings in the present study must be reviewed against the backdrop of the limitations which are observed in developing countries: poorly controlled chronic illness, lack of adequate equipment and sporadic supplies of drugs (10). A relatively high number of trauma cases, which, combined with severe shortage of blood products, was responsible for most of the operative mortalities in the present study (Table 8). The risks in face of these limitations may be offset by the fact that the UHWI is a postgraduate teaching institution with a high consultant: resident ratio (1:1.6). Other studies from the African continent (5) with poorer outcomes identified problems related to few medically qualified anaesthetists, lack of appropriate training and inadequate supervision of non-medical anaesthetists.

This study showed a significantly lower incidence of postoperative nausea (18 per 1000) and vomiting (16 per 1000) than the study of Cohen *et al* (6) with a combined rate of 72.2 – 142.7 per 1000. Under-reporting might have played a role, but the large difference suggests the possibility of other factors. A study from Guyana reported a recovery room incidence of postoperative nausea and vomiting (PONV) of 2.9% (11). A study from Nigeria reported a 1% incidence of vomiting during recovery and 19.6% for the first 24 hours postoperatively (12). It is possible, therefore, that there are ethnic variations. This study also had a higher ICU admission rate than the study of Cohen *et al* [23 per 1000 compared to 3.5 – 10 per 1000] (6). This might have resulted from the absence of a high dependency unit (HDU).

A French paediatric teaching hospital reported 31 per 1000 and 48 per 1000 incidences of intra-operative and recovery complications respectively [2000 – 2002] (13). Respiratory events were most frequent during anaesthesia and vomiting was commonest postoperatively. This study showed a higher risk of complications (139 per 1000 intra-operatively and 58 per 1000 during recovery), also with mainly respiratory problems. At UHWI, the number of paediatric surgical cases done yearly is low (n = 381, 12% of all anaesthetic procedures). The increase in observed risk may be due to insufficient paediatric anaesthetic experience.

Risk factors for developing complications were similar to other studies (2). The co-morbid conditions associated with most complications were diabetes mellitus and hypertension ($p < 0.001$). Other groups included valvular heart disease ($p = 0.001$), renal disease ($p = 0.002$) and asthma ($p = 0.01$). We cannot comment on complications in patients with chronic obstructive pulmonary disease (COPD) as the numbers were too low (n = 10). The complication risk, paradoxically, increased with the anaesthetist's level of experience. This is explained by the fact that senior levels of staff are most likely to be involved when risks are greatest. This was confirmed on further analysis of the data, which showed that compared to a resident, a consultant was twice as likely to attend a grade III or IV ASA (95% CI 1.53, 2.58, $p < 0.001$). A senior resident was 1.92 times more likely (95% CI 1.45, 2.54, $p < 0.001$).

The communication of risk information to patients is becoming more important for medical consent, and has medico-legal implications (14). The information gained from this study will be useful in the pre-operative interview to give patients a more accurate estimate of potential risks in this setting.

This study, like all morbidity studies, carries an intrinsic risk of under-reporting, due to reluctance to admit to problems or errors which may reflect negatively on the anaesthetist's perceived competence or carry the potential for blame (8, 9). There may also be subjectivity in recording of some of the data [*eg* ASA status] (2). It is impossible to completely eliminate these sources of bias.

In conclusion, the results of this study were similar to developed countries, except for apparently higher paediatric complication rates and ICU admission rates, and lower incidences of PONV. Risk factors were also similar, except for the anaesthetist's experience, which we concluded was due to the association between ill patients and the presence of senior staff. Further studies are needed to investigate post recovery room complications related to anaesthesia, and how specific anaesthetic agents affect complication rates. Recommendations arising from this study include:

- Rotation of staff through paediatric hospitals to improve experience in this area
- Establishment of a HDU to decrease admission rates to ICU for prolonged monitoring, where ventilation is not needed
- The need for better pre-operative control of chronic illnesses, especially hypertension and diabetes mellitus

ACKNOWLEDGEMENTS

The authors are grateful to the anaesthetic and recovery room staff, UHWI, for their assistance in data collection. Thanks to the research nurses from the Section of Surgery for assisting with data entry and to Professor R Carpenter for his invaluable advice.

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