

ORIGINAL STUDY

Survey and management of anaesthesia related complications in PACU

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ABSTRACT

It is the first prospective study about anaesthesia related postoperative complications conducted in Hamad General Hospital. Total 1128 adult patients admitted to the Post Anaesthesia Care Unit (PACU) during a period of three months were surveyed for anaesthesia related complications. Documented complications were found in 48 patients i.e. 4.25% of patients' population. The types of complications were related to the respiratory system, cardiovascular system, nausea/vomiting and body temperature in this descending order. Most of the complications happened to healthy ASA I and II patients. Factors that play major role in determining the immediate postoperative complications were the ASA status, the level of anaesthesia seniority attending the patient, the urgency and the nature of procedure. We tried to find other factors that may influence complications in addition, discussed below.

Keywords: anaesthesia, postoperative, complications, Post-anaesthesia Care Unit

INTRODUCTION

Advanced technology in monitoring, especially pulse oximetry has substantially reduced the extent of perioperative complications, enabled early detection and treatment of adverse events and promoted several changes in patient care.¹ An 'anaesthetic incident' was defined as 'any incident related to anaesthesia which either caused harm, or if uncorrected might have caused harm, to a patient.'² The Post Anaesthesia Care Unit (PACU) of the operating theatre suite in Hamad General Hospital has 12 beds. The surgical specialties in this hospital are the following: General Surgery, Urology, Orthopedic, Pediatric, Maxillofacial, Neuro and Vascular surgeries. Since 2004 quality control of anaesthesia related immediate complications had been regularly audited in a trial to improve the service.

Departmental policies and procedures have specifically defined a criterion for every vital sign e.g. Hypoxia if SpO2 < 92% on Oxygen therapy or Hypotension > 20% change of preoperative value and accordingly we are following these criteria in this study.

PATIENTS AND METHOD

After approval of the Research and Ethical Committee at Hamad Medical Corporation, all adult patients admitted to the PACU who had surgery (elective and emergency) under general anaesthesia (GA), Monitored Anaesthesia Care (MAC), Regional Anaesthesia (RA) were included in the study. Exclusion criteria were the following:

- Pediatric patients
- Patients who had surgery under local anaesthesia only, and
- Patients admitted to PACU in the course of transferring them to the Intensive Care Unit (ICU).

Prior to the survey, we had a meeting with all members of the anaesthesia department and the PACU nursing staff to review the survey data sheet, which is a three page check-box form.

We decided to have a pilot study to determine the areas of weaknesses and/ or difficulties. The survey sheets were again revised and restructured according to the feedback from the PACU nursing staff (Figs. 1, 2, 3).

The study began on November 2009 and completed on February 2010. Over the period of three months 1128 patients were included in the study.

COMPLICATIONS DETECTED IN THE PACU		
1	Cardiovascular <input type="checkbox"/> None	Management
	<input type="checkbox"/> Hypertension (20% change of preop. Value)	
	<input type="checkbox"/> Hypotension (20% change of preop. Value)	
	<input type="checkbox"/> Ischemia, MI (proved by 12-lead ECG)	
	<input type="checkbox"/> Shock (type) (Systolic BP <90 mmHg)	
	<input type="checkbox"/> Cardio respiratory arrest	
	<input type="checkbox"/> Angina	
	<input type="checkbox"/> Pulmonary edema	
	Arrhythmia requiring treatment (e.g. Atrial fibrillation)	Management
	<input type="checkbox"/> Tachycardia* (Heart Rate ≥100 beats/min)	
	<input type="checkbox"/> Bradycardia* (Heart Rate ≤50 beats/min)	
2	Airway & Respiratory <input type="checkbox"/> None	Management
	<input type="checkbox"/> Stridor <input type="checkbox"/> Aspiration <input type="checkbox"/> Wheezing	<input type="checkbox"/> Airway <input type="checkbox"/> BVM
	<input type="checkbox"/> Apnea <input type="checkbox"/> Hypoventilation	<input type="checkbox"/> ETT
	<input type="checkbox"/> Hypoxia (SpO2 <92% on oxygen)	<input type="checkbox"/> Medication: e.g. Ventolin, Naloxone
	<input type="checkbox"/> Others	<input type="checkbox"/> O ₂

Figure 2. Page two of the survey sheet.

All complications were documented by the nurse staff, reviewed next morning by the anaesthetist of the survey team and queries were settled. Involvements of other medical disciplines for consultation were documented as well.

RESULTS

The number of adult patients admitted to the PACU during the period of three months was 1128. Age ranges was from 14 to 90 years with a mean 37.39 + 14. Eight hundred and sixty patients were males and 268 females; the percentage is 76.2% and 23.8% respectively.

We stratified the patients according to their ASA category and urgency of the procedure (Table 1) The anaesthesia record sheet detailed the preoperative status of the patient and highlights comorbidities and hence it's correlation to PACU complications (Table 2) which significantly shows that those patients with comorbidities have had a higher incidence of post-operative complications.

Total number of patients who had complications in the PACU was 48 (4.25%) the distribution of complications according to patients' ASA status is displayed in (Table 3) and the table is uniquely showing that ASA I and II patients have the highest percentage of complications (81.23%) in either elective or emergency surgery 43.74%, 37.49% respectively. Majority of patients who

SURVEY AND MANAGEMENT OF COMPLICATIONS DETECTED IN THE PACU

Date:

<input type="checkbox"/> Type Of Surgery (Specify Site e.g. Lap, Chole...etc)	<input type="checkbox"/> GS <input type="checkbox"/> Chest <input type="checkbox"/> Orthopedic <input type="checkbox"/> Neurosurgery <input type="checkbox"/> ENT <input type="checkbox"/> Urology <input type="checkbox"/> Obs. /Gyn. <input type="checkbox"/> Vascular <input type="checkbox"/> Ophthalmology <input type="checkbox"/> Plastic Surgery <input type="checkbox"/> Maxillo Facial <input type="checkbox"/> Dental <input type="checkbox"/> Others (specify):
<input type="checkbox"/> Position During Surgery	<input type="checkbox"/> Supine <input type="checkbox"/> Prone <input type="checkbox"/> Lateral <input type="checkbox"/> Lithotomy <input type="checkbox"/> Others (specify):
<input type="checkbox"/> Type of Anesthesia *	<input type="checkbox"/> GA <input type="checkbox"/> Regional (Spinal, Epidural, Nerve block) <input type="checkbox"/> GA/RA Combined <input type="checkbox"/> MAC (Moderate/Deep Sedation/GA)
<input type="checkbox"/> Duration Of Anesthesia	Hrs: _____ Min: _____
<input type="checkbox"/> ASA Physical Status	(1) (2) (3) (4) (5) (E)
<input type="checkbox"/> Attending Anesthesiologist	<input type="checkbox"/> Consultant <input type="checkbox"/> Specialist <input type="checkbox"/> Resident
<input type="checkbox"/> Preexisting Co-morbidities	<input type="checkbox"/> Respiratory <input type="checkbox"/> CVS <input type="checkbox"/> Neurological <input type="checkbox"/> Renal/Endocrine <input type="checkbox"/> GIT <input type="checkbox"/> Trauma <input type="checkbox"/> Others <input type="checkbox"/> None
<input type="checkbox"/> Intra Operative complication	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> If (Y) specify:
REMARKS: *	

Figure 1. Page one of the survey sheet.

3	CNS <input type="checkbox"/> None Management		
	<input type="checkbox"/> Confusion <input type="checkbox"/> Delirium <input type="checkbox"/> Seizure		
	<input type="checkbox"/> Persistent Sedation		
	<input type="checkbox"/> Others		
4	GIT <input type="checkbox"/> None Management		
	<input type="checkbox"/> Nausea / vomiting		
5	Drug reaction <input type="checkbox"/> None Management		
	<input type="checkbox"/> Specify (skin rash, anaphylaxis)		
6	Miscellaneous Complications <input type="checkbox"/> None Management		
	<input type="checkbox"/> Incidental Trauma		
	<input type="checkbox"/> Ocular Injuries		
	<input type="checkbox"/> Oral, Pharyngeal & Laryngeal Injuries		
	<input type="checkbox"/> Nerve Injuries		
	<input type="checkbox"/> Soft Tissue		
	<input type="checkbox"/> Hypothermia & Shivering		
	<input type="checkbox"/> Hyperthermia		
	<input type="checkbox"/> Others		
7	Investigations <input type="checkbox"/> None Results		
	<input type="checkbox"/> ABG		
	<input type="checkbox"/> CSE		
	<input type="checkbox"/> CRBS		
	<input type="checkbox"/> ECG		
	<input type="checkbox"/> CXR		
	<input type="checkbox"/> Others		
8	<input type="checkbox"/> Medical consultation	<input type="checkbox"/> Y <input type="checkbox"/> N	
9	<input type="checkbox"/> Remarks		
10	<input type="checkbox"/> DURATION IN PACU	<input type="checkbox"/> HRS. <input type="checkbox"/> MIN.	
11	<input type="checkbox"/> TRANSFER TO	<input type="checkbox"/> WARD <input type="checkbox"/> ICU	

PACU Nurse: _____ Anesthesiologist: _____
 Date & Time: _____ Date & Time: _____

Figure 3. Page three of the survey sheet.

had complications fall under general surgery followed by orthopedics (Table 4).

Of the patients studied 987 had GA (87.8%). Forty patients of the 48 who had complications had GA constituting (83.3%) (Table 5) 7 patients (5.83%) of the total number of patients who had RA/Axial anaesthesia {not considering the patients who had combined RA/ Axial anaesthesia with GA} and one patient (5.55%) of the total patients had MAC. Table 5 shows that there is no major difference in the type of anaesthesia and the immediate postoperative complications.

Eleven patients out of the 48 were anaesthetized by consultants (Table 6). The majority of anaesthesia was administered by specialists; however the more critical

the patients and the procedures the more consultants were involved.

The type of complications is characteristically of respiratory system in the first place 41.66%; desaturation was mainly due to hypoventilation (Table 7) other causes such as bronchospasm were documented too. Cardiovascular system complications com second 27.06% which exceeds PONV 14.5% which comes third on our list.

Four patients required unplanned admission to the intensive care, one of them had MAC and the rest had GA. The first patient developed cardiorespiratory arrest after MAC for wound debridement, the second patient desaturated and suspected to have fat embolism after orthopedic procedure, the third patient had massive blood transfusion and decided to have him in ICU for further monitoring and the fourth patient had unexplained hypoglycemia for which a decision was taken to have him monitored in the ICU and to be further investigated. Two patients were of the ASA classes I and III E the other two of class IV E, their age range 25 – 65 years and duration procedures range between 15 to 150 min.

None of the 48 patients who had complications was found having any significant correlation to:

1. Position during surgery
2. Age
3. Duration of the procedure

DISCUSSION

In 1863, Florence Nightingale wrote on the efficacy of special areas for observation of post surgical patients.³ It took approximately more than half a century to adopt this idea and probably the first designated recovery area was established at the Johns Hopkins Hospital in 1923. In their review of PACU detected complications and how the introduction of pulse oximeter had affected outcome, Cooper et al.⁴ had described these incidents as Recovery Room Impact Event and defined it "an unanticipated, undesirable, possibly anaesthesia related effect that required intervention, was pertinent to recovery room care and did or could cause mortality or

Table 1. Distribution of the patients according to their ASA status and urgency.

ASA [§]	N = patients ^{(EL)*}	ASA	N = patients ^{(EM)*}	Total number (% of total)
I	267	I	253	520 (46%)
II	348	II	139	487 (43.1)
III	73	III	35	108 (9.21)
IV	6	IV	7	13 (1.15)
Total	694		434	1128

*EL = Elective, EM = Emergency, §ASA = American Society of Anesthesiologists.

Table 2. Preoperative comorbidities and PACU complications.

System affected	N of patients (% of total)	N of patients had complications
None	520 (46.09%)	15
Cardiac	316 (27%)	31
Endocrine	121 (18.75%)	
Smoking	105 (9.3%)	
Respiratory	83 (7.4%)	
Renal	82 (7.3%)	
Obese	74 (6.6%)	
Morbid obese	18 (1.5%)	
Gastrointestinal	31 (2.8%)	
Trauma	45 (4%)	
Others (malignancy, pregnancy, hematological)	63 (5.6%)	
Neurological	49 (4.3%)	

at least moderate morbidity". They measured many criteria and found that PACU anaesthesia related complications were 18% and in another series by Hines et al.⁵ was 23.7%, and then approximately 18 years later *Shauna ET* had shown that the figures haven't much changed and reported 23.4% rate of complications.⁶ The respiratory complications remain the major issue in the postoperative period followed by PONV.

The data extracted from our survey shows that the number of critically ill patients or complex procedures were cared for by consultants' level, for this reason a fairly less number of complications among them. As noticed, the main volume of patients were cared for by the specialist and usually of ASA I and II status, and the small number of patients done by the residents is due to the strict supervision by their seniors, this number really reflects anaesthetics administered by them independently as they were privileged.

The volume of ASA I and II patients, in the general population of the patients, is approximately 89% which explains why the complications is higher among these classes,⁷ meanwhile a good preoperative preparation for ASA III and IV patients explicate why this section of patients had comparatively less complications.

Table 3. Patients who had complication in relation to their ASA status.

ASA status	N = patients	Percentage of total	ICU admission
ASA I	7	7/48 = 14.58%	1
ASA II	14	29.16%	
ASA III	4	8.33%	
ASA I E	8	16.66%	
ASA II E	10	20.83%	
ASA III E	3	6.25%	1
ASA IV E	2	4.16%	2

Table 4. Distribution of patients to the type of surgery and complications.

Type of surgery	N of patients	Percentage% of total	N of patients with complications
General surgery	661	58.6	32 (4.84%)
Orthopedic surgery	223	19.8	7 (3.13%)
Urology	163	14.5	6 (3.68%)
Neurosurgery	35	3.1	2 (100%)
Maxillofacial	22	2	0
Vascular	16	1.4	0
Others (ENT, Plastic ... etc)	8	0.8	1 (5.71%)
Total	1128	100%	48

Table 5. Distribution of patients to the type of anaesthesia, number and percentage of patients who had complications in PACU.

Type of Anaesthesia	N (% of total)	N (% total complication and % to original figures)
GA	987 (87.8%)	40 (83.3%) = 4.05%
Axial block	108 (9.1%)	7 (14.58%) = 5.83%
RA(e.g. plexus block . . . etc)	12 (1.1%)	
MAC	18 (1.6%)	1 (2.08%) = 5.55%
RA combined with GA	3 (0.3%)	
Total	1128 (100%)	48 (100%)

Perioperative care has improved over the last few decades, as a result of developments in anaesthesia practice, mainly in monitoring, equipments, short acting anesthetics with fewer side effects and certainly in perioperative medicine and the availability of anaesthesia clinic usually run by senior anaesthetists with good infrastructure and experience; all in all have a great impact on outcome.^{7,8}

Of the 48 patients who had documented complication in PACU, the most common single occurring adverse event detected is desaturation⁹; the reported incidence in our survey is 41.66% of the 48 patients. Desaturation is found to be mainly related to hypoventilation and airway obstruction, all resolved by simple airway manual technique, oxygen therapy and salbutamol nebuliser for those with bronchospasm except for one patient who had desaturation after orthopedic procedure and admitted to ICU suspected to have fat embolism. In their study Rose DK et al. noted that respiratory adverse events are a consequence to extubation technique, residual anaesthetic, opioids effect, obesity, age, type of surgery¹⁰ and inadequate reversal of neuromuscular blockade, actually, the last factor has taken much of consideration and concern; Yip PC et al. and Murphy GS et al.^{11,12} have shed light on the incidence of critical respiratory events and its relation to inadequate reversal of muscle relaxants and illustrated that figures may exceed 31% of the cases concluding a recommendation

Table 6. Distribution of patients among the anaesthesia staff.

Anaesthetist Grade	Number patients (% of total)	N of patients with complications (% of 48 patients)
Consultant	295 (26.1)	11 (22.91)
Specialist	818 (72.51)	35 (72.91)
Resident	15 (1.3)	2 (4.16)

to frequently monitor for neuromuscular activity intraoperatively.

Cardiovascular complications (27.06%) are a major component of PACU adverse events. These complications range from hypotension to cardiac arrest. In our survey hypotension occurred in 10.9% of patients, responded to fluid challenge. Hypotension occurrence in PACU is mostly due to hypovolemia, blood loss and medication side effects. In our survey, the incidence of hypertension and tachycardia in PACU were 1.81% and 9.1% respectively. Rose DK et al.¹³ found that Hypertension and tachycardia in PACU are an infrequent finding; however it is associated with increased risk of unplanned ICU admission and mortality irrelevant to anaesthetic management.

PONV was the third most common complication [14.58%]. Macario A et al had their own view of the problem by having a list of questioners to the patients of prioritizing their postoperative concerns and found that PONV is one of the major complaints from the patients' perspective. Koivuranta M et al., in their findings PONV can be predicted to certain accuracy if the patient is: female, having gynecological procedure, of more 60 min duration, with history of motion sickness, non smoker and have previous postoperative sickness.^{14,15} In their extensive study, Christian CA et al. have discussed this problem in details and have suggested many techniques to overcome it¹⁶ however, multiple interventions should be reserved for high-risk patients, yet the issue of PONV remained complex and distressing.

Incidence of PONV is multifactorial depending on patient factors, intra-operative and postoperative risk factors. Patient factors include female gender, pediatric patients, non-smoking, ambulatory patients, diabetes and history of motion sickness, meanwhile intra-operative factors such as the use of opioids, inhalational anesthetic, reversal agents and type of surgery such as gynecology, orchidopexy and strabismus. Certainly, postoperative pain, hypotension, hypoglycemia, inadequate hydration

Table 7. Distribution of complications (PVC = Premature Ventricular Contraction) some of the patients had more than one problem as documented by the staff.

Type of complication	N (% of total)
Desaturation	20 (41.66%)
PONV	7 (14.58%)
Hypothermia	3 (6.25%)
Hyperthermia	9 (18.75%)
Hypertension	1 (2.08%)
Hypotension	6 (12.5%)
Tachycardia	5 (10.40%)
PVCs	1 (2.08%)
Confusion	1 (2.08%)
Others (Rashes-morphine induced, urine retention)	1 each (6.25%)

and the use of opioids will increase the frequency of nausea and vomiting.^{16–18}

The incidence of PONV in our study is comparatively lower than in the literature, however, the exclusion of pediatric patients as well as the survey does not have gynecological, ENT and ophthalmic patients can be the underlying reason of the low incidence.

Hypothermia in PACU essentially causes increase in oxygen requirement due to shivering, leading to increased myocardial oxygen demand. Surprisingly hyperthermia is observed in 16.7% of PACU complications in our study which is higher than reported in the literature. The main reason is the enthusiasm among the staff using body warmers which can be explained on their response to previous audit reports of hypothermia among patients.

In our study the PACU complications were 4.2% of the total population surveyed which is less than described in the literature, though the three months period may not

reflect the real figures and the need for more extensive study that encompasses other surgical specialties.

CONCLUSION

Since year 2004, a massive input of policies and guidelines were produced and implemented one of them is concerning PACU in reference to the American Society of Anesthesiologists¹⁹ Compliance and quality control of the anaesthesia and PACU nursing staff were monitored through surveying some specific indicators such as the incidence of hypothermia and PONV. The medical staff underwent extensive educational program to implement proactive plans avoiding or reducing complications including the establishment of anaesthesia clinic.

Despite the development in anaesthesia practice and advances in monitoring, immediate post anaesthesia complications do occur. The only explanation that most of the complications occurred to ASA 1 and 2 patients who had general anaesthesia for general surgical procedures was due to the large volume of this category of patients. Respiratory complications were the most common adverse events in our study as expected followed by cardiovascular complications and PONV. Probably the higher incidence of hyperthermia is connected to the overzealous use of body warmers and second to the disease processes.

The low incidence of complications in our survey can be elucidated to many factors:

- Good perioperative care
- Progressive education
- Early senior staff involvement

The weakness of the survey is the type of surgeries included in the study and the number of patients; we believe that inclusion of more patients and different surgical specialties such as Obs/gyn, ENT and pediatric surgeries would have changed the results in terms of kind and percentage of complications.

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