Original Article

An analysis of perioperative adverse neurological events associated with anesthetic management at a Tertiary Care Center of a developing country

Fauzia Anis Khan, Sobia Khan, Gauhar Afshan

Department of Anesthesiology, Aga Khan University, Karachi, Pakistan

Abstract

Background and Aims: Existing literature on neurological complications related to anesthesia is reported from affluent countries but the trends may vary in less affluent countries.

Material and Methods: The objective was to find the associated factors contributing to neurological adverse events occurring within 48 h of anesthesia and surgery. The existing departmental morbidity and mortality database was reviewed from 1992 to 2012 for major adverse neurological events. A standardized methodology was used in reviewing and classifying the data. All adverse events were predefined and categorized before filling the form into the following headers; meningitis, cord/plexus/peripheral nerve injury, stroke, paraparesis/paraplegia/quadriparesis/or quadriplegia, new onset postoperative seizures, postoperative vocal cord injury, and a miscellaneous group.

Results: During this period, 195,031 patients underwent anesthesia and twenty-nine patients had major neurological morbidity within 48 h (1:6700). There were three cases of meningitis/meningism, eight cases of cord, plexus or peripheral nerve injury, seven of stroke, four had new onset seizures, one had quadriparesis, five had vocal cord, and one had cranial nerve palsy. Forty-one percent cases received regional anesthesia alone or in combination with the general. In six cases, anesthesia was considered solely responsible. Human error contributed to 93% of these events.

Conclusion: This data has helped in identifying areas of concern and can serve as a reference for further audits in the region.

Key words: Anesthesia, complications, neurology, perioperative period

Introduction

Neurological adverse events related to anesthetic management are widely reported in literature as individual case reports, surveys, or retrospective review of databases. Most of the literature on the subject refers to affluent countries.[1-3] The pattern of anesthetic morbidity and mortality in developing countries may vary because of the relative lack of health care facilities and surgical patients presenting with more advanced disease as well as shortage of equipment and personale.[4]

Address for correspondence: Dr. Fauzia Anis Khan, Department of Anesthesiology, Aga Khan University, P. O. Box 3500, Stadium Road, Karachi 74800, Pakistan.
E-mail: fauzia.khan@aku.edu

Access this article online

Quick Response Code:

Website: www.joacp.org

DOI: 10.4103/0970-9185.202195

The Department of Anesthesia at our Tertiary Care Hospital has been conducting regular monthly morbidity and mortality review meetings where any adverse events leading to major or intermediate morbidity and/or mortality of the patient within 48 h perioperative period are reviewed, discussed and recorded. The definition of major and intermediate level morbidity adopted by the department is major morbidity: Permanent disability and sequel (e.g., spinal cord injury). Intermediate morbidity: Serious distress or prolongation of hospital stay or both without permanent sequelae, e.g., dental injury.[5]

How to cite this article: Khan FA, Khan S, Afshan G. An analysis of perioperative adverse neurological events associated with anesthetic management at a Tertiary Care Center of a developing country. J Anaesthesiol Clin Pharmacol 2017;33:48-56.

This database was reviewed from 1992 till 2012 (21 years) for all reported adverse neurological events. Our aim was to find out the associated and causative factors contributing to these events occurring during or following within 48 h of anesthesia and surgery while the secondary aim was to come up with recommendations to prevent future occurrences of such morbidity and/or mortality.

Material and Methods

Exemption was granted from our Institutional Ethical Review Committee for the purpose of this review. Identification of the patient and all names of medical or surgical care providers were kept confidential.

Our hospital is among the first private university hospital established in 1985 and is currently a 650-bed teaching hospital which is a referral center to patient population in the southern part of Pakistan. In 1992, the hospital had 450 beds, eight operating rooms. The current annual workload is approximately 15,000 anesthetics/year in 14 operating rooms, and all subspecialties of anesthesia except burns are catered for.

Our mechanism for capturing morbidity and mortality (M and M) is a multisource feedback from anesthesia consultants, trainees, and surgeons. This is the responsibility of the morbidity and mortality coordinator, a faculty member who is given this responsibility for a specified term. Formal postoperative rounds are also made on all patients who receive regional anesthesia or nerve blocks. All cases of moderate/intermediate to major morbidity and mortality are presented in the departmental morbidity and mortality meeting. At the time of presentation, the cases are discussed by all present and are additionally reviewed by two consultant anesthetists unconnected to the case, who document their analysis on the contribution of anesthetic management to the morbidity or mortality on a standard form. Case details and gist of discussion are also recorded by the M and M meeting coordinator on a standardized form [Appendix]. Contributing factors are identified, and the role of anesthesia is further classified as solely responsible, partially responsible or not contributing. A written feedback is provided to the primary consultant anesthetist and resident. A case file along with the two review reports is kept in the departmental records.

All departmental morbidity and mortality review forms and the case summary sheets with details of adverse perioperative neurological events present in our database from 1992 to 2012 were reviewed by the authors. This database consisted of 351 cases of intermediate and major morbidity and mortality. Patients who underwent cardiothoracic surgery were excluded as these are dealt in separate meetings. The cardiothoracic surgical cases were also excluded from the total number of anesthetics. Cases, where the reviewers were of the opinion that the morbidity was a direct result of surgical procedure were not included in the results of the analysis but are mentioned separately.

Two authors reviewed the anonymised departmental forms and summary sheets independently and filled a specially designed proforma. The patients case files and laboratory/radiographic data if available were accessed for any incomplete information if required.

All adverse events were predefined in the protocol before filling the forms and categorized under the following arbitrary headers:

1. Meningitis following central neuraxial blockade: Patients presenting with new onset fever, headache, and neck rigidity following an anesthetic and had a lumbar puncture performed to confirm the diagnosis
2. Postoperative cord/plexus/peripheral nerve injury: Patients presenting with loss of movement or sensations with clinical disability relating to spinal nerve roots or to individual nerves, following anesthesia which was not due to a direct result of surgical technique
3. Postoperative stroke: This was defined as a sudden onset of a neurological deficit due to focal disruption of cerebral circulation due to brain ischemia or hemorrhage
4. Postoperative paraparesis, paraplegia, quadriparesis, and quadriplegia: Decrease or loss of power in legs, arms or all four limbs presenting in the postoperative period within 48 h
5. New onset postoperative seizures due to a nonsurgical cause: When a patient with no prior history had generalized convulsive or tonic-clonic movements that required treatment
6. Postoperative vocal cord injury (due to neurological reasons): Patients presenting with hoarseness of voice postoperatively where a nonneurological reason was ruled out
7. Miscellaneous group: If the neurological morbidity did not fall in any of the above categories.

The main contributing factor to the morbidity was identified and further classified into human failure, communication or team error or organizational failure. The following definitions were used to classify the main contributing factor. Human failure was defined as situation where accepted/established practice was not followed in relation to and execution of clinical decisions. Communication or team errors were where communication breakdown between anesthesia team

members, or anesthesia or surgical team was primarily responsible. Organizational errors were where the system was at fault.[5]

Each set of case file and review forms were then discussed by the two reviewers. In case of any disagreement, the third author was approached. A summary of adopted methodology is shown in the Flow Chart.

Statistics

All statistical analysis was performed using Statistical Packages for Social Science Version 19 (SPSS Inc., Chicago, IL, USA). Qualitative variables such as morbidity, gender, American Society of Anesthesiologists (ASA) status, type of anesthesia, and surgery were presented as frequency and percentage while mean and standard deviation (SD) were computed for age.

Results

During the study period, 195,031 patients underwent anesthesia at our institution. We present the data of 29 patients who had major neurological morbidity (1:6700). Seventeen of these patients underwent general anesthesia (GA), six received regional anesthesia, and six combined GA and regional technique. The patient demographics and neurological injury observed are given in Table 1.

There were two cases of established meningitis and one case of meningism, all associated with spinal anesthesia. All three patients were males, between 20 and 46 years and had received spinal anesthesia for hip arthroplasty, external fixation of right tibia, and cystoscopy with bladder biopsy. Two patients presented with high-grade fever and neck rigidity within 24 h. In both these patients, cerebrospinal fluid (CSF) was characteristic with raised protein in spinal fluid, and a positive CSF culture. Patients were treated with antibiotics. In the third case, the patient presented with headache and painful neck movements. CSF had increased proteins but no growth. All three were referred to neurologists, and after treatment recovered completely with no residual defect. Sterile technique in performing blocks had been followed in all three cases.

There were eight cases of cord, plexus, or peripheral nerve injury. Six had lesions related to upper limbs, and two had lower limb involvement. The mean age of these patients was 40.2 (SD = 7.7) with age range of 35-53 years. The affected nerves, any predisposing factors, type of surgery, suspected mechanism, and outcome of this group are given in Table 1. All patients were referred to neurologists for opinion and management and underwent neurological investigations. Three patients recovered within 72 h while two had residual weakness at the time of follow-up. Three were lost to follow-up [Table 2].

Flow chart for classification and assessment of cases

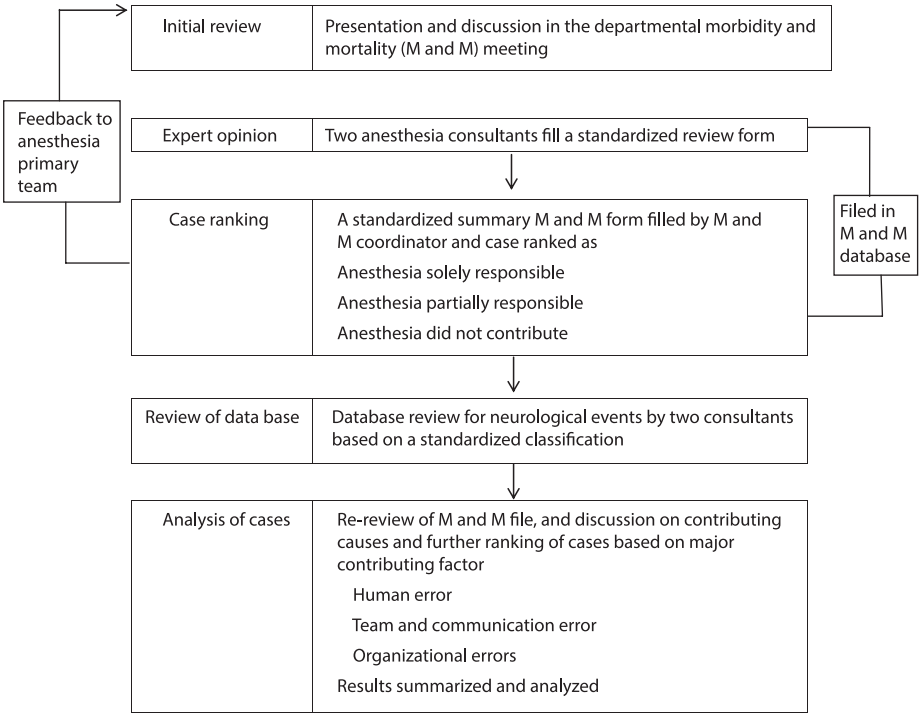


Table 1: Demographic data; age, gender, American Society Anesthesiology states, and neurological morbidity within 48 hours of anesthesia

Morbidity	*n*	Age mean (range) years	Gender (male:female)	ASA status				
				I	II	III	IV	V
Meningitis	3	20-46	3:0	—	2	1	—	—
Cord/plexus/peripheral nerve injury	8	40.2 (35-53)	4:3	4	3	—	—	—
Postoperative stroke	7	60.1 (45-75)	5:2	—	—	7	—	—
Paraparesis/quadriparesis/paraplegia	1	0.75	0:1	—	1	—	—	—
Postoperative seizures	4	0.5-26	0:4	1	—	2	1	—
Vocal cord injury	5	32-72	2:3	—	3	2	—	—
Miscellaneous	1	27	0:1	—	2	—	—	—

ASA = American Society Anesthesiology

Seven patients presented with postoperative stroke within 48 h of surgery. The mean age of these patients was 60.14 (SD = 9.8), and the age range was 45-75 years. Gender distribution was two females and five males. Four patients had undergone GA and three combined general and epidural. The surgical procedure, co-morbidity, and outcome of this group are listed in Table 3.

There was only one case in the fourth group where the patient developed quadriparesis related to anesthesia. This was a 7 kg, 9-month-old girl who developed quadriparesis following anesthesia for anorectoplasty for an imperforate anus. She had undergone previous surgery for colostomy. She received a combined GA and caudal epidural with catheter technique. The caudal catheter was inserted in the lateral position after inhalational induction with oxygen and sevoflurane and tracheal intubation. The patient was operated in the prone Jackknife position and received intraoperative analgesia through the epidural catheter as a continuous infusion of bupivacaine 0.25%. The duration of surgery was 7 h. Postoperative analgesia was continued via the caudal catheter with bupivacaine 0.1% and fentanyl 2 μg/ml (1 ml/h). Quadriparesis was suspected on day 2 postoperatively. Prior to this lack of limb movements was assumed to be a sign of pain relief.

Four patients had new onset seizures in the immediate postoperative period that required reintubation. All were females. Age range was 5 months to 26 years. None of the patients had previous history of seizure or epilepsy. Two of the patients were infants, and both had undergone exploratory laparotomy for intussusception. Both infants had history of fever and received 5% dextrose with 1/5th normal saline intraoperatively. Both developed seizures in recovery, trachea were intubated, and patients were loaded with antiepileptics. In one patient, the postoperative sodium was 120 mEq/L (preoperative 135 mEq/L). Both children were weaned off the ventilator on day 2 of surgery.

The other two patients had received regional anesthesia and had seizures postoperatively One was a 26-year-old female who underwent Cesarean section under combined spinal and epidural analgesia, she developed postdural puncture headache (PDPH) and had seizures postoperatively. The fourth patient had received epidural for obstetric pain relief. She had a wet tap and epidural was resited in the same space. A blood patch was planned, but patient had seizures and loss of vision immediately before that. CSF and magnetic resonance imaging (MRI) were reported as normal. This patient was labeled as posterior reversible encephalopathy syndrome (PRES).[6] Additional four patients who had seizures in the postoperative period following neurosurgery were not included in this group, and reviewers were of the opinion that anesthesia did not play a part in their morbidity.

Five patients developed vocal cord palsy postoperatively, four unilateral, and one bilateral palsy. All patients had undergone major surgery lasting 3-10 h. The mean age of these patients was 50.6 (SD = 15.3) years. The surgery included two craniotomies, one radical cystectomy, resection of gastric tumor, and Austin-Moore hemiarthroplasty. All patients presented with hoarseness of voice in the postoperative period and were referred to an ear, nose, and throat specialist. Central causes were ruled out in all cases. Cuff pressures were not monitored in any of the patients, and none was a difficult intubation.

In the miscellaneous group, one case was of sixth cranial nerve palsy. This was a 27-year-old female weighing 71 kg and 39 weeks pregnant who had received combined spinal-epidural anesthesia for labor pain relief as she presented late in labor. Spinal was performed with a 25-gauge pencil point needle and an epidural catheter inserted at L3/4 interspace with the first attempt. Pain relief was provided with 0.1% bupivacaine and 1 μg/ml fentanyl infusion. She developed post-PDPH on the 1st postdelivery day. She then developed diplopia and 6th nerve palsy on the 3rd postdelivery day. She received an epidural blood patch on day 6 and had completely recovered on a follow-up visit 3 months later.

Twelve of our cases had received spinal or epidural anesthesia (41%). The distribution of GA versus regional in relation to morbidity is given in Table 4.

Table 2: Details of patients who had cord, plexus, or peripheral nerve injury following anesthesia (n = 8)

Nerves affected	Type of surgery (duration)	Predisposing factors	Suspected mechanism	Outcome
Bilateral ulnar nerve numbness	Hemicolectomy (8.5 h)	Preoperative neck pain, chronic alcohol intake	Positioning	Patient lost to follow-up
C5, C6, C7	Reversal of Hartman's procedure (4 h)	—	Positioning (malfunctioning arm rest)	Patient lost to follow-up
Upper trunk injury of brachial plexus	Breast lumpectomy (45 min)	—	Intraoperative positioning	Partial recovery
Left upper limb sensory and motor weakness	Breast lumpectomy (45 min)	—	Positioning	Complete recovery after 48 h
Sensory loss and left foot drop	Laparoscopy and laparotomy (NA)	—	Intraoperative positioning	Residual weakness at 3 months follow-up
Left wrist drop	Anterior resection (8 h)	—	Intraoperative positioning	Complete recovery at 72 h
Bilateral tingling and numbness of both hands	Urethroplasty (NA)	—	Intraoperative positioning	Complete recovery after 1 week
L4 radiculopathy L4/5 isolated injury (no sensory loss)	Low anterior resection (5 h)	—	Intraoperative positioning and use of pelvic retractors	Complete recovery after 72 h

NA = Not available

In six (20.6%) cases, anesthesia was considered solely responsible and in 23 (79.3%) cases contributing to the morbidity in addition to surgical factors.

Human error contributed to 93%, teamwork and communication breakdown contributed to 3.4% and organizational failure to 3.4% of the morbidity.

Discussion

Neurological injuries following anesthetic management are of serious concern for both patient and anesthetist and may lead to litigation. Much of the available literature is restricted to data from developed countries.[5] It is important to document this data to identify risk factors[7] and for patient information and historical comparisons.[7] There is also a need to revisit these risk factors as they may change over time.[2] In addition, randomized controlled trials with large numbers are needed because of the rarity of such events, which are difficult to conduct, hence the reliance on databases.[8] Results may also vary as the risk factors may be different in less affluent countries as shown with mortality previously.[9]

Case analysis

Meningitis following regional can be due to contamination of spinal needle, not using an aseptic technique or rarely contamination of injected solutions. One of the patients had a history of diabetes but was not immunocompromised. None of the patients developed postoperative neurological complications. We reviewed our policies of sterility prior to regional anesthesia following these cases. The last of these cases was reported in 2005, and we have not had another case since then. In Finland, out of 86 claims of compensation (1987-1993), four patients had purulent meningitis following epidural or spinal anesthesia, all except one recovered.[10]

Four of the patients presented with brachial plexus injury, with motor and sensory weakness in the recovery room. Three of these patients had undergone major gastrointestinal surgery, and two cases had undergone breast lumpectomy; intraoperatively, the arms were abducted in all these cases. Both the later patients were thin females. Two patients had wrist drop one underwent urethroplasty, and the second underwent anterior resection with the left arm abducted. One female patient had foot drop following laparoscopy and laparotomy. She was operated in the lithotomy position and had a BMI <20. There are several causes of peripheral nerve injuries under anesthesia. It can be a direct result of anesthetic technique,[11] poor perioperative stretch, or compression due to positioning or to tourniquets and nature of surgery, e.g., neurosurgery, cardiac surgery, etc.[12,13] In addition, there can be predisposing factors such as diabetes involving

Table 3: Details of patients, type of surgery, co-morbidity and outcome of patients who had postoperative stroke

Morbidity	Age	Gender	Type of surgery (duration)	Co-morbidity	Cause	Diagnosis	Out come
Left hemiplegia	51	Male	Hepaticojejunostomy	Diabetes	Carotid artery puncture during CVP insertion	Right middle cerebral artery infarct	Hemiplegia
Left hemiplegia	65	Male	Radical cystectomy (8 h)	Diabetes	Carotid artery puncture	Cerebral artery infarct	Left arm recovery within 4 h, left leg paralysis, lost to follow up
Right hemiplegia	45	Male	Wound debridement and colostomy	Sepsis, burns	-	Right temporal lobe infarct	Died after 5 weeks
Left hemiperisis	60	Male	Maxillectomy for adenocarcinoma nose (6 h)	Ischemic heart disease	Carotid artery damage intraoperative, hypotension and delay in treatment	-	Hemiplegia on day 3
Right hemiperesis	60	Male	Cervical abscess drainage (NA)	Diabetes	No precautions taken for cord compression	-	Patient died on day 9 ventilated
Left hemiplegia	75	Female	Dynamic hip screw (4 h)	Hypertension and diabetes, AF	No anticoagulation	Ischemic infarct	Partial recovery after 24 hrs
Blurred vision, aphasia, right-visual field loss temporal	65	Female	Abdominoperinial resection (8.4 h)	Hypertension, diabetes and ischemic heart disease	BP fluctuation intraoperatively	Cerebral artery infarct	Improved vision at 6 weeks persistent aphasia

BP = Blood pressure, CVP = Central venous line, AF = Atrial Fibrillation, NA = Not available

microvasculature, hypertension, smoking, and perioperative factors such as hypovolemia, hypotension, dehydration, and hypothermia.[12] Retrospective reviews may underestimate whereas medicolegal databases may overestimate incidence of peripheral nerve injury.[13] The incidence of permanent nerve injury postsurgery is documented as 0.03-1.4%.[14] Permanent injury is rare, and nerve localization does not reduce the frequency of clinical injury.[15]

In all the reported cases, the reviewers were of the opinion that stretch and compression was the suspected cause. Patient positioning, especially during breast surgery and major abdominal surgery, was reviewed, and there has been no case since 2003. Combined lumbar epidural with GA was used in one of the above cases, and the reviewers were of the opinion that in addition to positioning the catheter may have impinged on the nerve.

In four of the cases (two wrist drops, one lower limb weakness, and one right arm weakness), recovery started within 48 h and was complete in 72 h, probably indicating neuropraxia. In two cases of brachial plexus injury, patients recovered after 1 or 1½ months. One patient with foot drop had a residual weakness after 3 months, and one patient was lost to follow-up (brachial plexus neuropathy). None of the patients in this group were diabetic. This data is consistent with other reports that most neurological injury symptoms resolve in 4-6 weeks in 92-97% cases and in 99% by 1 year.[16] Ben-David and Stahl conducted a retrospective review over 6 years for cases with postoperative brachial plexopathy and its prognosis and identified twenty-two patients. They found that all patients recovered significantly.[17]

All patients with stroke presented in the first 24 h of postsurgery. In a previous study, the overall incidence of perioperative stroke within 30 days of surgery was 0.6% in 37,927 anesthetics.[18] The risk factors identified in literature are advanced age, carotid disease, atherosclerosis, arterial fibrillations[19] previous stroke, and metabolic disease.[20] Two of our patients developed hemiparesis where carotid artery puncture had occurred during central venous line placement. Hemiparesis has been previously described following carotid puncture.[20] The recent trend of placing internal jugular catheters under ultrasound guidance is likely to decrease this complication. A third patient in our cohort had common carotid artery damaged during surgery.

Anesthetic management was implicated in a case of a 9-month-old child who underwent anorectoplasty under combined GA and caudal epidural and developed quadriparesis postoperatively. MRI on postoperative day 4 showed a swelling extending from C2 to C6.

Table 4: The distribution of general anesthesia versus regional in relation to morbidity

Category of adverse event	*n*	GA	Regional block			Combined epidural and GA
			Spinal	Epidural	CSE	
Seizures	4	2	—	1	1	—
Postoperative stroke	7	4	—	—	—	3
Cord/plexus injury	8	6	—	—	—	1
Meningitis	3	—	3	—	—	—
Vocal cord palsy	5	4	—	—	—	1
Paraplegia	1	—	—	—	—	1
Miscellaneous	1	—	—	—	1	—

CSE = Combined spinal epidural, GA = General anaesthesia

A later repeat MRI scan showed edema to be reduced but high signal changes in anterior horn cells suggestive of ischemia. Her electromyography confirmed anterior horn cell damage. In this case, the catheter length was not confirmed radiologically, intermittent injections of local anesthetic (LA) were given inspite of encountered resistance, and there were delays in picking up the neurological problems postoperatively due to the continuation of bupivacaine infusion postoperatively.[21]

Postoperative seizures are a recognized complication. The reasons are several, varying from preoperative seizure history, structural abnormality of the brain (tumors), LA overdose other epileptogenic drugs, etc.[22] Two of these patients were infants, in one the seizure appeared to be febrile and the second patient had electrolyte (sodium) abnormality. Two obstetric patients had seizures, one had obstetric epidural for labor pain, and the second had C-section. Both these patients had no history of pre-eclamptic toxemia. The latter case was diagnosed as PRES. In none of our cases, overdose of LA was associated with seizures.

Postoperative vocal cord palsy can be due to malignancy, neck hyperextension trauma, neurological disease, viral infection, or intubation trauma.[23] Twelve percent of the cases are idiopathic. None of our reported cases had difficult intubation. Neurology consult was also done to rule out central causes. Two of the cases had undergone craniotomy where the head was positioned to one side. Duration of both these surgeries was more than 5 h. Third patient had radical cystectomy. Fourth case was found to be severely hypothyroid postoperatively which was missed preoperatively and the fifth case had a prior history of hoarseness that was again not picked up preoperatively. None of the reported cases were related to thyroid surgery. In all these cases, the reviewers were of the opinion that excessive tracheal tube cuff pressure along with a high placement of tracheal tube was the most likely cause. Measuring tracheal tube cuff pressures routinely was recommended.

There was one case of sixth cranial nerve palsy following combined spinal epidural anesthesia. The incidence of cranial nerve palsy associated with spinal anesthesia ranges between 1% and 6%.[24,25]

Comparison to pattern of neurological complications of anesthesia in affluent countries

Most published literature from affluent countries relates to specific complications. This comparison has been covered in the relevant discussions of case analysis.[10,14,17,18,20,24]

We were unable to locate a similar audit where a broad range of neurological complications was covered; however, two publications merit a mention. First is the ASA closed claims database that studies the closed malpractice claims of adverse anesthetic outcomes. In 1991, Cheney *et al.* published the closed claim analysis of 670 anesthetic related nerve injuries.[26] The most frequent was ulnar nerve (28%), brachial plexus (20%), lumbosacral nerve route (16%), and spinal cord (13%). Eighty-five percent of the nerve injuries were more likely with GA.

A narrative review of neurological complications of surgery and anesthesia was published in 2014 and focused on delirium, postoperative cognitive decline, stroke, spinal cord ischemia, and postoperative visual loss.[27] One of the studies in this review identified a 0.1% incidence of perioperative stroke in noncardiac, nonvascular, and nonneurological population.

Lessons to learn

Recent publications have highlighted the importance of using large databases and recommend wider use of this research methodology for providing an evidence base and hence optimize care for patients.[28]

Though the information presented in this review has been already presented at our departmental M and M meetings, the impact of collated information is much greater. Further analysis of contributing causes into human error, communication, and team errors and organizational breakdown has highlighted the role of correctable elements which can provide areas of greater focus in making guidelines and protocols. Majority of contributing factors in our data were classified as human error or failure. These can be related to error of judgment, lack of competence, or lack of coverage. Some of these can be reduced by formulating and implementing guidelines.[29] Communication and teamwork errors have previously been shown to contribute in 43-65% sentinel events in the operating rooms leading to major morbidity and even mortality.[5]

Limitations

This analysis is based on peer review methodology; limitations

of this method are selection of information, recall, and reviewer bias, especially if un-blinded.[30] We tried to rule out bias by making the database reviewers blinded. It has also been pointed out that retrospective reviews may underestimate complications due to missing data whereas medicolegal databases may overestimate the incidence. Our source was morbidity and mortality database, collected on standardized forms and, therefore, the quality of data captured was better than simple retrospective reviews.

Second, this is a review of database of a single institution. Health care facilities in developing nations are complex and not uniform. The standards vary between different institutions due to lack of control.

Another problem in reviewing neurological morbidity is the lack of consistency of definitions in literature. Rates of complications also vary in different publications. There is also a probability that cases which may have presented late were missed. The possibility of underestimation therefore exists.

Another limitation was the lack of data of the total population at risk. Although we had a record of number of total cases who underwent anesthesia at our institution, we did not have a breakdown of anesthesia cases based on type of anesthesia, GA or regional anesthesia, number of total peripheral blocks done, or anesthesia risk classification, etc.

Conclusion

This particular audit has helped in identifying the pattern of neurological major morbidity and the anesthetic factors that have contributed to it in our institution. It has also helped in identifying suboptimal management of cases in the perioperative period. This data can serve as a reference for further such audits in our hospital and region.

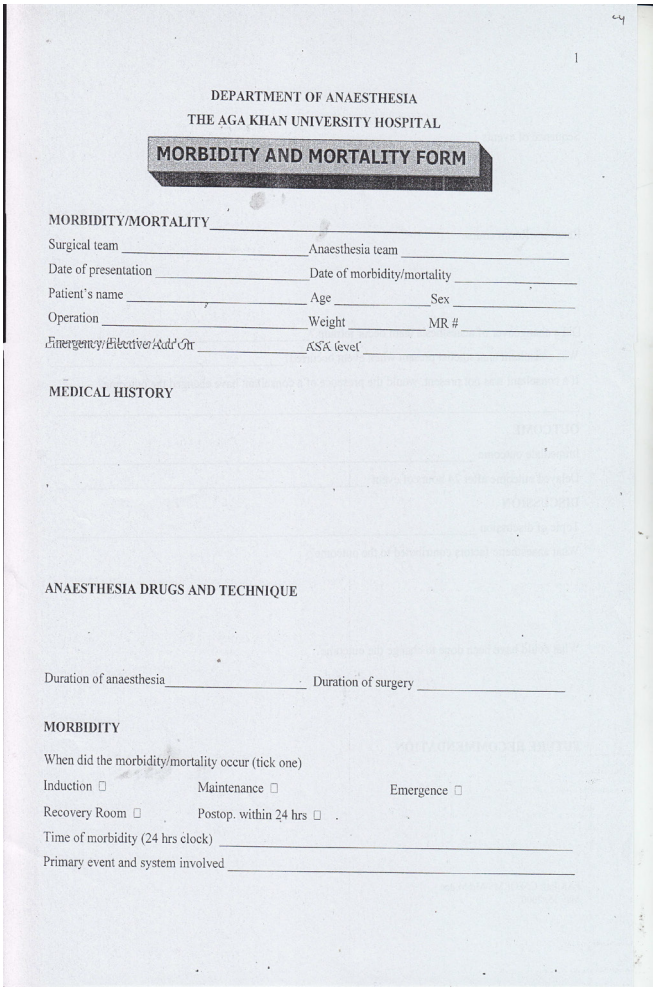
Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Derrington MC, Smith G. A review of studies of anaesthetic risk, morbidity and mortality. Br J Anaesth 1987;59:815-33.
2. Brull R, McCartney CJ, Chan VW, El-Beheiry H. Neurological complications after regional anesthesia: Contemporary estimates of risk. Anesth Analg 2007;104:965-74.
3. Warner MA, Warner DO, Matsumoto JY, Harper CM, Schroeder DR, Maxson PM. Ulnar neuropathy in surgical patients. Anesthesiology 1999;90:54-9.
4. Bainbridge D, Martin J, Arango M, Cheng D; Evidence-based Peri-operative Clinical Outcomes Research (EPiCOR) Group. Perioperative and anaesthetic-related mortality in developed and developing countries: A systematic review and meta-analysis. Lancet 2012;380:1075-81.
5. Haller G, Laroche T, Clergue F. Morbidity in anaesthesia: Today and tomorrow. Best Pract Res Clin Anaesthesiol 2011;25:123-32.
6. Fugate JE, Claassen DO, Cloft HJ, Kallmes DF, Kozak OS, Rabinstein AA. Posterior reversible encephalopathy syndrome: Associated clinical and radiologic findings. Mayo Clin Proc 2010;85:427-32.
7. Horlocker TT, McGregor DG, Matsushige DK, Schroeder DR, Besse JA. A retrospective review of 4767 consecutive spinal anesthetics: Central nervous system complications. Perioperative Outcomes Group. Anesth Analg 1997;84:578-84.
8. Neal JM, Bernards CM, Hadzic A, Hebl JR, Hogan QH, Horlocker TT, *et al*. ASRA practice advisory on neurologic complications in regional anesthesia and pain medicine. Reg Anesth Pain Med 2008;33:404-15.
9. Walker IA, Wilson IH. Anaesthesia in developing countries — A risk for patients. Lancet 2008;371:968-9.
10. Aromaa U, Lahdensuu M, Cozanitis DA. Severe complications associated with epidural and spinal anaesthesias in Finland 1987-1993. A study based on patient insurance claims [see comment]. Acta Anaesthesiol Scand 1997;41:445-52.
11. Kroll DA, Caplan RA, Posner K, Ward RJ, Cheney FW. Nerve injury associated with anesthesia. Anesthesiology 1990;73:202-7.
12. Lalken AG, Bhatia K. Parioperative peripheral nerve injuries. Contin Educ Anaesth Crit Care Pain 2012;12:38-42.
13. Welch MB, Brummett CM, Welch TD, Tremper KK, Shanks AM, Guglani P, *et al*. Perioperative peripheral nerve injuries: A retrospective study of 380,680 cases during a 10-year period at a single institution. Anesthesiology 2009;111:490-7.
14. Webster K. Peripheral nerve injuries and positioning for general anesthesia. ATOTW. 2012;258:1-8. Available from www.totw.anaesthesiologists.org
15. Barrington MJ, Watts SA, Gledhill SR, Thomas RD, Said SA, Snyder GL, *et al*. Preliminary results of the Australasian Regional Anaesthesia Collaboration: A prospective audit of more than 7000 peripheral nerve and plexus blocks for neurologic and other complications. Reg Anesth Pain Med 2009;34:534-41.
16. Urban MK, Urquhart B. Evaluation of brachial plexus anesthesia for upper extremity surgery. Reg Anesth 1994;19:175-82.
17. Ben-David B, Stahl S. Prognosis of intraoperative brachial plexus injury: A review of 22 cases. Br J Anaesth 1997;79:440-5.
18. Sharifpour M, Moore LE, Shanks AM, Didier TJ, Kheterpal S, Mashour GA. Incidence, predictors, and outcomes of perioperative stroke in noncarotid major vascular surgery. Anesth Analg 2013;116:424-34.
19. Ding DY, Christoforou D, Turner G, Tejwani NC. Postoperative stroke after hemiarthroplasty for femoral neck fracture: A report of 2 cases and review of literature. J Patient Saf 2014;10:117-20.
20. Raczak M, Lasek-Bal A, Hoffmann A, Mizia-Stec K, Czapska A, Wnuk-Wojnar AM. Stroke caused by carotid artery dissection during ablation of atrial arrhythmia. Postepy Kardiol Interwencyjnej 2014;10:119-22.
21. Polaner DM, Taenzer AH, Walker BJ, Bosenberg A, Krane EJ, Suresh S, *et al*. Pediatric Regional Anesthesia Network (PRAN): A multi-institutional study of the use and incidence of complications of pediatric regional anesthesia. Anesth Analg 2012;115:1353-64.
22. Manaka S, Ishijima B, Mayanagi Y. Postoperative seizures:

Epidemiology, pathology, and prophylaxis. Neurol Med Chir (Tokyo) 2003;43:589-600.
23. Al-Khtoum N, Shawakfeh N, Al-Safadi E, Al-Momani O, Hamasha K. Acquired unilateral vocal fold paralysis: Retrospective analysis of a single institutional experience. N Am J Med Sci 2013;5:699-702.
24. Yaman ME, Ayberk G, Eylen A, Ozveren MF. Isolated abducens nerve palsy following lumbar puncture: Case report and review of the mechanism of action. J Neurosurg Sci 2010;54:119-23.
25. Seyed Toutounchi SJ, Eydi M, Golzari SE, Ghaffari MR, Parvizian N. Vocal cord paralysis and its etiologies: A prospective study. J Cardiovasc Thorac Res 2014;6:47-50.
26. Cheney FW, Domino KB, Caplan RA, Posner KL. Nerve injury associated with anesthesia: A closed claims analysis. Anesthesiology 1999;90:1062-9.
27. Mashour GA, Woodrum DT, Avidan MS. Neurological complications of surgery and anaesthesia. Br J Anaesth 2015;114:194-203.
28. Freundlich RE, Kheterpal S. Perioperative effectiveness research using large databases. Best Pract Res Clin Anaesthesiol 2011;25:489-98.
29. de Vries EN, Prins HA, Crolla RM, den Outer AJ, van Andel G, van Helden SH, *et al*. Effect of a comprehensive surgical safety system on patient outcomes. N Engl J Med 2010;363:1928-37.
30. Caplan RA, Posner KL, Cheney FW. Effect of outcome on physician judgments of appropriateness of care. JAMA 1991;265:1957-60.



1

DEPARTMENT OF ANAESTHESIA
THE AGA KHAN UNIVERSITY HOSPITAL

MORBIDITY AND MORTALITY FORM

MORBIDITY/MORTALITY _____

Surgical team _____ Anaesthesia team _____

Date of presentation _____ Date of morbidity/mortality _____

Patient's name _____ Age _____ Sex _____

Operation _____ Weight _____ MR # _____

Emergency/Elective/Add On _____ ASA level _____

MEDICAL HISTORY

ANAESTHESIA DRUGS AND TECHNIQUE

Duration of anaesthesia _____ Duration of surgery _____

MORBIDITY

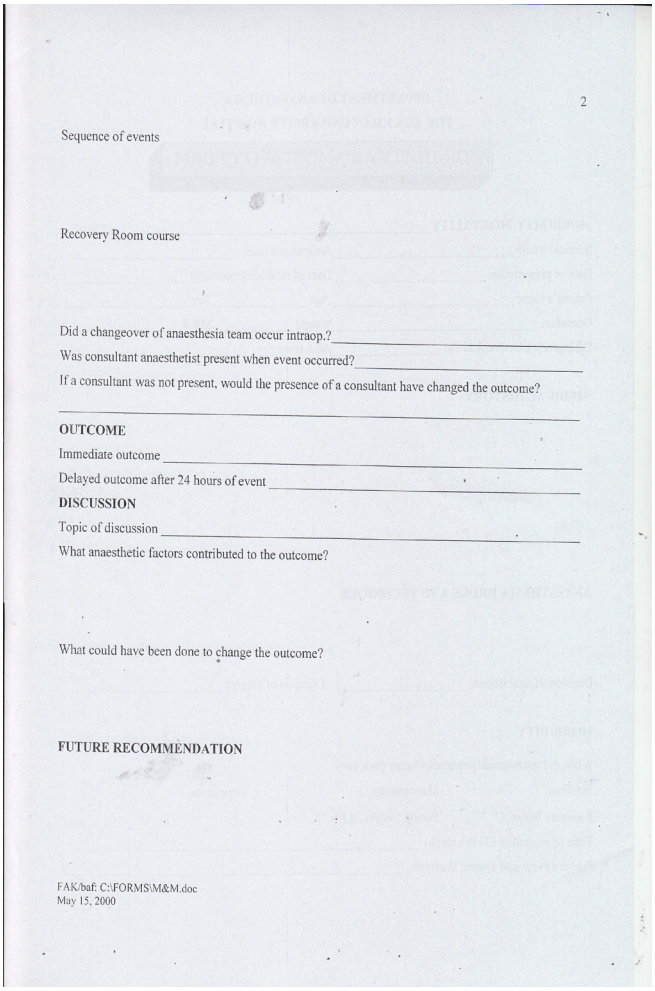
When did the morbidity/mortality occur (tick one)

Induction ☐ Maintenance ☐ Emergence ☐

Recovery Room ☐ Postop. within 24 hrs ☐

Time of morbidity (24 hrs clock) _____

Primary event and system involved _____



2

Sequence of events

Recovery Room course

Did a changeover of anaesthesia team occur intraop.? _____

Was consultant anaesthetist present when event occurred? _____

If a consultant was not present, would the presence of a consultant have changed the outcome?

_____

OUTCOME

Immediate outcome _____

Delayed outcome after 24 hours of event _____

DISCUSSION

Topic of discussion _____

What anaesthetic factors contributed to the outcome?

What could have been done to change the outcome?

FUTURE RECOMMENDATION

FAK/baf: C:\FORMS\M&M.doc
May 15, 2000