Original Article

Completeness of manual data recording in the anaesthesia information management system: A retrospective audit of 1000 neurosurgical cases

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ABSTRACT

Background and Aims: Anaesthesia information management system (AIMS) is increasingly implemented in many hospitals. Considering the capital cost involved in its installation and maintenance, it is important to evaluate its performance and adoptability by end users. This study assessed the completeness of manual data recording in the AIMS one year after its implementation and also evaluated potential predictors for completeness. **Methods:** In this retrospective audit of AIMS, 1000 electronic anaesthesia records of patients undergoing neurosurgical procedures over one year were assessed for completeness of 41 preidentified items, one year after its implementation. Parameters evaluated were patient identifiers, personnel identifiers, demographics, airway management parameters, anaesthesia management items and end-of-anaesthesia parameters. We hypothesised that completeness of anaesthesia record can be predicted by nature of surgeries, case sequence, seniority of anaesthesiologist and phase (first or second) of the study period. **Results:** We observed higher completeness of manual data recording during phase 2 of AIMS use compared to phase 1. Higher grade of anaesthesiologist, second case of the day and emergency surgery led to reduction in completeness of data entry. Anaesthesiologist grade significantly predicted complete entry of 18 (44%) variables, case number predicted 8 (20%) variables and phase- and procedure-type predicted 6 (15%) and 5 (12%) variables, respectively. **Conclusion:** Completeness of manual data recording in the electronic AIMS is poor after one year of implementation. First case of the day, second phase of study period, elective cases and trainee anaesthesiologist are associated with better completeness of manual data recording in the AIMS.

Key words: Data analysis, electronic medical record, integrated information management system, medical audit, quality improvement

INTRODUCTION

The electronic anaesthesia information management system (AIMS) provides a permanent paperless method for capturing and storing anaesthesia-related information during the perioperative period. The traditional method of manual record-keeping has various shortcomings.[1-3] To overcome this, the AIMS is being implemented in many hospitals including those in the developing countries. Considering the capital cost involved in its installation and maintenance in resource constraint settings, it is important to evaluate its performance and adoptability by the end users. Our hospital recently installed AIMS (Centricity™ Perioperative Anaesthesia, GE Healthcare) replacing the paper record to facilitate seamless and complete data acquisition and maintenance. This change of recording from manual to

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digital version was aimed to achieve several objectives such as legibility, complete and accurate capture of data, longer preservation of record, easy access to database for clinical, academic and research purpose and to establish a system compatible for any future medico-legal and quality assurance framework.

Our AIMS collects physiological data automatically from multiple sources (multiparameter monitor, anaesthesia workstation, target-controlled infusion pump and cardiac output monitor) and combines them into a consistent record of the perioperative period to support informed decisions and to improve quality of patient care. However, many other items such as demographics, drugs and infusions require manual entry. Our AIMS is independent from our picture archiving system and hospital information system. With completion of one year since the installation of this system, we planned to assess our AIMS for its efficiency, inadequacies and anaesthesiologists' adaptation to the change from manual to electronic record. Previous reports have observed improvements in the completeness of electronic anaesthetic data in comparison to manual records[4] but also noted inaccuracies in some of the items documented in the electronic AIMS.[5]

The primary objective of this audit was to assess completeness of the manual data recorded in the AIMS during neurosurgical procedures. Our secondary objective was to identify potential predictors of completeness of data recording.

METHODS

This retrospective audit of our AIMS was conducted at a tertiary care neurosciences academic centre, after approval from the institute's ethics committee (NIMHANS Ethics Committee, Approval no.—NIMHANS/IEC (BS & NS DIV/11th meeting 2018, Date—15/03/2018). Requirement for written informed consent was waived by our ethics committee. Electronic anaesthesia records from our AIMS beginning from 1st January 2018 to 31st December 2018 were extracted to assess completeness of preidentified parameters listed in Table 1. This period coincided with completion of one year of installation of AIMS at our institution. We planned to analyse 1000 anaesthesia records in this audit. We *a-priori* identified items that were part of our earlier manual anaesthesia record and also additional items from the AIMS that were deemed important for a good anaesthesia record. These 41 items were broadly classified as patient identifiers (4 variables), personnel identifiers (3 variables), demographics (8 variables), airway management parameters (5 variables), anaesthesia management items (13 variables) and end-of-anaesthesia parameters (8 variables). Each item was given a score of 0 for missing data entry, 1 for partial data entry and 2 for complete data entry or 0 = No and 1 = Yes, as applicable. Data regarding these preidentified parameters and predictors of their completeness obtained from 1000 electronic anaesthesia records were collected on a Microsoft Excel worksheet by two researchers for analyses.

We *a-priori* identified certain factors that could predict completeness of manual data entry into the AIMS. These factors were elective or emergency nature of surgeries, first or subsequent case of the day, seniority of the anaesthesiologist (resident or faculty) and phase 1 (January to June) or phase 2 (July to December) of the study period. We hypothesised that completeness of electronic anaesthesia chart would be better for 1) elective surgeries than emergency surgeries, 2) first case than subsequent cases of the day, 3) junior anaesthesiologists than senior anaesthesiologists and 4) phase 2 of the study period than phase 1. We also planned to solicit feedback from the users to suggest improvements in enhancing the completeness of manual recordings and efficiency of the AIMS.

Data were collated offline into a Microsoft Excel spreadsheet (version 2007). Data analysis was conducted using R software (ver. 3.5.2).[6] Data were complete for all of the samples (n = 1000), and all were included in the analyses. Predictor variables were predefined as phase of study period (1/2), procedure type (emergency/elective), case number of the day (1/2) and anaesthesiologist grade (residents- first year, second year, third year and faculty). All residents were supervised by a faculty but all faculties functioned independently. For each of the predefined predictor variables, Chi-square test was used to find association with all outcome variables. The variables found significantly associated at $P < 0.05$ were selected for inclusion in the final models. The outcome variables were grouped into six groups—patient identifiers, personnel identifiers, demographics, airway management details, anaesthesia management details and end-of-anaesthesia details.

Due to multiple possible correlations within the predictors and the outcomes, and need for modelling

Table 1: Percentages of completeness of variables in the AIMS

Variable	Levels	Percentages
Predictors		
Phase	Phase 1/Phase 2	50/50
Case number	First case/Second case	60.46/39.5
Procedure type	Elective/Emergency/Missing	66.8/4/29.2
Anaesthesiologist grade	Year 1/Year 2/Year 3/Faculty/Missing	42.2/24.9/16.7/15.2/1
Patient identifiers		
Hospital ID	No/Yes	8.7/91.3
Visit ID	No/Yes	36.34/63.6
Surgery date	No/Yes	0.1/99.9
Name	No/Yes	1.3/98.7
Demographics		
Age	No/Yes	34.03/65.9
Gender	No/Yes	3.3/96.7
Weight	No/Yes	25/75
ASA grade	No/Yes	7.2/92.8
Allergy details	No/Yes	38.4/61.6
Diagnosis details	Complete/No/Partial	68.5/13.7/17.8
Surgery details	Complete/No/Partial	63.6/15/21.4
Blood group	No/Yes	14.6/85.4
Personnel Identifiers		
Surgeon name	No/Yes	26.3/73.7
Anaesthesia faculty name	No/Yes	3.8/96.2
Anaesthesia resident name	No/Yes	18.1/81.9
Airway management details		
Intubation time	No/Yes	1.21/97.9
Intubation technique	No/Yes	8.91/90
Endotracheal tube size	No/Yes	1.52/97.4
Cormack Lehane grade	No/Yes	5.45/83.3
Length of ETT fixation	No/Yes	99.29/0.7
Anaesthesia management details		
Anaesthesia start time	No/Yes	0.4/99.6
Surgery start time	No/Yes	0.2/99.8
Anaesthesia close time	No/Yes	2.4/97.6
Surgery close time	No/Yes	4.4/95.6
Fluid intake	No/Yes	4.4/95.6
Urine output	No/Yes	25.5/74.5
Blood loss	No/Yes	28.3/71.7
Position details	No/Yes	3.2/96.8
Protection details	No/Yes	53.4/46.6
Loco-regional analgesia details	Complete/No/Partial	19.84/77.4/2.61
Intravenous access details	Complete/No/Partial	97.9/1.8/0.3
Intraoperative drug details	Complete/No/Partial	92.3/0.2/7.5
Antibiotic details	Complete/No/Partial	92.8/5/2.2
End of anaesthesia details		
Extubation time	No/Yes	58.2/38
NMB Reversal details	Complete/No/Partial	53.89/43.6/0.93
Postoperative instructions	Complete/No/Partial	60.3/27.6/12.1
Postoperative recovery details	Complete/No/Partial	58.06/33.5/8.41
Extubation	No/Yes	49.29/50.3
Extubation site	No/Yes	40.04/59.6
Transfer details	No/Yes	70.27/29.7
Anaesthesiologist signature	No/Yes	84.88/15.1

No – Absent/Incomplete, Yes – Complete; ASA – American Society of Anesthesiologists, ETT – Endotracheal tube, NMB – Neuromuscular blockade

multiple predictors for multiple outcomes, structural equation models (SEM) were built for each separate group of outcomes based on the variables found significant at univariate level. The predictors were entered into the model as ordinal variables such that phase 2 > 1, case number 2 > 1, procedure type

emergency > elective and anaesthesiologist grade scored by seniority. The model was estimated using diagonally weighted least squares (DWLS) estimator and robust "sandwich type" standard error calculation, with no constraints placed on any of the model parameters. The SEM was conducted using "lavaan" package of R.[7]

For the uninitiated to our statistical analyses, the interpretation of our statistical analyses is as follows. The estimates produced from the SEM models using DWLS estimator are akin to those from a proportional odds model. The estimates are additive in the native format and exponent of the estimate is the odds ratio for prediction of the outcome variable. The benefit of the models is that the estimates of the predictors for any given outcome within that model can be added up and exponent of the sum of estimates denotes the odds of the presence of the outcome.

RESULTS

A total of 2155 electronic anaesthetic records for neurosurgical procedures from seven operating rooms were retrieved from the AIMS for the study period. We excluded records of patients from three emergency operating rooms in a different building where AIMS was not installed, and records from elective operating rooms where technical reasons precluded use of AIMS. Emergency surgeries performed in the elective operating rooms were included. We then randomly selected 1000 electronic anaesthesia records for analyses of our objectives considering logistical reasons. The first author (SRP) blinded to the content of the records, randomly picked 500 electronic anaesthesia records from our AIMS server for each of the two study phases. This method (about 83 records for each month for both the phases) was used to avoid any selection bias.

The degree of completeness of all variables is represented in Table 1 as proportions. The detailed tables of univariate tests of association are presented as Supplementary Tables (S1-S4). The outcome variables that were found to be significantly associated are represented in Table S5. These supplementary Tables (S1-5) are accessible in the online version of this article. These significant variables were then entered into SEM models for each respective set of outcomes. The results of the models are represented in Tables 2-5. The models were found to have a good fit with model fit statistic Chi-square test (all $P > 0.05$), comparative fit index (all models CFI >0.95), Tucker Lewis index (all models TLI >0.95) and root-mean-square approximate error <0.05 for all models.

The completeness of intubation technique entry in the airway management model was significantly predicted by anaesthesiologist grade and procedure type with estimates of −0.136 and −0.552, respectively. Thus, if a second year resident conducts an emergency case, the estimate would add up to −0.688, which denotes an OR of 0.503. This means that in such a case the chance of complete recording of intubation technique reduces by approximately 50%.

Overall, it was found that for most outcomes, phase 2 of AIMS use led to improvement in completeness compared to phase 1. Increase in anaesthesiologist grade (higher seniority) and case number (second case of the day) led to reduction in completeness of data entry. Emergency cases had poorer data completeness compared to elective cases. Also, anaesthesiologist

Table 2: Results of SEM models of patient identifiers and personnel details completeness

Dependent	Independent	Estimate	*P*	OR (95% CL)
Patient identifiers				
Hospital ID	Anaesthesiologist grade	0.055	0.326	1.06 (0.95-1.18)
Visit ID	Anaesthesiologist grade	−0.158	<0.001	0.85 (0.79-0.92)
Name	Anaesthesiologist grade	−0.22	0.059	0.8 (0.64-1.01)
Hospital ID	Phase	0.454	0.002	1.57 (1.18-2.1)
Personnel Details				
Surgeon name	Anaesthesiologist grade	−0.163	0.002	0.85 (0.77-0.94)
Anaesthesia faculty name	Anaesthesiologist grade	−0.529	<0.001	0.59 (0.47-0.74)
Anaesthesia resident name	Anaesthesiologist grade	−2.205	<0.001	0.11 (0.08-0.15)
Surgeon name	Case number	−0.27	0.015	0.76 (0.61-0.95)
Surgeon name	Phase	0.379	0.001	1.46 (1.18-1.81)
Anaesthesia resident name	Phase	0.321	0.474	1.38 (0.57-3.31)
Surgeon name	Procedure type	−0.925	<0.001	0.4 (0.26-0.6)
Anaesthesia faculty name	Procedure type	−1.018	0.003	0.36 (0.19-0.7)

OR – Odds ratio, CL – Confidence limits, *P*<0.05 is statistically significant; SEM – Structural equation models

Table 3: Results of SEM model of completeness of patients' demographics

Dependent	Independent	Estimate	*P*	OR (95% CL)
Age	Anaesthesiologist grade	−0.053	0.199	0.95 (0.88-1.03)
Gender	Anaesthesiologist grade	−0.01	0.063	0.99 (0.98-1)
Weight	Anaesthesiologist grade	−0.086	<0.001	0.92 (0.88-0.96)
ASA grade	Anaesthesiologist grade	−0.005	0.597	1 (0.98-1.01)
Allergy details	Anaesthesiologist grade	−0.059	0.194	0.94 (0.86-1.03)
Diagnosis details	Anaesthesiologist grade	−0.067	0.001	0.94 (0.9-0.97)
Surgery details	Anaesthesiologist grade	−0.065	0.001	0.94 (0.9-0.98)
Blood group	Anaesthesiologist grade	−0.082	<0.001	0.92 (0.9-0.94)
Age	Phase	0.586	<0.001	1.8 (1.52-2.13)
ASA grade	Phase	0.039	0.096	1.04 (0.99-1.09)
Diagnosis details	Phase	0.055	0.249	1.06 (0.96-1.16)
Surgery details	Phase	−0.023	0.637	0.98 (0.89-1.08)
Blood group	Phase	−0.036	0.111	0.96 (0.92-1.01)
Age	Case number	−0.09	0.29	0.91 (0.77-1.08)
Weight	Case number	−0.114	0.002	0.89 (0.83-0.96)
Allergy details	Case number	−0.12	0.207	0.89 (0.74-1.07)
Diagnosis details	Case number	−0.114	0.015	0.89 (0.81-0.98)
Surgery details	Case number	−0.14	0.004	0.87 (0.79-0.96)
Blood group	Case number	−0.063	0.005	0.94 (0.9-0.98)

OR – Odds ratio, CL – Confidence limits, *P*<0.05 is statistically significant; ASA – American Society of Anesthesiologists; SEM – Structural equation models

Table 4: Results of SEM model of completeness of airway and anaesthesia details

Dependent	Independent	Estimate	*P*	OR (95% CL)
Airway details				
Intubation technique	Anaesthesiologist grade	−0.136	0.045	0.87 (0.76-1)
Intubation technique	Phase	−0.164	0.257	0.85 (0.64-1.13)
Intubation technique	Procedure type	−0.552	0.032	0.58 (0.35-0.95)
Anaesthesia details				
Fluid intake	Anaesthesiologist grade	−0.132	0.18	0.88 (0.72-1.06)
Urine output	Anaesthesiologist grade	−0.24	<0.001	0.79 (0.71-0.87)
Blood loss	Anaesthesiologist grade	−0.056	0.01	0.95 (0.91-0.99)
Protection	Anaesthesiologist grade	−0.301	<0.001	0.74 (0.67-0.82)
Loco-regional analgesia	Anaesthesiologist grade	−0.145	0.014	0.87 (0.77-0.97)
Antibiotic details	Anaesthesiologist grade	0.192	0.01	1.21 (1.05-1.4)
Urine output	Case number	−0.407	<0.001	0.67 (0.54-0.83)
Blood loss	Case number	−0.121	0.012	0.89 (0.81-0.97)
IV access details	Case number	−0.646	0.839	0.52 (0-262.96)
Antibiotic details	Case number	−0.347	0.036	0.71 (0.51-0.98)
Protection	Procedure type	−0.668	0.002	0.51 (0.34-0.78)
Protection	Phase	0.361	<0.001	1.43 (1.18-1.74)
Loco-regional analgesia	Phase	0.061	0.552	1.06 (0.87-1.3)
Intraoperative drug details	Phase	0.292	0.063	1.34 (0.99-1.82)
Antibiotic details	Phase	−0.366	0.047	0.69 (0.48-1)

OR – Odds ratio, CL – Confidence limits, *P*<0.05 is statistically significant; SEM – Structural equation models

grade significantly predicted complete entry of 18 (44%) variables, case number predicted 8 (20%) variables and phase- and procedure-type predicted 6 (15%) and 5 (12%) variables, respectively.

DISCUSSION

The use of AIMS has benefits such as legibility, faster data entry, reduction in human errors, enhanced data completeness, cost savings and easy access to previous records. However, the presence of AIMS by itself does not guarantee completeness and accuracy of anaesthesia information during surgery. This is predominantly observed during initial phase of introduction of AIMS from lack of familiarity and training. This study demonstrated that manual data entries in AIMS remains incomplete for many items and degree of incompleteness is observed more for the end-of-anaesthesia parameters. Our predefined factors were predictive of completeness of manual data entry in the AIMS.

Table 5: Results of SEM model of end-of-anaesthesia details completeness

Dependent	Independent	Estimate	*P*	OR (95% CL)
Extubation time	Anaesthesiologist grade	−0.23	<0.001	0.79 (0.72-0.88)
Postoperative instructions	Anaesthesiologist grade	−0.331	<0.001	0.72 (0.65-0.79)
Transfer details	Anaesthesiologist grade	−0.163	0.002	0.85 (0.77-0.94)
Anaesthesiologist signature	Anaesthesiologist grade	−0.347	<0.001	0.71 (0.62-0.81)
Transfer details	Case number	−0.161	0.138	0.85 (0.69-1.05)
Extubation	Procedure type	−0.535	0.019	0.59 (0.37-0.92)
Signature of anaesthesiologist	Procedure type	−0.731	0.09	0.48 (0.21-1.12)
Extubation time	Phase	0.03	0.764	1.03 (0.85-1.26)
Postoperative instructions	Phase	0.932	<0.001	2.54 (2.06-3.14)
Extubation	Phase	0.134	0.186	1.14 (0.94-1.4)
Transfer details	Phase	0.139	0.182	1.15 (0.94-1.41)
Anaesthesiologist signature	Phase	0.127	0.298	1.14 (0.89-1.44)

OR – Odds ratio, CL – Confidence limits, $P<0.05$ is statistically significant; SEM – Structural equation models

An African audit of manual anaesthesia records noted only 30% (85/284) completion and for 71/284 (25%) anaesthetics, records were not used at all.[3] Driscoll *et al.* noted completeness in documentation of electronic anaesthesia record of 59% to 92% for six variables studied. They observed that dependence on free-text remarks and inability to automatically present entries in logical sequences by AIMS was associated with incomplete data entry.[8] In contrast, study examining introduction of context-sensitive mandatory fields in AIMS documented high (>98%) completeness rate and data concordance, and high rating for usability by anaesthesiologists.[9]

The wide variation in completeness of manual aspects of AIMS reported in the literature reflects deficiencies such as inadequate training prior to introduction of AIMS, lack of user friendliness, absence of mandatory field application and haphazard workflow of components requiring completion. Earlier studies have reported increased completion rate with education, workflow integration and individual feedback,[10] automated text prompts,[11] and including context-sensitive mandatory data entry fields.[9] Sandberg *et al.* observed significant improvement in completion of nonmandatory allergy information in the AIMS by implementing an automated text message to the user if no allergy information was documented within 15 min of the start of case.[11]

The suggested measures to improve data completeness of manual components of AIMS based on the literature and feedback from users in our study are 1) mandatory data entry fields for essential items 2) periodic training of anaesthesiologists in the use of AIMS to increase familiarity, 3) increase user-friendliness of commercially available system by customising record as per local needs, 4) restricting manual entry fields to minimum required 5) identify pathways to capture core items to avoid duplication 6) time-sensitive on-screen prompts to complete missing items 7) sign-out of chart by attending consultant (to ensure double checking) and 8) regular screening by medical records department for incompleteness and providing timeline for its completion. Our users provided feedback to mandatorily add certain missing elements into AIMS such as documentation of bilateral air entry in lungs on auscultation after intubation, number of attempts at intubation and mark of tracheal tube fixation. A need for developing filter to automatically remove artefacts was deemed necessary in place of the current option to manual recording of artefacts in our AIMS as several instances of artefacts being recorded as events are reported in the literature.[12]

We observed poor completeness with emergency cases. An Australian study analysing 850 anaesthesia records also reported poor completeness for emergency surgeries.[13] Similar findings were noted by Ige *et al.* for obstetric manual anaesthesia records.[14] These findings are understandable as the focus of clinicians is more on resuscitation and maintenance of patient's clinical condition with data completeness taking a back seat. Greater education and emphasis is required to improve completion rates in this population.

Our residents attended training more frequently than faculty on AIMS and, therefore, demonstrated more compliance with data completeness. The records of trainees are randomly verified by faculty but similar verification is absent for faculty. These factors might have contributed to better completeness among residents. A previous study noted no difference in completeness based on anaesthesiologist's age, level of training or number of years in practice.[15] However, close observation of anaesthesiologists during data

entry increases completeness suggesting role of human behaviour during supervision of tasks.[16]

We noted that first case of the day had better completeness than the subsequent cases. Fresh start to the day, adequate time and clarity of workflow might have contributed to this finding. Improper hand-over between shifts, anaesthesiologist fatigue, extension of elective surgeries beyond routine work hours and increased events during latter part of the day could have contributed to poor completeness during the subsequent cases of the day.

We observed that phase-1 was associated with poor completeness of manual entries in the AIMS. It is likely that increased familiarity with time and more training sessions (two additional sessions during this period) contributed to increased completeness during phase-2 of study. An earlier study also documented improved completeness of manual record with passage of time. The percentage of adequately documented intraoperative records increased to 35.1% in 2014 in comparison to 25.5% in 2009.[17] Likewise, significant improvement in adequacy of documentation of anaesthetic record for obstetric spinal anaesthesia was noted after a teaching intervention.[18] Similar improvement for in-patient medical record completeness (from 73% to 84%) was seen after modifying the record format and training.[19]

The strength of our study is that this study evaluated more than 40 variables important to anaesthesia. Anaesthesia record is a faithful compilation of all aspects of peri-anaesthetic care and, therefore, should document all information that can help improve anaesthetic processes and reduce untoward outcomes. Therefore, we assessed all variables that we considered as important from this perspective, unlike previous studies that selectively examined few items such as drug entry[20] and six predetermined clinical documentation elements.[8] Second, we evaluated potential predictors that can affect completeness of anaesthesia record. As some of these factors are modifiable, addressing these issues is likely to improve completeness.

This study is not without limitations. We performed assessment of only one type of AIMS customised to a neuroanaesthesia setup after one year of installation, and hence, our findings may not be generalisable to other hospitals or systems or time frame. Secondly, we did not assess time-sensitiveness of the manual entries, which reflects accuracy of data entry in the AIMS. This requires a prospective audit and, hence, could not be performed in our current study. Thirdly, we did not compare manual record with our AIMS. This would have provided better insight into factors contributing to different completion rates.

CONCLUSION

The completeness of manual data entry into the electronic AIMS is poor after one year of its implementation at a tertiary neurosciences centre. First case of the day, second phase of the study period, elective cases and trainee anaesthesiologist are associated with better completeness of the manual data recording into the AIMS. Frequent audit of the system and implementation of the above-suggested corrective measures is likely to increase completeness of manual data recording in the AIMS.

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Conflicts of interest

There are no conflicts of interest.

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Table S1: Association of phase with all outcome variables					
Response variable	**Levels**	**Phase 1**	**Phase 2**	**Statistic**	***P***
Hospital ID	No/Yes	12.4/87.6	5/95	16.300	<0.001
Visit ID	No/Yes	37.4/62.6	35.3/64.7	0.402	0.526
Surgery date	No/Yes	0.2/99.8	0/100	<0.001	1.000
Age	No/Yes	44.3/55.7	23.8/76.2	45.800	<0.001
Name	No/Yes	1.8/98.2	0.8/99.2	1.250	0.264
Gender	No/Yes	2.6/97.4	4/96	1.130	0.288
Weight	No/Yes	25.2/74.8	24.8/75.2	0.005	0.942
ASA grade	No/Yes	9.2/90.8	5.2/94.8	5.400	0.020
Allergy details	No/Yes	35.8/64.2	41/59	2.640	0.104
Diagnosis details	Complete/No/Partial	70.4/17.8/11.8	66.6/9.6/23.8	33.000	<0.001
Surgery details	Complete/No/Partial	68.2/18/13.8	59/12/29	36.300	<0.001
Surgeon name	No/Yes	33.8/66.2	18.8/81.2	28.300	<0.001
Anaesthesia faculty name	No/Yes	4.6/95.4	3/97	1.340	0.247
Anaesthesia resident name	No/Yes	14/86	22.2/77.8	10.800	0.001
Anaesthesia start time	No/Yes	0.8/99.2	0/100	2.260	0.133
Surgery start time	No/Yes	0/100	0.4/99.6	0.501	0.479
Anaesthesia close time	No/Yes	2/98	2.8/97.2	0.384	0.535
Surgery close time	No/Yes	4.2/95.8	4.6/95.4	0.024	0.877
Fluid intake	No/Yes	4/96	4.8/95.2	0.214	0.644
Urine output	No/Yes	25.6/74.4	25.4/74.6	<0.001	1.000
Blood group	No/Yes	11.8/88.2	17.4/82.6	5.850	0.016
Blood loss	No/Yes	26.6/73.4	30/70	1.260	0.261
Intubation time	No/Yes	1.613/98.387	0.808/99.192	0.753	0.386
ETT size	No/Yes	1.81/98.19	1.22/98.78	0.259	0.611
Cormack Lehane grade	No/Yes	5.02/94.98	5.83/94.17	0.143	0.705
Length of ETT fixation	No/Yes	98.79/1.21	99.797/0.203	2.280	0.131
Intubation technique	No/Yes	6.65/93.35	11.18/88.82	5.690	0.017
Position details	No/Yes	3.4/96.6	3/97	0.032	0.857
Protection	No/Yes	57.4/42.6	49.4/50.6	6.110	0.013
Loco-regional analgesia details	Complete/No/Partial	16.8/79.4/3.8	22.89/75.7/1.41	10.600	0.005
Intravenous access details	Complete/No/Partial	97.4/2.2/0.4	98.4/1.4/0.2	1.250	0.536
Intraoperative drug details	Complete/No/Partial	90/0.2/9.8	94.6/0.2/5.2	7.630	0.022
Antibiotic details	Complete/No/Partial	93.2/2.8/4	92.4/7.2/0.4	24.400	<0.001
Extubation time	No/Yes	54.5/45.5	61.9/38.1	4.900	0.027
NMB Reversal details	Complete/No/Partial	58.367/40.816/0.816	49.263/49.684/1.053	8.050	0.018
Postoperative instructions	Complete/No/Partial	47.4/35.6/17	73.2/19.6/7.2	70.600	<0.001
Postoperative recovery details	Complete/No/Partial	53.6/34/12.4	62.53/33.07/4.41	22.500	<0.001
Extubation	No/Yes	52.5/47.5	46.1/53.9	3.880	0.049
Extubation site	No/Yes	45.5/54.5	34.5/65.5	11.900	0.001
Transfer details	No/Yes	73.4/26.6	67.1/32.9	4.400	0.036
Anaesthesiologist signature	No/Yes	87.6/12.4	82.2/17.8	5.340	0.021

ETT – Endotracheal tube size, NMB – Neuromuscular blockade, Descriptives presented are percentages. *P*<0.05 is statistically significant

Table S2: Association of case number with all outcome variables					
Response variable	**Levels**	**First case**	**Second case**	**Statistic**	***P***
Hospital ID	No/Yes	8.77/91.23	8.61/91.39	<0.001	1.000
Visit ID	No/Yes	36.8/63.2	35.7/64.3	0.085	0.770
Surgery date	No/Yes	0.166/99.834	0/100	<0.001	1.000
Age	No/Yes	32.6/67.4	36.3/63.7	1.280	0.258
Name	No/Yes	0.993/99.007	1.772/98.228	0.603	0.437
Gender	No/Yes	2.98/97.02	3.8/96.2	0.276	0.599
Weight	No/Yes	20.7/79.3	31.6/68.4	14.700	<0.001
ASA grade	No/Yes	6.95/93.05	7.59/92.41	0.067	0.796
Allergy details	No/Yes	33.9/66.1	45.3/54.7	12.600	<0.001
Diagnosis details	Complete/No/Partial	71/11.6/17.4	64.6/17/18.5	6.650	0.036
Surgery details	Complete/No/Partial	66.9/12.7/20.4	58.5/18.5/23	8.680	0.013
Surgeon name	No/Yes	22.8/77.2	31.6/68.4	9.080	0.003
Anaesthesia faculty name	No/Yes	2.81/97.19	5.32/94.68	3.430	0.064
Anaesthesia resident name	No/Yes	18.2/81.8	18/82	<0.001	0.991
Anaesthesia start time	No/Yes	0.166/99.834	0.759/99.241	0.886	0.347
Surgery start time	No/Yes	0.331/99.669	0/100	0.177	0.674
Anaesthesia close time	No/Yes	1.82/98.18	3.29/96.71	1.620	0.203
Surgery close time	No/Yes	4.47/95.53	4.3/95.7	<0.001	1.000
Fluid intake	No/Yes	3.48/96.52	5.82/94.18	2.590	0.108
Urine output	No/Yes	20.4/79.6	33.4/66.6	20.700	<0.001
Blood group	No/Yes	12.4/87.6	18/82	5.470	0.019
Blood loss	No/Yes	23.7/76.3	35.4/64.6	15.700	<0.001
Intubation time	No/Yes	1.16/98.84	1.29/98.71	<0.001	1.000
Endotracheal tube size	No/Yes	1.16/98.84	2.07/97.93	0.765	0.382
Cormack Lehane grade	No/Yes	4.98/95.02	6.21/93.79	0.397	0.529
Length of ETT fixation	No/Yes	99.169/0.831	99.482/0.518	0.033	0.855
Intubation technique	No/Yes	8.65/91.35	9.33/90.67	0.062	0.804
Position details	No/Yes	2.48/97.52	4.3/95.7	2.000	0.157
Protection	No/Yes	51/49	57.2/42.8	3.470	0.063
Loco-regional analgesia details	Complete/No/Partial	20.9/76.12/2.99	18.27/79.7/2.03	2.050	0.359
Intravenous access details	Complete/No/Partial	99.007/0.993/0	96.203/3.038/0.759	10.300	0.006
Intraoperative drug details	Complete/No/Partial	93.212/0.331/6.457	90.886/0/9.114	3.690	0.158
Antibiotic details	Complete/No/Partial	94.54/3.64/1.82	90.13/7.09/2.78	7.170	0.028
Extubation time	No/Yes	57.6/42.4	59.1/40.9	0.160	0.689
NMB Reversal details	Complete/No/Partial	53.152/45.826/1.022	55.172/44.032/0.796	0.464	0.793
Postoperative instructions	Complete/No/Partial	60.4/28/11.6	60/27.1/12.9	0.421	0.810
Postoperative recovery details	Complete/No/Partial	59.27/33.11/7.62	56.35/34.01/9.64	1.570	0.455
Extubation	No/Yes	49.5/50.5	48.8/51.2	0.019	0.891
Extubation site	No/Yes	39.2/60.8	41.2/58.8	0.307	0.580
Transfer details	No/Yes	67.9/32.1	74.1/25.9	4.140	0.042
Anaesthesiologist signature	No/Yes	83.1/16.9	87.8/12.2	3.770	0.052

ETT – Endotracheal tube size, NMB – Neuromuscular blockade, Descriptives presented are percentages. *P*<0.05 is statistically significant

Table S3: Association of procedure type with all outcome variables					
Response variable	**Levels**	**Elective**	**Emergency**	**Statistic**	***P***
Hospital ID	No/Yes	6.59/93.41	7.5/92.5	<0.001	1.000
Visit ID	No/Yes	30.3/69.7	22.5/77.5	0.752	0.386
Surgery date	No/Yes	0.15/99.85	0/100	<0.001	1.000
Age	No/Yes	28.3/71.7	47.5/52.5	5.820	0.016
Name	No/Yes	0.599/99.401	0/100	<0.001	1.000
Gender	No/Yes	0.449/99.551	2.5/97.5	0.354	0.552
Weight	No/Yes	16.9/83.1	40/60	12.000	0.001
ASA grade	No/Yes	4.79/95.21	12.5/87.5	3.110	0.078
Allergy details	No/Yes	28/72	45/55	4.510	0.034
Diagnosis details	Complete/No/Partial	73.5/9.73/16.77	72.5/17.5/10	3.300	0.192
Surgery details	Complete/No/Partial	69.6/10/20.4	70/17.5/12.5	3.190	0.203
Surgeon name	No/Yes	20.1/79.9	52.5/47.5	21.400	<0.001
Anaesthesia faculty name	No/Yes	1.95/98.05	12.5/87.5	13.000	<0.001
Anaesthesia resident name	No/Yes	11.7/88.3	10/90	0.005	0.946
Anaesthesia start time	No/Yes	0.299/99.701	0/100	<0.001	1.000
Surgery start time	No/Yes	0.299/99.701	0/100	<0.001	1.000
Anaesthesia close time	No/Yes	1.95/98.05	0/100	0.081	0.776
Surgery close time	No/Yes	2.69/97.31	5/95	0.132	0.716
Fluid intake	No/Yes	3.44/96.56	2.5/97.5	<0.001	1.000
Urine output	No/Yes	21.1/78.9	27.5/72.5	0.575	0.448
Blood group	No/Yes	7.34/92.66	10/90	0.098	0.754
Blood loss	No/Yes	25.4/74.6	30/70	0.206	0.650
Intubation time	No/Yes	1.06/98.94	0/100	<0.001	1.000
Endotracheal tube size	No/Yes	1.06/98.94	0/100	<0.001	1.000
Cormack Lehane grade	No/Yes	3.23/96.77	2.86/97.14	<0.001	1.000
Length of ETT fixation	No/Yes	99.092/0.908	100/0	<0.001	1.000
Intubation technique	No/Yes	6.82/93.18	17.5/82.5	4.800	0.028
Position details	No/Yes	2.69/97.31	2.5/97.5	<0.001	1.000
Protection	No/Yes	45.2/54.8	70/30	8.350	0.004
Loco-regional analgesia details	Complete/No/Partial	22.97/74.17/2.85	20/75/5	0.735	0.693
Intravenous access details	Complete/No/Partial	99.251/0.599/0.15	100/0/0	0.302	0.860
Intraoperative drug details	Complete/No/Partial	93.56/0.15/6.29	90/0/10	0.912	0.634
Antibiotic details	Complete/No/Partial	94.461/4.79/0.749	97.5/2.5/0	0.761	0.684
Extubation time	No/Yes	54.5/45.5	63.6/36.4	0.727	0.394
NMB reversal details	Complete/No/Partial	55.97/42.95/1.09	47.37/52.63/0	1.660	0.435
Postoperative instructions	Complete/No/Partial	65/24.1/10.9	47.5/35/17.5	5.060	0.080
Postoperative recovery details	Complete/No/Partial	63.7/29.1/7.2	57.5/30/12.5	1.660	0.437
Extubation	No/Yes	43.8/56.2	65/35	6.020	0.014
Extubation site	No/Yes	34.7/65.3	42.5/57.5	0.696	0.404
Transfer details	No/Yes	63.9/36.1	77.5/22.5	2.500	0.114
Anaesthesiologist signature	No/Yes	80.1/19.9	95/5	4.530	0.033

ETT – Endotracheal tube size, NMB – Neuromuscular blockade, Descriptives presented are percentages. *P*<0.05 is statistically significant

Table S4: Association of Anaesthesiologist's grade with all outcome variables							
Response Variable	**Levels**	**First year**	**Second year**	**Third year**	**Faculty**	**Statistic**	***P***
Hospital ID	No/Yes	12.56/87.44	4.02/95.98	2.99/97.01	11.18/88.82	23.100	<0.001
Visit ID	No/Yes	34.9/65.1	29.3/70.7	22.8/77.2	64.5/35.5	71.200	<0.001
Surgery date	No/Yes	0/100	0.402/99.598	0/100	0/100	2.980	0.395
Age	No/Yes	27.3/72.7	49.4/50.6	35.9/64.1	25/75	40.500	<0.001
Name	No/Yes	0.474/99.526	2.41/97.59	0/100	3.289/96.711	11.400	0.010
Gender	No/Yes	2.84/97.16	2.81/97.19	1.2/98.8	7.89/92.11	12.700	0.005
Weight	No/Yes	15.2/84.8	27.7/72.3	32.3/67.7	40.1/59.9	46.000	<0.001
ASA grade	No/Yes	7.11/92.89	8.03/91.97	2.4/97.6	10.53/89.47	8.670	0.034
Allergy details	No/Yes	37.2/62.8	30.9/69.1	27.5/72.5	66.4/33.6	65.000	<0.001
Diagnosis details	Complete/ No/Partial	67.3/11.85/20.85	75.9/14.86/9.24	80.24/3.59/16.17	47.37/27.63/25	67.900	<0.001
Surgery details	Complete/ No/Partial	61.61/13.03/25.36	71.89/14.86/13.25	75.45/3.59/20.96	43.42/32.89/23.68	75.800	<0.001
Surgeon name	No/Yes	23/77	24.9/75.1	22.8/77.2	37.5/62.5	13.600	0.004
Anaesthesia faculty name	No/Yes	0.948/99.052	1.205/98.795	2.395/97.605	17.763/82.237	95.000	<0.001
Anaesthesia resident name	No/Yes	3.555/96.445	0.402/99.598	2.994/97.006	98.684/1.316	834.000	<0.001
Anaesthesia start time	No/Yes	0.711/99.289	0.402/99.598	0/100	0/100	2.280	0.516
Surgery start time	No/Yes	0/100	0.402/99.598	0/100	0.658/99.342	3.250	0.355
Anaesthesia close time	No/Yes	1.9/98.1	2.01/97.99	2.4/97.6	3.95/96.05	2.220	0.528
Surgery close time	No/Yes	4.03/95.97	2.81/97.19	6.59/93.41	5.92/94.08	4.320	0.229
Fluid intake	No/Yes	2.84/97.16	4.82/95.18	3.59/96.41	9.21/90.79	11.000	0.012
Urine output	No/Yes	22.5/77.5	19.7/80.3	24/76	44.7/55.3	36.300	<0.001
Blood group	No/Yes	8.06/91.94	10.04/89.96	16.17/83.83	37.5/62.5	83.600	<0.001
Blood loss	No/Yes	27.5/72.5	19.7/80.3	27.5/72.5	44.7/55.3	29.600	<0.001
Intubation time	No/Yes	1.429/98.571	0.813/99.187	1.807/98.193	0.671/99.329	1.330	0.721
Endotracheal tube size	No/Yes	1.909/98.091	0.813/99.187	1.818/98.182	1.342/98.658	1.360	0.714
Cormack Lehane grade	No/Yes	5.39/94.61	3.24/96.76	6.9/93.1	7.86/92.14	4.170	0.244
Length of ETT fixation	No/Yes	99.045/0.955	99.593/0.407	99.394/0.606	99.329/0.671	0.700	0.873
Intubation technique	No/Yes	6.44/93.56	8.54/91.46	8.48/91.52	17.57/82.43	16.700	0.001
Position details	No/Yes	3.08/96.92	3.21/96.79	3.59/96.41	3.29/96.71	0.102	0.992
Protection	No/Yes	43.1/56.9	51.4/48.6	50.9/49.1	86.2/13.8	84.300	<0.001
Loco-regional analgesia details	Complete/ No/Partial	19.29/77.38/3.33	31.33/66.67/2.01	17.37/78.44/4.19	6.58/93.42/0	45.800	<0.001
Intravenous access details	Complete/ No/Partial	97.393/1.896/0.711	98.795/1.205/0	98.802/1.198/0	96.711/3.289/0	6.800	0.340
Intraoperative drug details	Complete/ No/Partial	91.706/0/8.294	92.771/0.402/6.827	92.814/0/7.186	92.105/0.658/7.237	3.800	0.704
Antibiotic details	Complete/ No/Partial	89.81/6.635/3.555	95.181/4.016/0.803	97.006/2.395/0.599	92.105/5.263/2.632	13.600	0.035
Extubation time	No/Yes	47.9/52.1	58.1/41.9	61.1/38.9	80.7/19.3	47.100	<0.001
NMB Reversal details	Complete/ No/Partial	54.768/44.254/0.978	53.942/44.813/1.245	58.491/41.509/0	46.575/52.055/1.37	6.240	0.397
Postoperative instructions	Complete/ No/Partial	69.67/17.3/13.03	61.04/30.92/8.03	51.5/30.54/17.96	45.39/44.74/9.87	57.200	<0.001
Postoperative recovery details	Complete/ No/Partial	57.82/32.94/9.24	63.45/30.92/5.62	56.89/32.34/10.78	52.32/41.06/6.62	9.700	0.138
Extubation	No/Yes	47.8/52.2	47.4/52.6	51.5/48.5	51.3/48.7	1.220	0.747
Extubation site	No/Yes	39.3/60.7	39.7/60.3	41.3/58.7	40.7/59.3	0.247	0.970
Transfer details	No/Yes	68.7/31.3	65.5/34.5	71.3/28.7	80.8/19.2	11.300	0.010
Anaesthesiologist signature	No/Yes	80.09/19.91	86.35/13.65	85.63/14.37	94.04/5.96	17.700	0.001

ETT – Endotracheal tube size, NMB – Neuromuscular blockade, Descriptives presented as percentages. $P<0.05$ is statistically significant

Table S5: List of outcome variables found to be significantly associated with respective predictors after univariate tests

Phase	Case number	Procedure type	Anaesthesiologist grade
Hospital ID	Weight	Age	Hospital ID
Age	Allergy details	Weight	Visit ID
ASA grade	Diagnosis details	Allergy details	Age
Diagnosis details	Surgery details	Surgeon name	Name
Surgery details	Surgeon name	Anaesthesia faculty name	Gender
Surgeon name	Urine output	Intubation technique	Weight
Anaesthesia resident name	Blood group	Protection	ASA grade
Blood group	Blood loss	Extubation	Allergy details
Intubation technique	IV access	Signature of anaesthesiologist	Diagnosis details
Protection	Antibiotic details		Surgery details
Loco-regional analgesia details	Transfer details		Surgeon name
Intraoperative drug details			Anaesthesia faculty name
Antibiotic details			Anaesthesia resident name
Extubation time			Intubation technique
NMB Reversal details			Fluid intake
Postoperative instructions			Urine output
Postoperative recovery details			Blood group
Extubation			Blood loss
Extubation site			Protection
Transfer details			Loco-regional analgesia details
Anaesthesiologist signature			Antibiotic details
			Extubation time
			Postoperative instructions
			Transfer details
			Signature of anaesthesiologist