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Anaesthetic workload in the United Kingdom in 2016: The NAP6 Activity Survey

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Brief title: NAP6: activity survey

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Abstract (247 words)

Background. United Kingdom anaesthetic activity was studied in 2013 as part of the NAP5 project but the methodology did not enable examination of weekend working.

Methods. As part of the NAP6 project we surveyed 356 National Health Service hospitals to determine anaesthetic activity in October 2016.

Results. Responses were received from 342 (96%) hospitals, and an estimated 96% of cases were reported. An annual anaesthetic workload is ≈3.13 million cases. Approximately 95% of elective work, 72% of emergency work and 13% of all work is performed on weekdays. Senior anaesthetists lead ≈90% of cases, and those with <2 years anaesthetic experience lead <1%. During weekends the urgency of work increases, the proportion of healthy patients reduces and the case mix changes. Senior involvement, including higher risk cases at the weekend remains high but falls through Saturday (89%) and Sunday (65%). Obstetric anaesthesia care is evenly distributed and is associated with the lowest levels of senor anaesthetic involvement (69%), especially at weekends (45%). Senior involvement in emergency orthopaedic procedures is high during the week (93%) and at weekends (89%). We noted increases in the proportion of patients with obesity and elective weekend working compared to data from 2013. Depth of anaesthesia monitoring has increased but neuromuscular monitoring has not, suggesting that current guidelines are not implemented.

Conclusions. UK anaesthesia care remains predominantly senior clinician delivered, including at weekends. The findings in this report are of importance for any planned workforce reorganisation to meet the requirements of 7-day working.

Key Words: audit; anaesthesia; monitoring; technique; workforce

The Sixth National Audit Project of the Royal College of Anaesthetists (NAP6), is a prospective service evaluation across the National Health Service in the United Kingdom, aiming to provide quantitative and qualitative information about life-threatening perioperative anaphylaxis in the UK. A one-year registry collected a report of every suspected case in 2015-16[1,2].

In order to interpret the results of the registry created in this period, contemporary information about anaesthetic care provided in participating hospitals was required. The first component of the Activity Survey, described here, provides information on patient demographics, anaesthetic workload and anaesthetic technique. The second part of the Activity Survey, described in an accompanying paper[3], enables estimation of the incidence of perioperative anaphylaxis by providing a denominator for the annual number of cases involving anaesthetic care and individual drug use.

In 2013, the NAP5 project reported a similar activity survey[4] providing information on the number of cases involving anaesthetic care in operating theatres, intensive care units and emergency departments. Published Hospital Episode Statistics (HES)[5] show an increase in inpatient and day case procedures since 2013, but do not give detailed information on anaesthetists' involvement. NHS Maternity Statistics show a slight decrease in deliveries in NHS hospitals since 2013, of which 60% involved anaesthetic intervention[6]. Such changes over time mean that figures used for NAP5 may not necessarily be applicable for the 2016 data collection period.

The current survey, performed with similar methods to NAP5, enables identification of subsequent changes in anaesthetic practice, including any that might have occurred as a consequence of the recommendations made in the NAP5 report, such as increased used of depth of anaesthesia (DOA) monitoring and peripheral nerve stimulators[7,8].

There has been much recent debate about the 'weekend effect', the seniority of physicians administering care outside of routine hours and any consequent impact on patient care[9–12]. Information related to day of the week was not reported in the NAP5 activity survey. Reports recording NHS work patterns such as the 2003 'Who Operates When II'[13] are now out of date and there is the need for information on anaesthetic-specific workload.

This manuscript describes anaesthetic caseload and working practice, examines activity by day of the week and highlights any changes in the state of UK anaesthesia since the NAP5 survey in 2013[4].

Methods

The NAP6 project was defined as a service evaluation by the Health Regulatory Authority therefore did not require National Research Ethics Service approval.

Local co-ordinators (LCs) were approached at 356 NHS hospitals and organised data collection from every perioperative case involving the care of an anaesthetist. This included all adult and paediatric cases requiring general, regional and local

anaesthesia, as well as sedation if involving an anaesthetist. Obstetric cases, included epidural pain relief in labour.

Any cases where sedation or local anaesthesia was delivered by a non-anaesthetist were not included. Routine sedation in intensive care was excluded.

The majority of data collection took place between 13th and 31st October 2016, during which time there were no public holidays; seven sites collected data between January and June 2017 for logistical reasons. Data were recorded using a paper proforma (Appendix 1) and each form was transferred, using optical character recognition, to electronic storage. Each hospital was randomised to record activity on two consecutive days of the week, with specialist hospitals (cardiac, neurology or paediatric centres) block-randomised separately to prevent skewed allocation. Patient characteristics, method of anaesthesia, anaesthetic staffing, induction location, type of monitoring and drugs used, and the presence of any allergy history were reported for each case. Local co-ordinators were also asked to record a capture rate at their site to estimate the proportion of cases for which a completed case report form was submitted. Data regarding drug usage and allergy status are reported separately[3].

Data were analysed using SPSS (version 23). An annual caseload was estimated by multiplying the number of cases by a scaling factor. This factor was calculated by converting the number of cases from two days to one week (scaling factor of 3.5), and from one week to one year (scaling factor of 50.6, the effective number of working weeks in 2016 (Appendix 2). This was then divided by the hospital response

rate, the mean reported capture rate at individual sites and the proportion of interpretable forms, to account for cases that were not reported. Responses marked as 'unknown' and incomplete fields were combined and reported as 'unknown'. Ethnicity data was re-categorised to follow categories stipulated by the Office of National Statistics for comparison purposes.

Results

Data were returned from 342 hospitals, a return rate of 96%. Eleven sites had no cases to report during the data collection period. In total 15 942 case report forms were interpretable (263 forms from 18 sites were not interpretable), consequently the return rate of interpretable forms was 98%. A median of 39 forms were submitted per hospital. The mean capture rate per site reported by LCs was 96%. Therefore, the number of reported cases equates to an annual caseload of 15 942 x (3.5x50.60)/(0.96x0.96x0.98) = 3 126 067. The field most frequently left incomplete was 'NCEPOD priority' which was blank in 6% of cases; all other fields were completed in at least 97% of cases.

Patient Characteristics

Overall more patients were female (n=9 052; 58.7%). The male: female ratio varied with age (Fig. 1).

(Fig 1 near here)

The majority of cases were White Caucasian (n=13 926; 87.4%). Asian and Black/African/Caribbean patients accounted for 5.5% and 3.0% of cases respectively

with the remainder classified as Multiple/Mixed or 'Other'. There was a higher proportion of non-white Caucasian cases in the younger age groups (Supplemental Fig. 1). Approximately half of patients (n=7876; 49.4%) had a 'normal' body mass index (BMI) (18.5-24.9 $kg.m^{-2}$), 22.9% (n=3648) were overweight (BMI 25-39.9 $kg.m^{-2}$) and 20.2% (n=3224) obese (BMI 30-34.9 $kg.m^{-2}$) or morbidly obese (BMI >35 $kg.m^{-2}$). In the remaining cases the patient was underweight (2.9%) or the weight was unknown (4.6%). Significantly more patients (Chi^2 15.14, p=0.004) were morbidly obese compared to NAP5 data (Supplemental Table 1). In the paediatric population (age <16 yrs), 75.3% (n=1546) of patients had a 'normal' BMI, 5.9% (n=122) were overweight and 1.9% were obese or morbidly obese (n=40) (Supplemental Figure 2). Of obstetric cases 12.5% (n=165) were obese and 7.6% (100) morbidly obese.

(Figure 2 near here)

Orthopaedics/trauma (21.1%) and general surgery (16.2%) were the surgical specialties accounting for the largest proportion of activity, and obstetric anaesthesia accounted for 8.3% of the workload (Fig. 2). The most common procedures in men were orthopaedics (23.7%), general surgery (18.0%) and urology (16.4%), whilst in women 31.8% of cases were obstetrics and gynaecology, 19.4% orthopaedics and 14.9% general surgery.

(Figure 3 near here)

Of the 1317 obstetric cases, 875 were Caesarean Sections (Classification of urgency: Category 1, n=114 (13.0%); Category 2, n=302 (34.5%); Category 3, n=106 (12.1%); Category 4, n=325 (37.2%); unknown Category, n=28 (3.3%)).

The majority of patients were American Association of Anesthesiologists physical status (ASA) 1 or 2 (77.0%) with only 2.76% being ASA 4 or 5 (Table 1). Two thirds of the workload was elective (65.6%), of which 47.9% was classified as 'day case' (Table 1). Just over one quarter (27.5%) of cases were classified as emergency procedures and these patents had higher ASA statuses than elective cases (Table 1).

(Table 1 near here)

Timing of anaesthesia and staffing

Weekend working (case reported as commencing on a Saturday or Sunday) accounted for 12.4% of anaesthetic caseload. Monday and Thursday were the 'busiest' weekdays and Friday was the least busy. Sixty per cent of procedures on Sunday, and 43% on Saturday, were urgent or immediate (Fig. 3 and Supplementary Table 2). Of the elective workload, 5.4% occurred at weekends, compared to 1.7% in NAP5.

The proportion of ASA 4, 5 and 6 cases remained constant across the week whereas ASA 1-3 reduced at the weekends (Supplemental Fig.3).

Weekend workload was dominated by orthopaedic, general and obstetric surgery (Table 2) and, in obstetrics 30.5%, (i.e. approximately 2/7th) of the weekly workload took place at the weekend.

(Table 2 near here)

The majority of all cases (88.7%) were under the direct care of a consultant or career grade anaesthetist. On Saturday and Sunday, this proportion decreased to 80.5% and 65.9% respectively. Senior anaesthetic involvement was seen in overall obstetric care less frequently: consultant or career grade anaesthetists delivered 68.5% of direct care on weekdays and 45.3% at weekends (Fig. 4). Conversely a senior anaesthetist was involved in the direct care of 93.4% of emergency orthopaedic procedures on weekdays and 88.8% at weekends.

For Caesarean sections, 84.3% of Category 4 procedures were under the direct care of a senior anaesthetist, compared to 62.3% of Category 1 deliveries (Supplementary Fig. 3)

All cases involving a patient < 1 year old, and 94% of patients > 75 years-old, were led by a senior anaesthetist. Specialties with the largest proportion of trainee-led cases were obstetrics, neurosurgery, plastics and general surgery, although overall numbers were small for neurosurgery (Supplemental Table 3). No cardiac anaesthetic was delivered by a trainee alone.

Overall, the proportion of cases under the direct care of a senior anaesthetist increased as ASA grade increased (Fig. 5). Although the proportion of ASA 5 cases on

a Sunday under the direct care of a senior anaesthetist was low, only three ASA 5 cases were reported in total.

(Figure 5 near here)

The proportion of emergency cases under direct consultant care was smaller at weekends than during the week.

(Figure 6 near here)

The most senior anaesthetist was a core trainee in 180 (1.1%) cases. These cases were mostly in general surgery, obstetrics and gynaecology and included mainly patients of ASA grade 1 or 2 (Supplemental Fig 4 and Supplemental Table 4).

Anaesthetic Conduct

Over three-quarters (n=12 213; 76.6%) of cases were conducted with general anaesthesia (Supplemental Table 5), an annual estimated caseload of 2 394 847. Cases involving sedation accounted for 8.3% of cases (n=1317) and in 14.2% (n=2256) of cases the patient was awake. The proportion of cases involving sedation increased with age (Supplementary Fig 5) and the peak of awake cases in the age group 26-35 years was mainly attributable to Caesarean section under neuraxial anaesthesia (95.5% of awake cases). The use of local anaesthetics, delivered by any route, was reported in 74.2% (n=11831) of cases.

Location

In cases of all ages involving general anaesthesia, induction occurred in the anaesthetic room in 77.3%, in theatre in 18.8%, and less than one per cent of cases were managed in ICU or the emergency department (Supplemental Table 6). These figures show no significant changes since 2013.

For cases involving paediatric patients, induction occurred in an anaesthetic room in 77.2% compared to 77.9% in adults. The proportion of cases induced in the operating theatre was highest for obstetric (92.3%), thoracic (35.8%), dental (34.7%) and vascular cases (26.2%) (Supplemental Table 7). Induction in theatre was used in elective and emergency cases differently depending on the specialty of procedure being performed (Fig. 7).

(Figure 7 near here)

Depth of Anaesthesia (DOA) Monitoring

Depth of anaesthesia monitoring was used in 12.0% of general anaesthetic cases and more commonly in cases involving the use of non-depolarising neuromuscular blocking agents (NMBA) than those that did not (14.2% versus 10.1%). In cases where propofol was the main agent for maintenance of anaesthesia, DOA monitoring was used more frequently (31.5%) than when an inhalational agent was used (10.0%). DOA monitoring was used when TIVA was combined with a neuromuscular blocking agent in 39.7% (Fig. 8).

(Figure 8 near here)

DOA monitoring use was evenly distributed over all BMI categories (Supplemental Fig. 6) and was used most frequently in cardiac (42.9% of general anaesthetic cases) and thoracic cases (35.9% cases). In obstetrics, DOA monitoring was used in 7.7% of general anaesthetic cases (Fig. 9).

In paediatric cases, DOA monitoring was used less frequently than in adults (Supplemental Fig. 7). DOA monitoring was used most commonly in cases under the care of a consultant (12%) or a very junior anaesthetist (CT1s 21.1%) (Supplemental Fig 8).

(Figure 9 near here)

Neuromuscular Monitoring

Amongst general anaesthesia cases 45.3% (n=5 532) received a non-depolarising NMBA. Peripheral Nerve Stimulator (PNS) monitoring was used in 36.7% of these cases (n=2 032) and quantitative neuromuscular monitoring (QM) was used in 2.8% (n=159). Reversal agents were used in 64.6% of these cases (compared to 68% in the NAP5 survey) and, when sugammadex was used, 50.2% of cases included PNS monitoring. When no reversal agent was used, a high proportion of cases did not undergo any type of neuromuscular monitoring. This was most marked if the patient received pancuronium and vecuronium and the majority of these cases were cardiac (all cases involving pancuronium and 54.8% of cases involving vecuronium), or

neurosurgical (16.7% of cases involving vecuronium) (Table 3), many of whom may receive post-operative care on ICU.

(Table 3 near here)

PNS monitoring was used most commonly in the theatre environment but was also used in 11.5% of emergency department, 20.6% of radiology or cardiac catheter suite and 10.0% of ICU cases involving NMBA use. Trainee anaesthetists were more likely to use PNS monitoring than consultants or career grade anaesthetists (Fig. 10).

(Figure 10 near here)

Discussion

This survey represents the most recent, comprehensive snapshot of anaesthetic activity and drug use in the United Kingdom. By using similar methods to those used in the NAP5 project[4], it is possible to estimate changes in anaesthetic practice since 2013. NAP5 collected data in two-day epochs, rather on a single-day basis, and the current survey provides a more precise reflection of how the anaesthetic workforce is working throughout the week. We believe that this is the first detailed examination of the variability in anaesthetic workload over the days of the week and highlights the high proportion of cases under direct supervision of senior anaesthetists.

The 'weekend effect' describes putative variability in hospital mortality associated with the day of the week of hospital admission[10]. The topic is highly controversial with data being presented to support both sides of the argument. While mostly focussed on admissions via the emergency department the weekend effect has also been identified in some surgical populations.[14,15] The effect has in part been attributed to a lack of availability of senior staff at weekends leading to higher

mortality, particularly in complex patients[16]. These observations have driven plans for changing how hospitals are staffed over the week[17].

Our results show that elective workload is increasing at weekends with 5.8% of elective work being performed at weekends compared to 1.7% in 2013 during NAP5. In 2003 the NCEPOD WOW2 project reported that 4.3% of elective operations took place at the weekend[13]. Explanations for fluctuations in elective weekend workload could include 'waiting list' initiatives where extra elective operating lists are carried out at the weekend to fulfil increasing elective demands[18].

Our data enable comment on the impact of delivering a seven day working pattern for staffing in anaesthesia. If, the current total elective work were to be distributed evenly throughout the week so that roughly 14% occurred every day, elective workload on a Saturday would have to increase by 230% and on Sunday by 1 245%. Alternatively, if the current weekday workload were to be continued at the same daily level at weekends, just under 300 000 extra operations on Saturdays and 366 000 on Sundays would need to be funded and staffed each year.

This survey shows that weekend elective work was almost exclusively carried out by consultant or career grade anaesthetists (98.8%). Significant changes in the working practice of consultants would be needed to maintain such a high proportion of senior care for elective operations at the weekend should the number of cases increase. The seniority of anaesthetists involved in weekend elective care appears to have increased in the last 13 years, as the 2003 WOW2 report indicated that only 68% of weekend daytime elective care was delivered by senior anaesthetists.

In contrast, our results show that fewer emergency cases were under the direct care of a senior anaesthetist (68.1%) at weekends compared to weekdays (84.5%). Despite this, during both weekends and on weekdays, as ASA grade increased, the proportion of cases under the direct care of a senior anaesthetist increased, suggesting the most unwell patients are cared for by the most senior anaesthetists. This apparent paradox is explained in part by the high number of obstetric cases at

the weekend, which are often emergency procedures in healthy patients (low ASA grade), and are frequently trainee-led. Obstetrics stands out as a specialty with both a high weekend workload and a high proportion of cases where anaesthetic care is trainee led. This was also noted in the NAP5 activity survey. Since such a high proportion of obstetric emergency workload occurs out of hours, increasing senior anaesthetic cover for this cohort of emergency cases presents a significant challenge. Indeed, the 2013 joint OAA/AAGBI guideline[19] for obstetric anaesthetic services recognised the provision of a weekend, consultant led obstetric anaesthetic service as an aspiration for future workforce development.

The WOW2 project reported that the specialties accounting for majority of non-elective cases were general surgery, obstetrics and orthopaedics and this appears to have remained consistent in the intervening 13 years.

Changes in anaesthetic practice occurring between NAP5 and NAP6

Our results suggest that a higher proportion of patients undergoing surgical procedures are morbidly obese than in the NAP5 activity survey, reflecting the increasing prevalence of morbid obesity in the general population. An unexpected finding is that the adult surgical population overall appears to be slightly less obese than the general population (23% versus 27%[20]).

The use of DOA monitoring in cases where neuromuscular blockade is used has increased since NAP5 (12% versus 2.8%). One of the NAP5 recommendations was that the use of DOA monitoring should be used in cases involving NMB agents, particularly when TIVA is used. The AAGBI also updated their standards for monitoring of anaesthesia in 2015 to recommend the use of DOA monitoring for cases where TIVA or NMBA are used[21]. NICE guidance published in 2012[22] more broadly recommended DOA monitoring in high risk cases. DOA monitoring was most common in cardiac and thoracic cases, a group historically and in NAP5 identified as at higher than normal risk of accidental awareness during general anaesthesia (AAGA)[23] and where the consequences of excessive depth of anaesthesia are a

particular concern[24]. In obstetrics, despite being reported as a very high-risk specialty for AAGA in NAP5, use remained low (7.7% of GA cases).

Anaesthesia involving NMBAs has been associated with an increased risk of AAGA[25,26] and incomplete neuromuscular recovery can impair respiration and upper airway protection[27,28]. Residual blockade can be detected more than two hours after administration in a high proportion of patients[28,29] therefore routine use of PNS monitoring is necessary. In contrast to a reported increase in use of DOA monitoring, the use of peripheral nerve stimulators (PNS) has not increased since 2013 (36.7% NAP6 versus 38% NAP5). The NAP5 report recommended their use and the AAGBI minimum monitoring guideline stated that neuromuscular monitoring is mandatory in all patients receiving a NMBA[21]. The AAGBI guidance recommends quantitative monitoring due to the relative imprecision of qualitative monitoring. In this survey the rate of PNS monitoring was low, quantitative monitoring was used in fewer than 1 in 30 relevant cases, significant numbers of patients received NMBAs without reversal agents and monitoring of neuromuscular function was especially low when reversal was not given. While some patients (particularly those undergoing cardiac or neurosurgical procedures) may have been transferred to ICU still intubated it appears that that overall stewardship of NMBA monitoring falls well below current recommendations.

It is not clear why the use of PNS is so low, although this phenomenon has also been identified outside of the UK, with a Singaporean survey reporting that only 13% of anaesthetists routinely used PNS monitoring[30]. Possible reasons for low take-up of neuromuscular monitoring, include ignorance of recommendations, disagreement with the guidance or lack of equipment. There seems to have been little change in use of neuromuscular junction monitoring or use of reversal agents since NAP5.

Data validity

This survey suggests an annual caseload of 3 126 067 which is a 15% reduction compared to that reported in NAP5 (3 685 800). We are not aware of any comparable data against which to benchmark. Of note the NAP6 annual estimate of

Caesarean section caseload (171, 579) is within <2% of that reported in NHS maternity data (174, 720). [31] We attempted to control for limitations in data collection by incorporating an estimated capture rate per hospital, accounting for uninterpretable forms, and calculating a scaling factor to include bank holidays. The mean capture rate per hospital in NAP5 was slightly higher (98% in NAP5 versus 96% in NAP6) therefore a slightly larger scaling factor was used in this report.

Although the difference in caseload between NAP5 and NAP6 could be due to a reduced capture rate, it might also be due in part to differences in monthly operating (October in NAP6 versus September in NAP5) or random variation in the numbers of cases reported in certain hospitals due to sampling on different days of the week. A recent NHS Key Statistics paper[18] showed that a higher proportion of operations were cancelled in 2016 (1.06%) compared to 2013 (0.90%) which may have contributed to a decrease in the total number of cases.

The many proportional similarities between the NAP5 and NAP6 datasets, such as the distribution of patient age, gender ratio and operating specialty suggests that a similarly representative set of cases has been collected.

Conclusion

This repeated national survey of anaesthetic practice in the United Kingdom enables confirmation of important nationwide findings and gives detailed evidence for modelling the impact of any 'seven day working' policies on anaesthetic workload, staffing and funding. It shows that the proportion of cases under direct senior care is high and appears to be increasing over time. In addition, changes in patient characteristics, such as morbid obesity, are likely to influence demands on heath service resources. Since NAP5 there have been significant increases of DOA monitoring, but monitoring of neuromuscular function remains non-compliant with current guidelines.

Declaration of interest

TMC: is an associate editor of the British Journal of Anaesthesia. He is not aware of any financial conflicts.

HK, SM, LF, MB, WE, SF, KF, KF, TG, JH, SK, K-LK, NM, SN, NL, MT, HT, AW and NH all declare they have no conflicts of interest.

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Authors' contributions and authorship

HK – Contributed to design and methodology or the study. Analysed results. Wrote all drafts of the paper and the final draft.

SM - Contributed to design and methodology or the study. Analysed results. Reviewed and revised early drafts of the paper and the final draft.

TC - Contributed to design and methodology or the study. Analysed results. Reviewed and revised early drafts of the paper and the final draft.

NH - Contributed to design and methodology or the study. Analysed results. Reviewed and revised early drafts of the paper and the final draft.

LF - Contributed to design and methodology or the study. Administered study. Took part in review of draft manuscript leading to finalisation.

All other panel members contributed to the design and methodology of the study, reviewed the results and took part in review of draft manuscript leading to finalisation.

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Table 1. Distribution of cases by American Society of Anaesthetists (ASA) grade and National Confidential Enquiry into Patient Outcome and Death (NCEPOD) classification for urgency of surgery.

ASA	NCEPOD Classification					Total (%)
	Elective	Expedited	Immediate	Urgent	Unknown	
1	3723	394	132	1063	496	5808 (36.43)
2	4690	420	78	859	425	6472 (40.60)
3	1741	347	52	646	114	2900 (18.19)
4	84	61	61	196	16	418 (2.62)
5	1		18	3	1	23 (0.14)
6	0	1	0	2	0	3 (0.02)
Unknown	214	25	3	31	45	318 (1.99)
Total (%)	**10453 (65.6)**	**1248 (7.7)**	**344 (2.2)**	**2800 (17.6)**	**1097 (6.9)**	**15942**

Table 2. Proportions of each specialties workload performed at weekends and proportion of overall weekend workload attributable to each specialty. *includes pain, psychiatry and 'other' major or minor operations

Specialty	% of specialty workload that occur at weekend	% of weekend workload attributable to specialty
Orthopaedics/Trauma	13.65	23.37
Obstetrics	30.52	20.43
General surgery	13.09	17.17
Urology	10.71	7.98
Gynaecology	5.48	4.52
Ophthalmology	8.97	4.27
ENT	5.08	3.2
Plastics	11.71	3.1
Neurosurgery	15.3	2.08
Maxillofacial	10.89	1.98
Dental	5.59	1.58
Radiology	15.3	1.42
Vascular	9.96	1.42
Gastroenterology	8.0	0.91
Cardiac surgery	11.27	0.81
Cardiology	8.59	0.56
Other*	13.67	5.18

Table 3. Use of peripheral nerve stimulator or quantitative monitoring in cases in which a non-depolarising neuromuscular blocking agent was administered. NMBA=neuromuscular blocking agent; PNS=peripheral nerve stimulator; QM=quantitative monitoring

Agent	Total number of cases	PNS used, n (%)	QM used, n (%)	No reversal agent used, n (%)	Proportion of cases with NMBA, but no reversal agent and no neuromuscular monitoring (%)
Atracurium	2828	963 (34.1)	67 (2.4)	722 (25.5)	79.2
Cisatracurium	95	38 (40.0)	0 (0.0)	32 (33.7)	59.4
Mivacurium	157	25 (15.9)	0 (0.0)	128 (81.5)	88.3
Rocuronium	2341	991 (42.3)	86(3.6)	445 (19.0)	75.1
Vecuronium	124	32 (25.8)	7 (5.7)	46 (37.1)	91.3
Pancuronium	36	0 (0.0)	0 (0.0)	32 (88.9)	100.0
Sugammadex	327	164 (50.2)	17 (5.2)	-	-

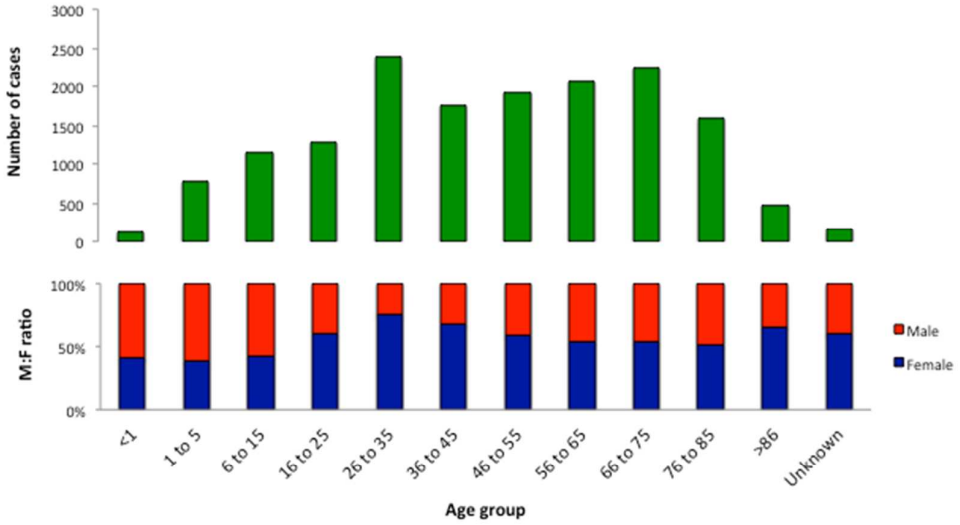

Fig 1. Age distribution of cases. Top chart shows all cases, bottom chart shows male: female ratio for each age group

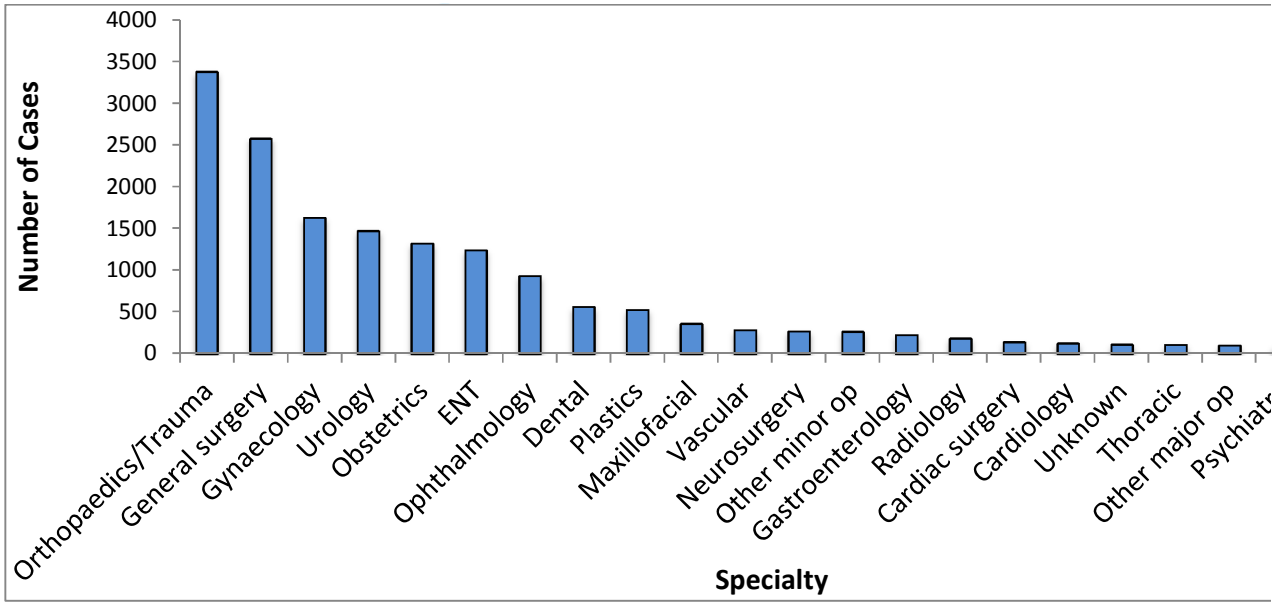

Fig 2. Number of cases by specialty of main procedure.

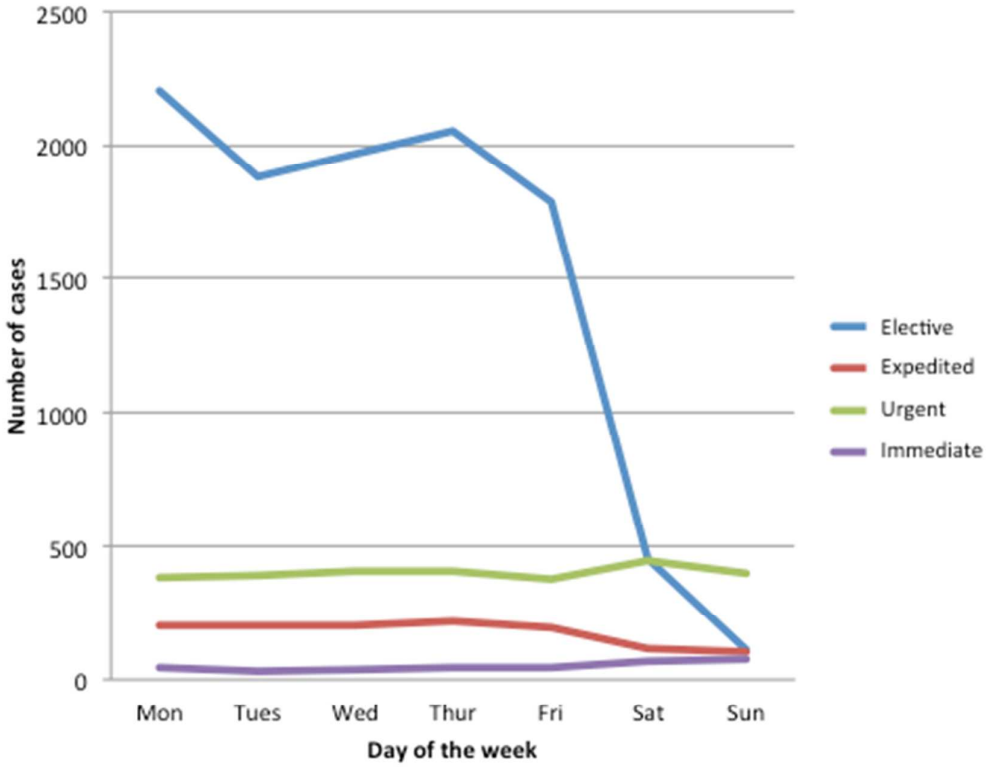

Fig 3. NCEPOD Classification of urgency of procedures performed by day of the week

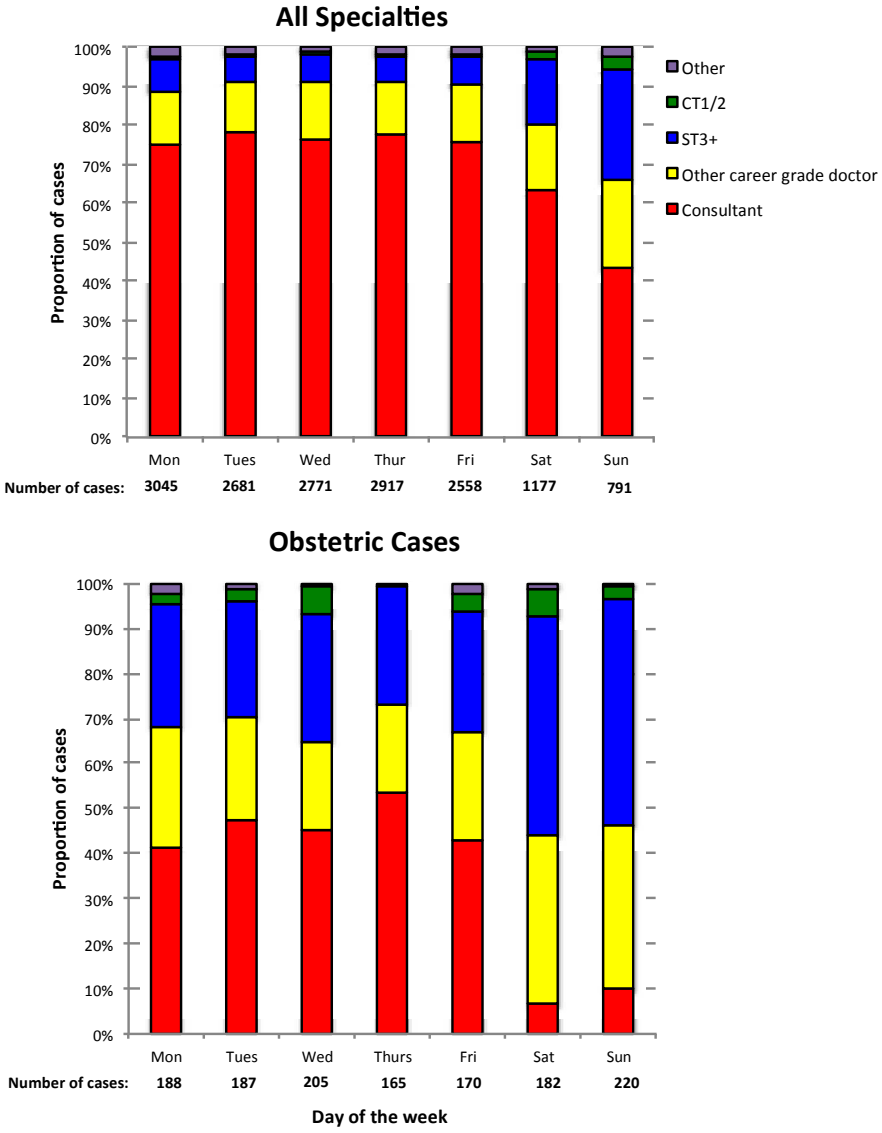

Fig 4. Seniority of anaesthetist by day of the week for a) all specialties and b) obstetrics

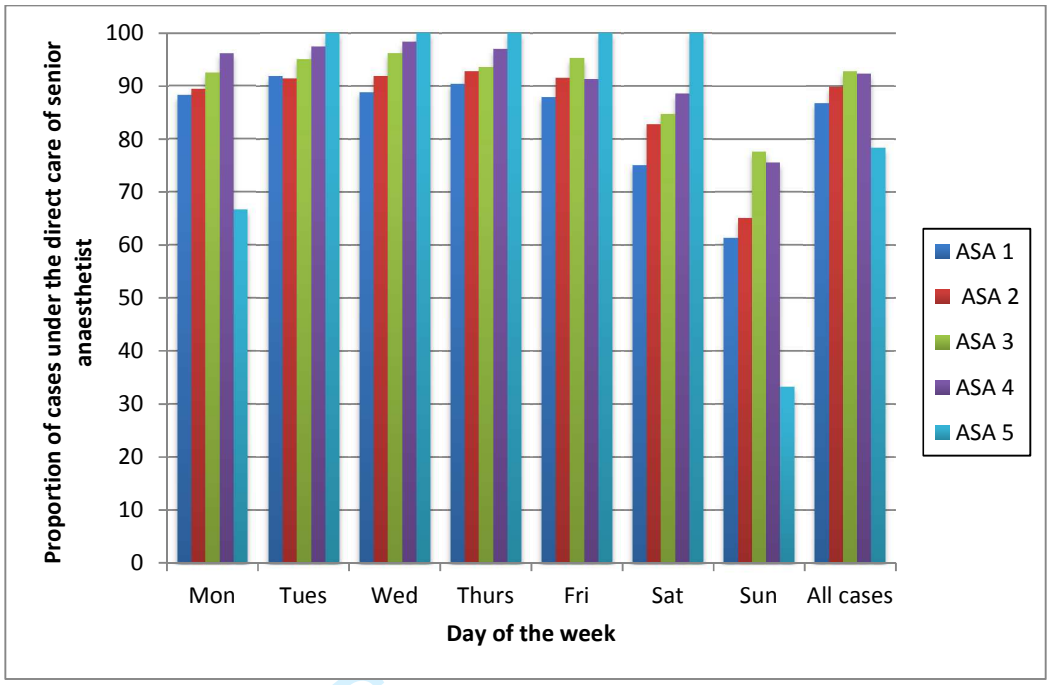

Fig 5. Proportion of cases by ASA grade under the direct care of a senior anaesthetist (consultant or career grade) for each day of the week *total number of ASA 5 cases = 23

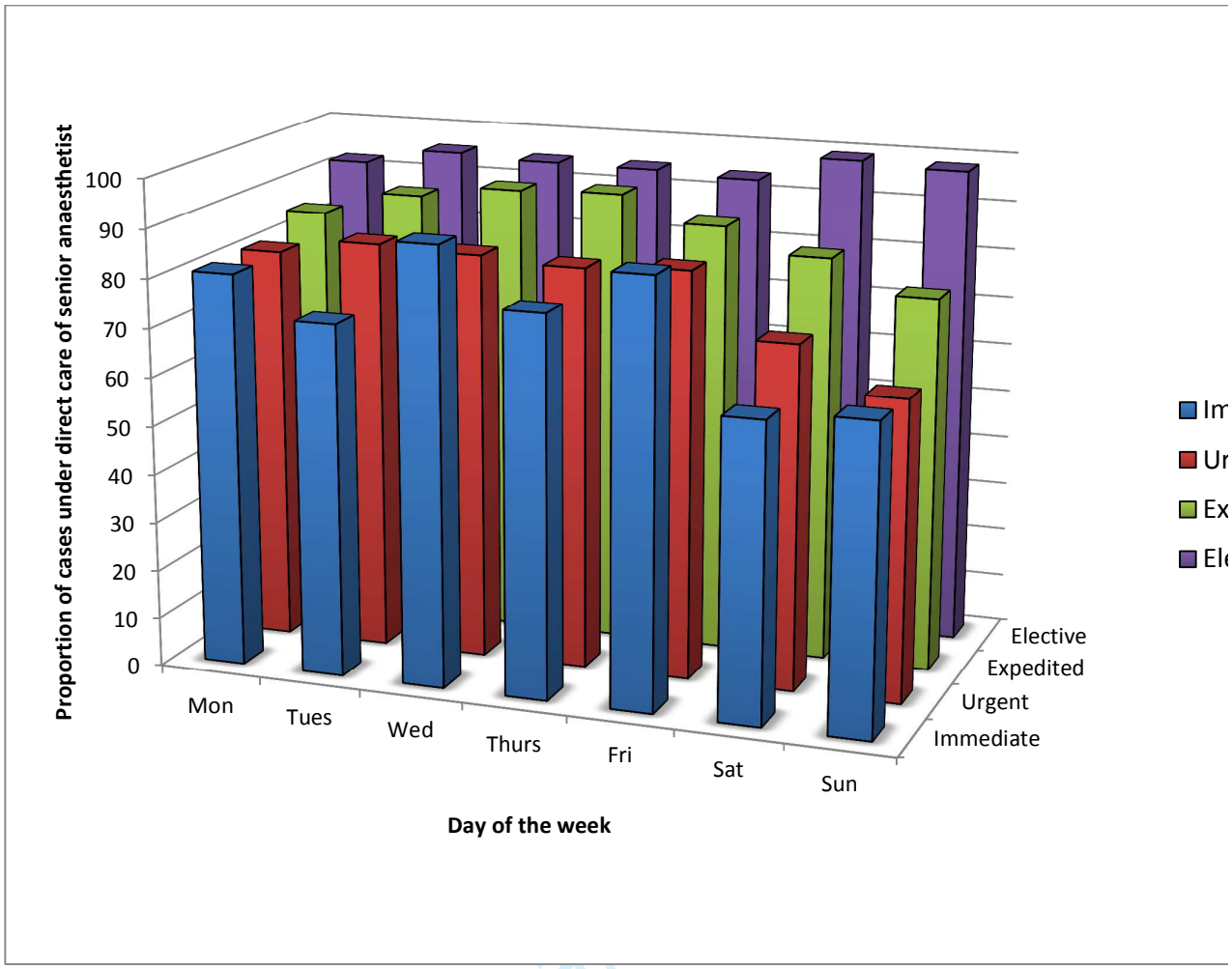

Fig 6. Proportion of cases by NCEPOD category under the direct care of a senior anaesthetist (consultant or career grade) for each day of the week

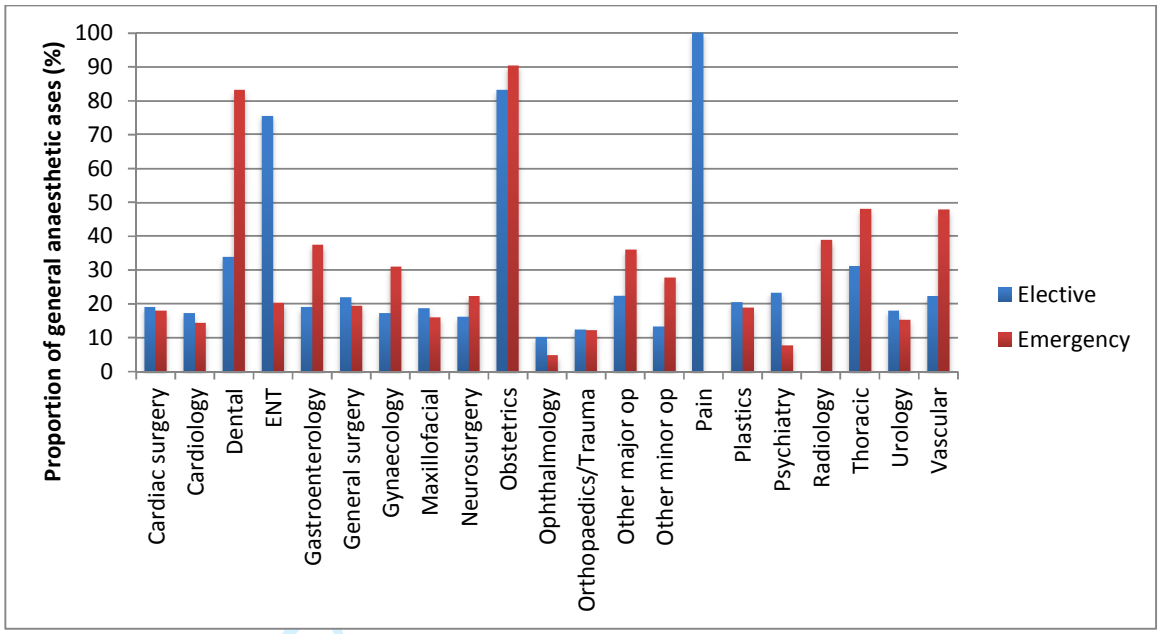

Fig 7. Proportion of elective and emergency cases general anaesthetic cases when induction occurred in theatre by specialty

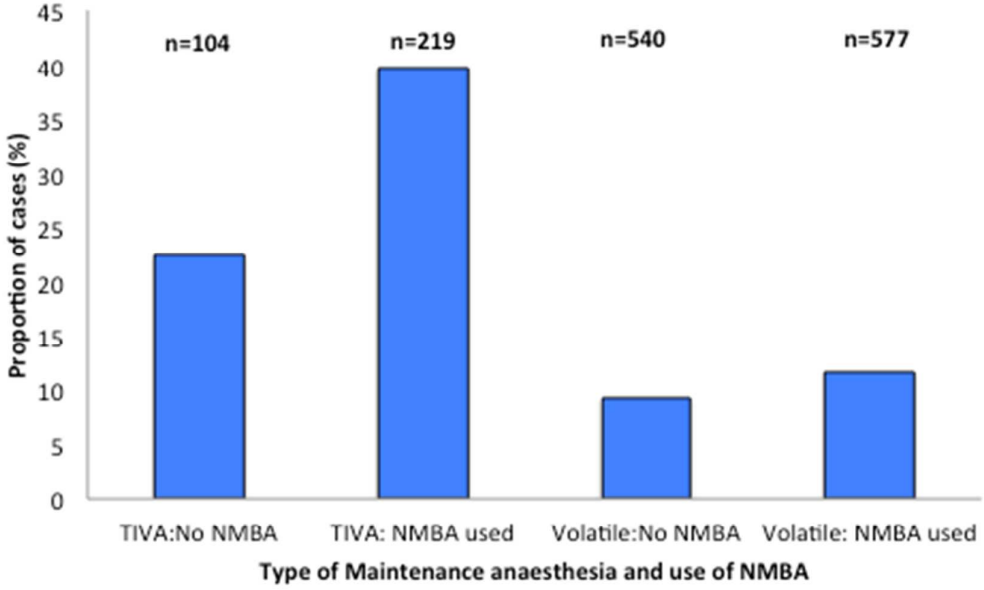

Fig 8. Proportion of cases where depth of anaesthesia monitoring was used, with different anaesthetic techniques.

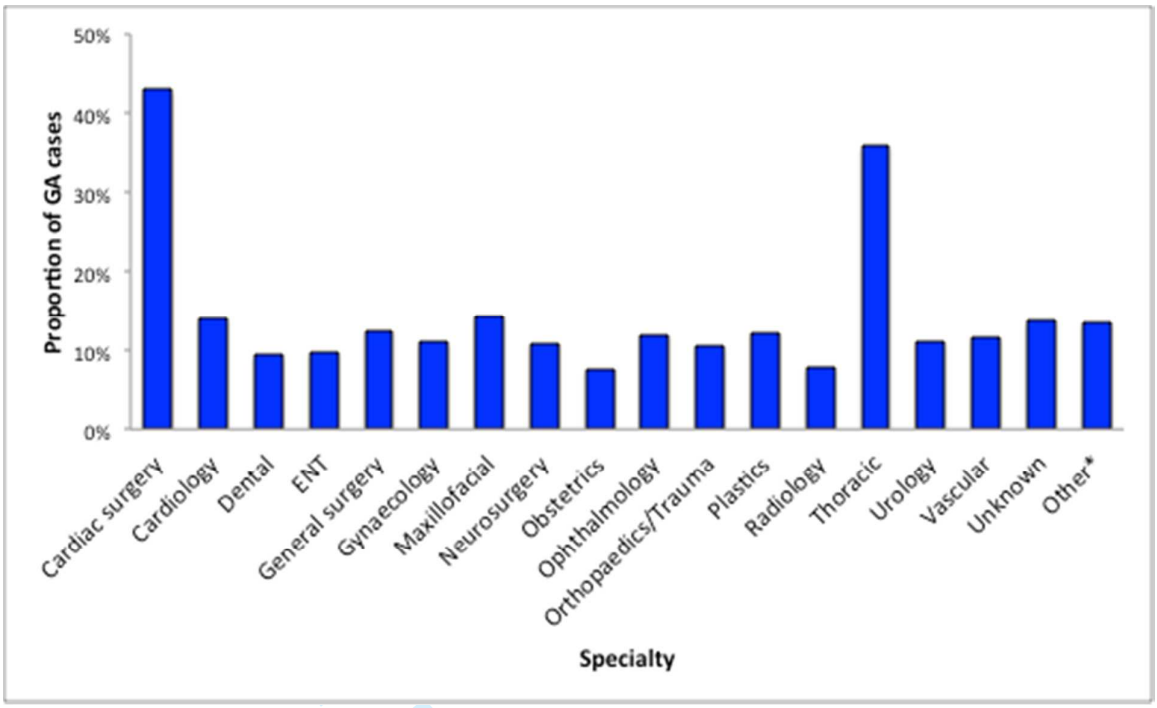

Fig 9. Proportion of general anaesthesia cases where depth of anaesthesia monitoring was used by specialty *includes pain, psychiatry or 'other' major or minor procedure

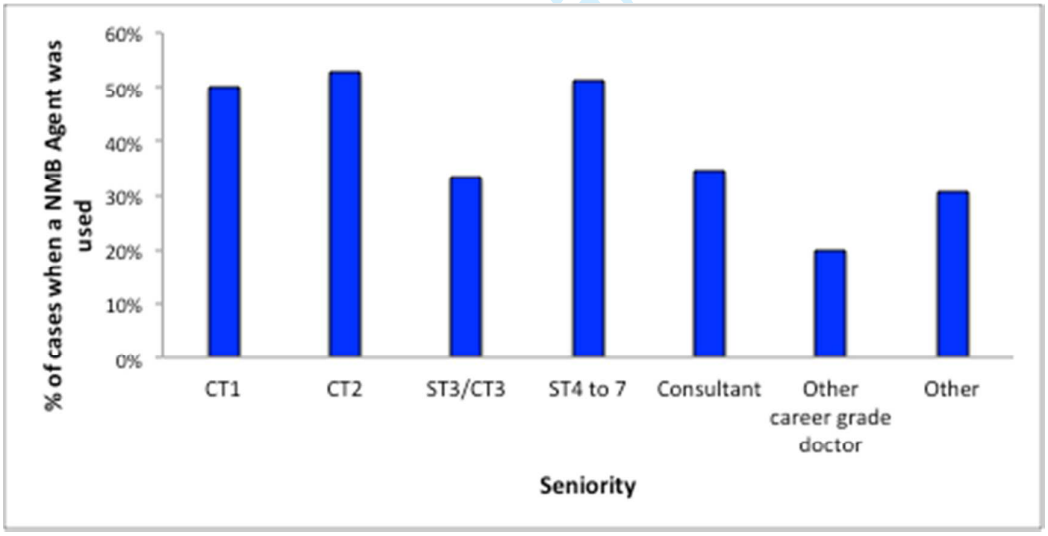

Fig 10. Proportion of cases involving neuromuscular blockade where a peripheral nerve stimulator monitoring was used, by seniority of anaesthetist

Appendix 1. Survey questionnaire

NAP6 Anaesthetic Activity/Allergen Exposure Survey

NAP6 Hospital Code: ☐☐☐ Date: d d / m m / y y

PLEASE INDICATE ALL SPECIFIED DRUGS/SUBSTANCES THE PATIENT WAS EXPOSED TO DURING THE PERIOPERATIVE PERIOD (until patient discharged to the ward or HDU/ICU) *PLEASE SELECT ALL BOXES THAT APPLY IN EACH CATEGORY*

Theatre Number/Location: _____ **Actual List Order** (first patient is 01): ☐☐

Please complete this form for all patients where anaesthesia care is provided by an Anaesthetist during the two day survey period

Day of the Week
☐ Mon ☐ Tues ☐ Wed ☐ Thurs ☐ Fri ☐ Sat ☐ Sun

Admission Type
☐ Elective Day Case
☐ Elective Inpatient
☐ Emergency
☐ Other
☐ Unknown

Main Procedure
☐ Cardiac surgery
☐ Cardiology
☐ Dental
☐ Maxillo-facial
☐ ENT
☐ Gastroenterology
☐ General surgery
☐ Gynaecology
☐ Neurosurgery
☐ Obstetrics
☐ Ophthalmology
☐ Orthopaedics/Trauma
☐ Pain
☐ Plastics
☐ Psychiatry
☐ Radiology
☐ Thoracic
☐ Urology
☐ Vascular
☐ Other minor op
☐ Other major op

Either
NCEPOD Priority
☐ Immediate ☐ Urgent ☐ Expedited ☐ Elective ☐ Unknown

Or
Caesarean Category
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ Unknown

Age of Patient (yrs)
☐ <1 ☐ 1-5 ☐ 6-15 ☐ 16-25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ 56-65 ☐ 66-75 ☐ 76-85 ☐ >86 ☐ Unknown

Sex of Patient
☐ Male ☐ Female ☐ Unknown

ASA Grade
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ Unknown

Body Habitus (BMI)
☐ Underweight (<18.5)
☐ Healthy weight (18.5-24.9)
☐ Overweight (25-29.9)
☐ Obese 1 (30-34.9)
☐ Obese 2 (35-39.9)
☐ Obese 3 (>40)
☐ Unknown

Ethnicity
☐ British (White)
☐ Irish (White)
☐ Any other White Background
☐ White and Black Caribbean (Mixed)
☐ White and Black African (Mixed)
☐ White and Asian (Mixed)
☐ Any other Mixed Background
☐ Indian (Asian or Asian British)
☐ Pakistani (Asian or Asian British)
☐ Bangladeshi (Asian or Asian British)
☐ Any Other Asian Background
☐ Caribbean (Black or Black British)
☐ African (Black or Black British)
☐ Any other Black Background
☐ Chinese (Other Ethnic Group)
☐ Any Other Ethnic Group
☐ Not Known

Premed Given on the Ward
☐ Yes ☐ No ☐ Unknown

Induction Location
☐ Theatre anaesthetic room
☐ Theatre
☐ Radiology or Cath-lab
☐ ICU
☐ Emergency Department
☐ Other
☐ Unknown

Intended Conscious Level
☐ General anaesthesia
☐ Deep sedation
☐ Moderate sedation
☐ Minimal sedation
☐ Managed anaesthesia care

Was Your Choice of Drugs Influenced By Previous Allergy History?
☐ No ☐ Yes - antibiotic ☐ Yes - other ☐ Unknown

Latex Exposure During This Case
☐ Yes (gloves)
☐ Yes (other latex)
☐ Latex-free environment
☐ Unknown

Povidone Iodine Exposure During This Case
☐ Skin prep (anaesthetist)
☐ Skin prep (surgeon)
☐ Surgical irrigation
☐ Other
☐ None
☐ Unknown

Chlorhexidine Exposure During This Case
☐ Coated/impregnated CVC
☐ Urethral
☐ Skin prep (anaesthetist)
☐ Skin prep (surgeon)
☐ Surgical irrigation
☐ Other
☐ None
☐ Unknown

Induction Agents
☐ Propofol
☐ Thiopental
☐ Etomidate
☐ Midazolam
☐ Ketamine
☐ Sevoflurane
☐ Other volatile agent
☐ Not applicable
☐ Other
☐ Unknown

Maintenance Agents
☐ Volatile agent
☐ Nitrous oxide
☐ Propofol infusion (not TCI)
☐ Propofol infusion (TCI)
☐ Intermittent bolus Propofol
☐ Other
☐ Unknown

Analgesics (any route)
☐ None
☐ Paracetamol
☐ Morphine
☐ Diamorphine
☐ Fentanyl
☐ Alfentanil
☐ Remifentanil bolus(es)
☐ Remifentanil infusion
☐ Codeine
☐ Dihydrocodeine
☐ Oxycodone
☐ Methadone
☐ Tramadol
☐ Parecoxib
☐ Ketorolac
☐ Diclofenac
☐ Clonidine
☐ Unknown

Neuromuscular Blockers
☐ None
☐ Suxamethonium
☐ Atracurium
☐ Cisatracurium
☐ Mivacurium
☐ Rocuronium
☐ Vecuronium
☐ Pancuronium
☐ Unknown

Reversal Drugs
☐ None
☐ Neostigmine
☐ Sugammadex
☐ Unknown

Local Anaesthetics (any route)
☐ None
☐ Lidocaine
☐ Bupivacaine
☐ Levobupivacaine
☐ Ropivacaine
☐ Prilocaine
☐ Other
☐ Unknown

Antibiotics
☐ None
☐ Co-amoxiclav
☐ Flucloxacillin
☐ Other penicillin
☐ Teicoplanin
☐ Gentamicin
☐ Vancomycin
☐ Cefuroxime
☐ Ceftriaxone
☐ Other Cephalosporin
☐ Other
☐ Unknown

IV Colloids/Blood Products
☐ Gelatin or gelatin-containing
☐ Starch or starch-containing
☐ Albumin
☐ Red cells
☐ Platelets
☐ Fresh Frozen Plasma
☐ Specific coagulation factors
☐ Other
☐ Unknown

Anti-Emetics
☐ None
☐ Ondansetron
☐ Dexamethasone
☐ Cyclizine
☐ Metoclopramide
☐ Droperidol
☐ Other

Coagulation Drugs
☐ Heparin (any)
☐ Tranexamic acid
☐ Aprotinin
☐ Protamine
☐ Other

Miscellaneous Exposure
☐ Patent blue dye
☐ Methylene blue dye
☐ X-Ray contrast

Monitoring
☐ Depth of Anaesthesia
☐ Peripheral nerve stimulator
☐ Quantitative neuromuscular monitoring
☐ Cardiac output

Most Senior Anaesthetist Present
☐ Consultant
☐ Other career grade doctor
☐ ST4-7
☐ ST3/CT3
☐ CT2
☐ CT1
☐ Other (e.g. research fellow)
☐ Unknown

Appendix 1

Scaling factor workings

Number of weeks in the year

The week caseload may not be multiplied by 52 to estimate a year caseload because several weeks have Bank Holidays. Assuming that the activity on a Bank Holiday is similar to a weekend day, the 'effective' number of weeks can be calculated. For 2016, the number of weeks used as a scaling factor to estimate annual activity was 50.60, as per the workings below.

There were 366 days in 2016, and 52.29 weeks (366/7 = 52.29).

Using the number of weekdays, a scaling a factor x, and y as the number of 'effective' weeks in 2016:

5/7 * x = 52.29 and 253/366 * x = y

Therefore x = 7*52.29/5 = y*366/253

And y = (7*52.29*253) / (5 * 366) = 50.60

Calculations to account for cases not reported

Return rate

LCs were asked to estimate their site's return rate. The median return rate was 0.96.

Forms scanned rate

Out of 16,205 forms returned, 326 could not be scanned, giving a form scanned rate of 0.98.

Site return rate

Forms were received from 342 out of 356 sites, giving a site return rate of 0.96.

Scaling factor to annualise number of cases

Scaling factor = (3.5 * 50.60) / (0.96 * 0.98 * 0.96) = **196.09**

Estimated annual caseload = number of scanned forms * scaling factor = **3,126,067**