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ORTHOPAEDICS
Research Article

Optimising Theatre Utilization: Assessing Theatre Staff Orthopaedic Surgical Time Estimate Accuracy

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Abstract

Background: Efficient use of theatre time can reduce the cost of health care in hospitals. The accuracy of different members of the theatre team at estimating the surgical time has not been well documented and may aid in more efficient use when planning theatre time. This study aims to identify the most accurate team members to estimate orthopaedic surgical time.

Methods: Prospective data was collected for orthopaedic trauma and elective cases. Prior to each operating list a senior member of each team, anaesthetics, orthopaedics and scrub/scout nursing was asked to make blinded estimates of the surgical time for each of the cases after being provided with information regarding each case. The absolute difference between the actual surgical times and estimated times was calculated.

Results: When expressed as percentage difference from the actual surgical time, the orthopaedic team was the most accurate at estimating overall with an average absolute difference of 33.0%, followed by nursing with 40.5% and finally anaesthetics were the least accurate with 50.9%. The orthopaedic team also had the most estimations within the limits of 20% underestimating and 10% overestimating deemed as clinically significant, nursing were again next best followed by the anaesthetics team.

Conclusions: The orthopaedic team was the most accurate at estimating surgical time. These estimates should continue to be used in some capacity for theatre planning and aid in computer algorithms used for theatre scheduling.

Keywords: *Surgical time; Theatre time; Orthopaedic; Estimation; Health resources*

Introduction

The efficient use of hospital theatre time is important for members of the community to have their operations performed in a timely manner, reducing cancellations and the monetary cost wasted in under-utilised theatre time [1]. The Australian Institute of Health and Welfare reported a 4.2% increase in elective case admissions during the period of 2013-2014 [2]. These increases cite the need for more efficient use of hospital resources, particularly in the operating theatre environment with an emphasis on improved surgical scheduling [3]. Whilst theatre booking programs have been utilised in an attempt to improve this, these have been shown to be less accurate than surgeon estimations, and are more irrelevant when considering emergency surgery [4-6]. Orthopaedic trauma theatres have been shown to be potentially inefficient in the utilization of theatre time [7]. Given that accurate surgical time estimations are essential for the accurate booking and utilization of available theatre time, reliance on surgeons' estimates alone may prove to be inaccurate. We undertook a prospective observational study to analyse the surgical time estimations of Orthopaedic surgeons, Orthopaedic registrars, Anaesthetists, Anaesthetic registrars and experienced theatre nursing staff in an effort to determine the accuracy of surgical time predictions between the groups of theatre staff.

Methods

We conducted a prospective observational study from November 2014 to February 2015 recording surgical time predictions and actual times in Orthopaedic trauma and elective lists. The study was undertaken at a referral base hospital in regional NSW with 265 acute care beds and a catchment of approximately 300,000. The elective Orthopaedic surgical scope covered a range of subspecialties including hip, knee, foot/ankle, arthroplasty, hand/microsurgery, shoulder/elbow, paediatrics and spine. Most Orthopaedic trauma was undertaken with the exceptions of pelvic and spinal trauma. There are 8 Orthopaedic surgeons servicing the hospital. Prior to the list commencing each member of the theatre team was provided with a description of the booked procedure from the surgical team and asked to record an estimation of surgical time for each case on a printed pro forma. Surgical time was defined as the time from commencement of skin preparation with antiseptic until completion of application of the final dressings or plaster if required. The set up time for cases was not included as it was felt that the set up time would be fairly constant, similarly for transport and transfer of patients.

The most senior member from each component of the surgical team including scrub/scout nursing, anaesthetics and orthopaedic surgical team were surveyed for their time estimations for all cases. Each member was surveyed independently with responses being written and were asked not to discuss their estimates with other team members.The actual start and stop times were recorded by the scout nurse at the instruction of the orthopaedic surgical team at the commencement of preparation and on dressing application. Nursing and anaesthetic staff were permitted to ask any questions from the surgical team regarding the operation including intended procedure, potential for conversion to a difference procedure, likely proceduralist and assistant and anticipated difficultly level of the procedure – as would be performed normally when booking theatre cases. On the occasions that a spinal or epidural anaesthetic was utilised, an estimation of spinal anaesthetic time was also recorded for each team members with the same definition for anaesthetic spinal time defined as from application of preparation to dressing application.

Procedures which did not require a sterile environment and skin preparation for example closed reduction and plastering were excluded from the study.

Data recorded on the pro forma data sheets included: proposed procedure, surgical time estimate (in minutes), elective vs trauma surgery, primary proceduralist, seniority (if surgical or anaesthetic staff) and group (surgery/anaesthetic/nursing) of the person estimating.

Statistical methods

Data was analysed using SPSS statistical software. Mean estimation time differences from the actual surgical time for each of the three groups were collected. Differences were expressed as a percentage difference from the actual time.

Estimations were considered acceptable if they were between 20 percent under - 10 percent over the actual surgical time, as this was deemed representative of a clinically acceptable margin of error for theatre planning. It would be preferable for slight overestimation of surgical time to occur rather than underestimation. Elective and emergency surgery estimations were analysed separately and as pooled data. An analysis of variance between the groups was used to analyse the data as well as Chi Squared tests.

Results

We obtained 990 surgical time data entries, including 329 from scrub/scout nursing, 317 from the anaesthetics team and 344 from the orthopaedic surgical team. Differences in data numbers is from incomplete data entry by participants. For spinal anaesthesia 116 time data entries were obtained, 34 from nursing, 43 from the anaesthetics team and 39 from the orthopaedic surgical team. The results are summarised in table 1.

	Orthopaedic surgical team mean difference from actual time	Nursing mean difference from actual time	Anaesthetics team mean difference from actual time	One way analysis of variance	Orthopaedic team within 20% under/10% over actual time	Nursing within 20% under/10% over actual time	Anaesthetics team within 20% under/10% over actual time	Chi squared for 20/10% differences from actual time
All Surgery	33.0% (SD 49.4)	40.5% (SD 58.4)	53.9% (SD 99.4)	P=0.001	35.8%	28.9%	22.3%	P=0.001
Elective Surgery	33.1% (SD 61.8)	43.6% (SD 76.8)	58.6% (SD 125.4)	P=0.066	39.3%	29.3%	20.2%	P=0.002
Emergency Surgery	32.9% (SD 38.0)	38.3% (SD 39.7)	50.5% (SD 75.2)	P=0.005	32.7%	28.6%	25.1%	P=0.267

Table 1:

All surgery

For all surgery combined as a pooled group, the mean deviation of the estimate from the actual surgical time for each group (as a percentage of actual time) was 40.5% (Stddev: 58.4) for nursing, 53.9% (Stddev: 99.4) for the anaesthetics team and 33.0% (Stddev: 49.4) for the orthopaedic surgical team (Figure 1). These differences being statistically significant, using the one way analysis of variance (p = 0.001).

For all surgery combined nursing had 95 of 329 (28.9%), the anaesthetics team 70 of 314 (22.3%) and the orthopaedic surgical team 123 of 344 (35.8%) estimations within the acceptable limits (20% under – 10% over the actual time). These differences between groups were statistically significant (Chi Squared p = 0.001).

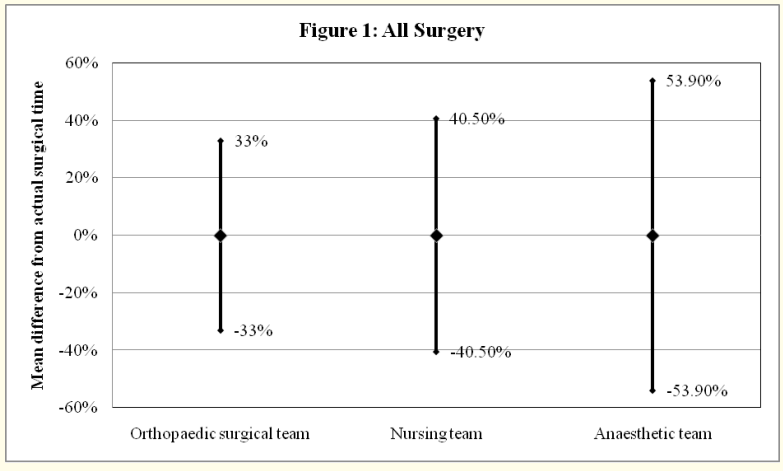

Figure 1: *All Surgery.*

Elective Surgery

When elective surgery was analysed separately, the mean deviation from the actual surgical time for each group (as a percentage of the actual surgical time) was 43.6% (Stddev: 76.8) for nursing, 58.6% (Stddev: 125.4) for the anaesthetics team and 33.1% (Stddev: 61.8) for the orthopaedic surgical team (Figure 2). The differences between these groups were not statistically significant, although did show a trend towards significance using the one way analysis of variance(p = 0.066). The difference between the anaesthetics team and orthopaedic surgical team of 25.5% (Stddev: 11.7) was statistically significant when analysed in isolation (p=0.03). For elective surgery,

nursing had 41 of 140 (29.3%), the anaesthetics team 27 of 134 (20.2%) and the orthopaedic surgical team 57 of 145 (39.3%) estimations within the acceptable limit. These differences were statistically significant using the Chi Square test (p = 0.002).

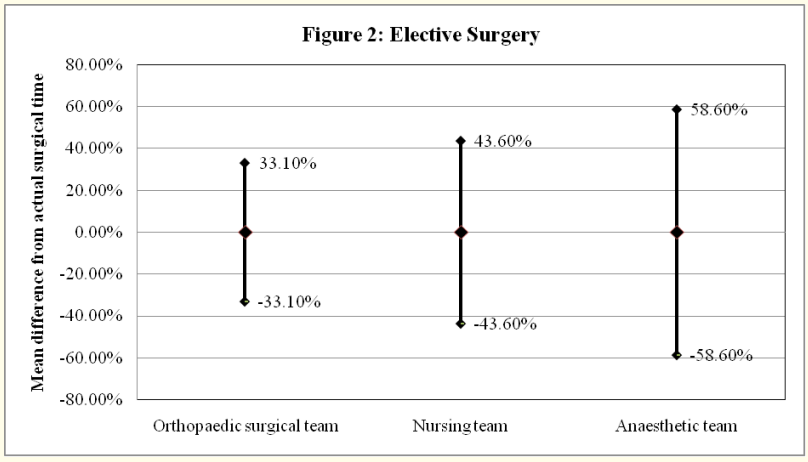

Figure 2: *Elective Surgery.*

Emergency Surgery

For emergency surgery analysed separately the mean deviation from the actual surgical time for each group (as a percentage of the actual surgical time) was 38.3% (Stddev: 39.7) for nursing, 50.5% (Stddev: 75.2) for the anaesthetics team and 32.9% (Stddev: 38.0) for the orthopaedic surgical team (Figure 3). The difference between group means was statistically significant using the one way analysis of variance (p = 0.005). For emergency surgery, nursing had 54 of 189 (28.6%), anaesthetists 46 of 183 (25.1%) and surgeons 65 of 199 (32.7%) estimations within the acceptable limits. The differences between the groups was not statistically significant (Chi Square p = 0.267).

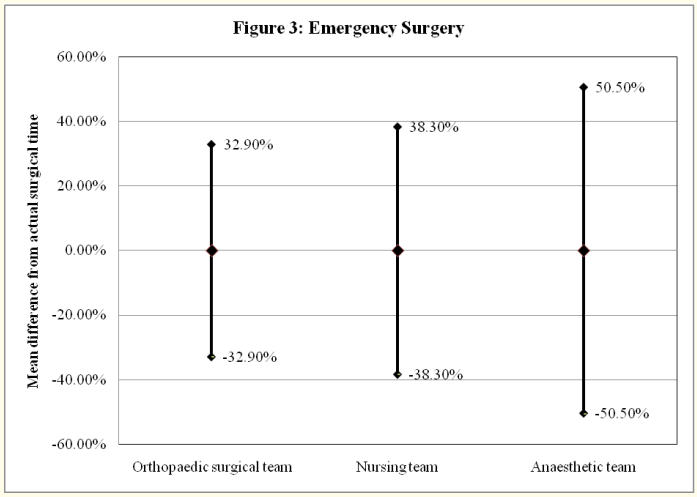

Figure 3: *Emergency Surgery.*

Spinal Anaesthesia: For spinal anaesthesia the mean deviation of estimates from the actual spinal time (expressed as a percentage) were 10.4% for nursing, 7.2% for the anaesthetics team and 8.3% for the orthopaedic surgical team. The differences between group estimations was not statistically significant using the one way analysis of variance ($p = 0.193$).

Discussion

Our results show that all members of the theatre team are relatively inaccurate at estimating theatre times. Even the orthopaedic surgical team who performed the best, were on average 33 percent incorrect in their estimation when compared with the actual time. This equates to an average of a 20 minute inaccuracy during an hour long case. Surprisingly nursing staff and the anaesthetics team were more accurate at predicting the surgical time for emergency cases than elective, despite the potential inherent uncertainty and complications that come with emergency surgery. The orthopaedic surgical team however was again more accurate than the nursing and the anaesthetic team groups. The ability of the orthopaedic surgical team to accurately predict the time to an acceptable range (20 percent under to 10 percent over the actual time) was greater for elective (39% of cases) compared to emergency (33% of cases) surgery.

A previous study undertaken by Travis., *et al*. [8] also compared theatre estimation times by orthopaedic surgeons and anaesthetists. They reported an average difference of 1.1 percent from the actual time for Orthopaedic surgeon estimates compared to an average of 33 percent in our study. Their study, like ours also showed anaesthetists were more inaccurate than surgeons in estimating, having a difference of 167.5% from the actual surgical time, compared to the 53.9% difference elicited by our study. Two notable differences between the paper by Travis et al8 and our own may explain the significant differences in results.

Firstly, there is a large difference in sample size, with Travis., *et al.* [8] only having 25 samples for the orthopaedic group and 17 for the anaesthetic group, compared to the 344 and 317 in our paper respectively. Secondly Travis., *et al.* [8] averaged the predicted times, and averaged the actual time then calculated the difference. In our study the individual absolute difference as a percent of the actual time was calculated then the mean taken of the differences, ensuring that a positive and negative result would not cancel each other out thus falsely increasing the accuracy. The absolute error of the orthopaedic surgical team in our study was comparable to data collected in a similar manner for all disciplines of surgeons in the study undertaken by Wright., *et al*. [5] with a 34% absolute difference compared to our 33% absolute difference.

Anecdotally surgeons are often accused of being inaccurate at estimating theatre time, often significantly underestimating required time, especially when it comes to adding an emergency case at the end of a list, or after hours. Our study validates the anecdotal assumption that the orthopaedic surgical team are relatively inaccurate at estimating theatre times. However those who are often highlighting the inaccuracy of orthopaedic surgeons, namely nursing and anaesthetic staff are no more accurate, and are in fact significantly less accurate in time estimation, up to 21% in the case of anaesthetists. Given that computer scheduling is no better [4-6], taking the estimation of the surgeon still seems the most accurate way we have to predict the surgical time. Prediction models similar to those studied previously [5,9,10] show promise in providing increased accuracy however these are yet to be implemented and lack clinical evidence for their accuracy. Thus until prediction models are proven to be able to be implemented effectively and deliver increased accuracy, orthopaedic surgeon estimations are likely to provide the most accurate estimate of surgical time and thus increase the utility and help to minimise cost associated with theatre.

Limitations of our study include that orthopaedic surgeons who were privy to their own estimations were sometimes performing the surgery. Whilst in a professional environment we would assume this would not influence surgical behaviour or decisions, in a research situation it does lend itself to potentially creating a bias. Similarly the ability for the nursing and anaesthetic members to estimate relied somewhat on the ability of the orthopaedic team to convey a description of the case and any complexities or potential difficulties. Our study focussed on the surgical time. Total theatre time including patient movement through theatre, anaesthetic time, set up time and other unexpected delays all factor into theatre time estimation and are outside the scope of the variable measured in our study.

Our data was taken in a situation where the majority of cases were pre booked on an orthopaedic list, which avoids the situation where a surgeon is booking a case after hours and/or competing with other surgical specialities and may inadvertently or directly underestimate the surgical time in an effort to sound more appealing to the theatre staff.

Future areas of research may explore the accuracy of surgeon estimates when applying for theatre time after hours or on a shared list when these external pressures are increased. The ability and validity of algorithms to aid in the surgical time estimates may be the future in increasing accuracy of estimations, especially when these are combined with orthopaedic team estimations.

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