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A prospective cohort study investigating the use of a surgical planning tool to improve patient fasting times in orthopaedic trauma

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A prospective cohort study investigating the use of a surgical planning tool to improve patient fasting times in orthopaedic trauma

Abstract

Objectives

To improve surgical planning and reduce fasting times with a tool designed to predict average surgical times for the commonest orthopaedic trauma operations.

Methods

A prospective cohort study comprising two 2-week periods before and after introduction of a surgical planning tool. The tool was used in the post-intervention group to predict surgical times for each patient and the predicted end-time for each list. The study was conducted in a UK trauma unit with consecutive orthopaedic trauma patients listed for surgery with no exclusions.

Intervention

A surgical planning tool was generated by analysing 5146 electronic records for trauma procedure times. Average surgical times for the commonest 20 procedures were generated with 95% confidence intervals. The primary outcome measure was number of patients fasted for a single day. The secondary outcome measures were the day of surgery and total fast times for food and fluids.

Results

After introduction of the planning tool, patients were more likely to fast for only one day (65% 46/71 vs 53% 40/75, $p < 0.05$). Day of surgery food fast was significantly lower with

use of the surgical planning tool (13:11h to 11:44h, $p<0.05$). Fast times were lower for patients with hip fractures after the intervention, with a reduction in day of surgery fast from 8:25h to 4:28h ($p<0.05$) and a total fluid of 13:00h to 4:31h ($p<0.001$).

Conclusions

Introduction of a surgical planning tool was associated with a decrease in fasting times for orthopaedic trauma patients with no patient cancelled for not being adequately fasted.

Keywords

Orthopedics

Trauma

Surgical planning

Fasting

Introduction

Background

Planning is essential for efficient implementation of surgical lists. The variability of orthopaedic trauma, however, makes it extremely difficult to predict workload and capacity^{1,2}. The surgical priority of patients can change relatively quickly and some complications can render patients acutely unfit for surgery³. In addition, out-of-hours admissions can be delayed due to need for senior review, changing priority of other patients and ambiguity of planned management. To minimise uncertainty, it is necessary for surgeons planning trauma lists to try to predict duration of surgery. Evidence suggests surgeons are accurate at predicting surgical times, but time from knife-to-skin until closure is only part of the story in surgical planning. A team-based approach is essential, with greater emphasis on advance planning^{4,5}.

Due to the unpredictable nature of trauma surgery, patients are often fasted for longer than is necessary. Fasting is necessary to reduce the risk of aspiration, but fasting for significant periods of time is associated with the risk of other significant complications. These include increased catabolism, dehydration, hypoglycaemia and immunosuppression⁶⁻⁸. The European Society of Anesthesiologists recommends a minimum of 2 hours fasting from fluids and 6 hours from foods prior to an anaesthetic⁹. Due to concern over cancelling patients who require urgent surgery for trauma, orthopaedic surgeons often adopt an extremely conservative approach and keep patients fasted for significantly longer periods of time than guidelines recommend¹⁰.

Prolonged preoperative fasting is particularly problematic for the subgroup of trauma patients with a neck of femur (hip) fracture. These patients tend to be older with more medical

comorbidities and a reduced functional reserve¹¹. Hip fracture patients are particularly vulnerable to the complications of prolonged fasting and are a higher risk of dehydration, hypoxia and acute cardiovascular events¹². In addition, there is clear evidence of increased mortality with surgical delay^{13,14}. Any intervention aimed at improving surgical planning and reducing fasting times in trauma should prioritise this vulnerable group to minimise delay to surgery.

Aims

The goal of this study was to use previously collected surgical times to improve trauma list planning and improve preoperative fasting times. It was hypothesised that an effective tool to aid surgical planning could reduce both the number of days and the number of hours fasted.

The aims of this study were to:

1. Quantify fasting times for orthopaedic trauma patients
2. Assess whether a surgical planning tool could improve surgical planning (measured through change in fasting time as a surrogate marker for unplanned/late cancellation)
3. Ensure that any improvement seen included or prioritised the vulnerable neck of femur (hip) fracture patients.

The primary outcome measure was number of days fasted preoperatively. We also considered the day of surgery and total fast time (in hours) for both food and fluids as secondary outcomes.

Methods & materials

Patient population

This prospective clinical audit consisted of two cycles pre- and post-introduction of a surgical planning tool. Each cycle recruited consecutive orthopaedic trauma patients admitted to a regional trauma unit over two 14-day periods. All orthopaedic trauma patients who proceeded to surgery were included. The regional trauma unit in which this study took place operates on paediatric and adult orthopaedic trauma patients on a single trauma list, therefore both populations have been included in this study.

We did not include patients admitted for emergency (same day) surgery e.g. unstable pelvis fractures as the preoperative planning for these patients is done on an ad hoc basis on admission.

Data collection & outcome measures

Both electronic and paper records were reviewed to extract data on surgical times and patient fasting. The primary outcome measure was number of days fasted, calculated from the number of separate dates on which it was recorded in the patient's notes that they were fasting for theatre (data extracted from combined medical and nursing documentation in patient notes). If patients were cancelled for theatre after the morning trauma meeting and ward round (i.e. before 10am) and then fed, this was not considered a fasting day. Secondary outcome measures included the day of surgery fast time and the total fast time (sum of fast times over all days fasted) for food and fluids. Fasting times were calculated from last time food or fluid consumed as documented on the patient's check-in to theatre on the World Health Organisation 'WHO' pre-op checklist in hours¹⁵.

Pre-intervention group

In the pre-intervention group, all trauma admissions over a 24-hour period were collated overnight by an orthopaedic registrar with senior input to generate the trauma theatre list. A provisional list order was often made by the on-call consultant on the preceding night but the final list order was frequently subject to change based on overnight admissions. Due to the unpredictable nature of orthopaedic trauma admissions, it is uncommon for fasting instructions to be issued by the on-call consultant on the preceding evening, and the final list order and fasting is usually decided after the morning trauma meeting and ward round.

Surgical planning tool

To meet the aim of improving trauma list planning and minimising pre-operative fasting, a surgical planning tool was developed for the post-intervention cycle. Data for the surgical planning tool was extracted from the hospital's OPERA system, an electronic database used within the hospital for documenting theatre times. Data on orthopaedic trauma theatre times over a two-year period was extracted from this system and analysed according to number of procedures in a single anaesthetic, type of surgery and combined anaesthetic and surgical times. From this analysis, the commonest 20 orthopaedic trauma operations were identified. For each procedure, the average total theatre time (sum of anaesthetic and surgical time in minutes) was then calculated. 95% confidence intervals (CI) were calculated to assess intra-procedure variability. This data was used to create the surgical planning tool (Table 1), a list of the predicted surgical time for the 20 commonest trauma procedures with 95% CIs. For example, the predicted total theatre time for an ankle fracture fixation was 1 hour 51 minutes (1:51h with 95% CI 1:46-1:56h).

Post-intervention group

During the post-intervention study before the start of each trauma list, data from the surgical planning tool was populated into the trauma theatre list as shown in Table 2. Theatre start time was 09:15am as this was the average time into anaesthetic in the pre-intervention group. Each theatre case was populated with the predicted theatre time (anaesthetic + surgical time), start and end time, and the predicted time for completion of the trauma list. Data for cases where there might be variation in surgical procedure undertaken (e.g. distal radius which might require manipulation or internal fixation) was collated together to minimise the risk for underestimation of surgical time and due to frequent preoperative uncertainty over surgical plan.

Proximal hip fracture patient subgroup

Within the pre- and post-intervention groups, a subgroup of proximal femoral (hip) fracture patients was identified. Improved surgical planning was expected to benefit this group in particular, by ensuring that this group, who have a documented higher mortality with delay in surgical fixation, were prioritised when the trauma lists were full and more likely to overrun.

Limitation of potential sources of bias

Theatre times data is input on the OPERA system by theatre staff contemporaneously during the trauma list. In order to minimise observer-expectancy bias, nursing staff were not aware that the outcome measure of the study was fasting time. A single researcher was responsible for extracting fasting times from records. It was not possible to blind the researcher to a patient's pre/post-intervention status as the groups were separated in time, however further bias was minimised by only recording fasting times if these were specifically documented within patient notes by an objective member of staff.

Statistical analysis

No sample size calculation was performed prior to the study since this was considered a pilot study aimed at providing proof of concept. Data was analysed using the Chi-square test for categorical variables and the student's t-test for continuous variables, with significance set at $p < 0.05$. Where missing data was present, this has been recorded.

Results

Surgical planning tool

Electronic surgical times data was extracted from the computerised surgical times software OPERA (see Methods) from the 01/01/2013-31/11/2014 (23 months). Over this period, 5146 orthopaedic trauma procedures were performed on 3269 patients. 1625 patients had a single procedure performed (47%) and of these, the commonest 20 orthopaedic trauma procedures were identified. Data was extracted on surgical times (time from entry into anaesthetic room to end of surgery) for these 1625 patients along with procedure type. This was used to generate a list of the commonest trauma procedures and average surgical time with 95% confidence intervals (CI) (Table 1).

Validation of surgical planning tool

Electronic data for actual surgical times from the pre-intervention group was used to validate the surgical planning tool. 12 trauma lists were analysed (two lists were excluded as they did not start until 2pm and 5pm). Overall, the average deviation from actual to predicted theatre end time was -31 minutes (the tool tended to underestimate surgical time by 31 minutes, range -05:11h to +05:16h, median -9 minutes). For full details, see Table, Supplemental Digital Content 1. Due to the tendency towards underestimation, during the post-intervention study the standard deviation was added to the mean surgical times to prevent the risk of underestimating and therefore inadequately fasting a patient prior to theatre (e.g. for hip hemiarthroplasty, time used in the post-intervention study was mean surgical time 01:55h + standard deviation 00:28h = 02:23h, see Table 1).

Participants

The study periods took place from 6-19/12/2014 (pre-intervention) and 1-14/06/2015 (post-intervention). Each comprised a 14-day consecutive study period, with demographic data summarised in Table 3. There were 103 and 105 patients listed for surgery in the pre- and post-intervention studies, respectively.

In the pre- and post-intervention groups, similar numbers of patients who were listed proceeded to surgery (73% 75/103 and 68% 71/105, respectively). Theatre start time was similar in the pre- and post-intervention cohorts (mean start time 09:49 and 09:52, respectively). Around ten percent of patients in both groups were listed then cancelled (9% 9/103 and 10% 10/105, respectively) and around twenty percent of patients had their surgery delayed. There were similar times between cases in the pre- and post-intervention cohorts (mean 27 (range 00:02-01:20) and 29 minutes (range 00:04-01:15) respectively, range). Workload and the need to optimise a patient's condition (e.g. time to reverse anticoagulation) were the commonest reasons for delay. No patient was listed for theatre then cancelled as they were not adequately fasted. No patient was lost to follow-up.

Within both the pre- and post-intervention groups, a subgroup of proximal femoral (hip) fracture patients was identified. Patients in the hip fracture subgroup were older than other trauma patients in both pre- and post-intervention groups (mean age 79 and 76 versus 59 and 48 years, respectively) and three quarters proceeded to surgery (18/24 75% and 15/20 75%, respectively). Hip fracture patients were less likely to be delayed due to workload in the post-intervention group compared to the pre-intervention group (0/5 and 2/6, respectively). For full demographic data on the hip fracture patient subgroup, see Table, Supplemental Digital Content 2.

Days fasted

Introduction of the surgical planning tool was associated with a reduction in the number of patients fasting for a single day prior to surgery ($p<0.05$, Figure 1). The total number of fasting days (sum of all days fasted) was 75 pre-intervention and 67 days post-intervention (average 1 and 0.9 days per patient, respectively). Patients fasted for a range of 1-3 days. In the post-intervention group, patients were more likely to fast for only one day prior to surgery (53% 40/75 compared to 65% 46/71, $p<0.05$).

Day of surgery fast

Introduction of the surgical planning tool was associated with a reduction in day of surgery fast times for both foods and fluid, as summarised in Table 4. The average food fast on day of surgery fell from 13 hours and 11 minutes (13:11h) in the pre-intervention study to 11:44h ($p<0.05$). The average day of surgery fluid fast time fell from 6:55h to 5:55h.

Total fast

Total fast time per patient was calculated by adding the time fasted on each day of fasting. Use of the surgical planning tool was associated with a reduction in total fast times for both foods and fluid (Table 4). Total food fast fell from 16:25h in the pre-intervention group to 14:41h in the post-intervention group. Total fast for fluids fell from 9:35h to 7:38h.

Hip fracture patient subgroup

Post-intervention, more patients in the neck of femur (hip) fracture subgroup fasted for one day only (80% 12/15 compared to 50% 9/18 in the pre-intervention group $p<0.05$, Figure 2). Day of surgery fast fell from 14:28h to 12:55h for food and from 8:25h to 4:28h for fluids

($p < 0.05$ for both, Table 5). Total fast also fell in the hip fracture subgroup, from 18:32h to 13:40h for food ($p = 0.01$) and from 13h to 4:31h for fluids ($p < 0.001$) (Table 5).

No patient in any of the groups was listed for theatre then cancelled for not being adequately fasted.

Discussion

Validation of the surgical planning tool in our trauma unit showed a relatively unsurprising large variation between predicted and actual surgical times from 5 hours' underestimation to 5 hours' overestimation. On average, there was a tendency to underestimate by 30 minutes, which was deemed adequate to proceed with the post-intervention study. This degree of accuracy was comparable to medical staff (including orthopaedic surgeon) estimation in the global literature, whereby the best estimates of trauma time were within 30% of actual surgical times¹⁶. Some studies have shown greater accuracy of orthopaedic surgeons in predicting surgical time but these did not include anaesthetic time, which is vital when predicting timing for orthopaedic trauma lists¹⁷.

Orthopaedic trauma lists are, by their very nature, extremely changeable and it was impossible to assess for specific reasons for delay or change in list order since this is a dynamic, often verbal decision made by the on-call consultant throughout the day's operating list. Our centre operates a 'Golden patient' policy whereby the first patient listed on each day's trauma list is identified the previous day and is a fit patient with a clear operative plan. Previous work in our department has shown that the biggest cause of delay due to extra-theatre factors is change in list order, and our departmental compliance with the golden patient policy is 78-81% (S Downie 2015, unpublished work available on request).

The primary outcome of this study was the number of patients fasting for a single day prior to surgery. Introduction of the surgical planning tool was associated with a significant increase in the number of patients fasting for one day only. The secondary outcome measures of day of surgery fasting and total fasting times for food and fluid were also significantly improved in the post-intervention group. The differences seen were particularly marked in the hip

fracture patient subgroup, where the day of surgery fluid fast was halved (from 8:25h to 4:28h) and the total fluid fast was reduced by a factor of 3 (13:00h to 4:31h). This was considered a significant achievement since this group of patients are known to be at risk of delay due to prioritisation of more complex trauma requiring subspecialist input in-hours¹⁸. Previous studies have focused on improving fluid fasting times over food fasting times as the fasting parameter most likely to impact on patient complications, and have failed to institute such significant changes in preoperative fasting status through improved documentation of senior clinical decision-making alone¹⁹.

Of note, the improvements in patient fasting were not associated with any patient being cancelled for theatre due to not being adequately fasted, which is often reported (or anecdotally noted) as a concern in planning trauma lists.

Limitations

The study design was deemed adequate to answer the research questions but there were several potential sources of bias which we have tried to address. A single researcher collected the fasting data for both pre- and post-intervention studies and there is therefore the potential for observer bias in the improved fasting times after introduction of the surgical planning tool. If present, it would be expected that any observer bias would favour an improvement in fasting times. However, the researcher only recorded fasting times as documented in patient notes and we would expect this to minimise the risk of observer bias. It is also possible that fasting times did not change and that the changes seen after introduction of the planning tool reflect improved documentation. The authors think this is unlikely as it was not publicised to the orthopaedic department that the outcome measure was fasting time and none of the researchers who did know this was the outcome were involved in documenting fasting times. It is also possible that the surgical times from the OPERA system

used to generate the surgical planning tool and evaluate its results may be inaccurate. However, this data is input by theatre staff contemporaneously and not by any of the researchers involved in the study. If systematic inaccuracies are present, it is still calculated that we are ‘comparing apples with apples’ and this was deemed acceptable.

Finally, we didn’t address the problem of multiple trauma (several procedures on a single patient under a single anaesthetic) or seniority of surgeon/anaesthetist as this would have made the surgical planning tool too complex to utilise easily by the overnight registrar in trauma list planning. Both anaesthetic and orthopaedic services in our centre are consultant-led and we do not expect to see significant differences in surgical times due to medical staff experience, however future work should address this issue.

Interpretation

This study was a prospective cohort study and not a randomised controlled trial, therefore we cannot state with absolute certainty that the surgical planning tool was the direct cause of the improved fasting times seen in the study. We have established that the pre- and post-intervention cohorts were largely similar in the number of patients listed, the number of patients undergoing surgery and the reason for delay. We believe the improvement in number of days fasted and the day of surgery and total fasting times is due to an enhanced ability to plan orthopaedic trauma lists due to the presence of the surgical planning tool and that this improved planning is reflected in improved fasting times for all patients. However, fasting times are still too long and it is clear that we need to drive further improvements in surgical planning to maximise patient comfort, nutrition and outcomes. We think the heightened improvements seen in the hip fracture patient subgroup highlights that this surgical planning tool is particularly useful in ensuring that this vulnerable patient group have

their surgery timeously and would hope that this would enhance outcomes and potentially survival in this group.

Generalisability

The process of applying our surgical planning tool to other centres would require validation of our average surgical times against other trauma unit populations. Once this had been completed, it seems highly likely that the same tool could be used in other orthopaedic trauma centres with the same benefits. This is a simple tool that pragmatically focuses on the most common orthopaedic trauma procedures and is extremely easy and quick to implement.

Future work

Despite the overall improvement in fasting times seen in this study, there was still a large buffer between the minimum necessary fasting times and the actual fasting times documented in trauma patients. We recorded an improvement in day of surgery fasting times from 13 hours to 12 hours for food and 7 hours to 6 hours for fluids but saw a significant improvement in fasting times for hip fracture patients. This still means that we are on average fasting trauma patients for twice as long as required from foods and three times as long as required from fluids and not cancelling any patients for not being fasted. Dissemination of these results within the department and wider community has to occur to encourage further enhancement of efficiency in surgical planning with a further improvement in fasting times. We need to make surgical planning more of a priority, particularly in the vulnerable elderly patient groups including those with fractured neck of femurs. In addition, increased use of rapidly digested carbohydrate-loaded drinks preoperatively to patient comfort and maximise early outcomes such as immune function and mobility should be

encouraged with a view to ameliorating the necessary fasting times required for orthopaedic trauma lists^{20,21}.

Finally, it should no longer be a task for the junior orthopaedic registrar on-call to decide on patient order and inclusion on trauma lists. The current trend in the UK is towards increasing senior presence out of hours during trauma takes and advance, experience-driven trauma list planning. This should be undertaken with multidisciplinary input from anaesthetic & specialist nursing staff with consideration of the variety of factors that influence patient outcomes. Our surgical planning tool can only aid in this complex and difficult task.

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Table 1

Surgical planning tool. Data on total theatre times (anaesthetic + surgery) for the 20 commonest orthopaedic trauma procedures with 95% confidence intervals (CI).

Procedure	Anaesthetic + surgical time (hh:mm)	95% CI	SD (hh:mm)	No. of procedures.	%/1625 (frequency)
Hip hemiarthroplasty	01:55	01:00 – 02:49	00:28	376	23%
Distal radius fixation	01:35	00:00 – 003:09	00:48	269	17%
Compression hip screw	01:50	00:47 – 02:52	00:32	223	14%
Ankle fixation	01:51	00:28 – 03:13	00:42	221	14%
Reduction of hip prosthesis	01:22	00:00 – 03:31	01:06	105	7%
Forearm fixation	01:31	00:00 – 03:16	00:54	91	6%
Proximal femur nail	02:32	00:48 – 04:15	00:53	89	6%
Hip replacement (THR)	02:24	01:11 – 03:36	00:37	83	5%
Femoral shaft fixation/nail	02:37	01:10 – 04:03	00:44	62	4%
Knee arthroscopy	01:10	00:13 – 02:06	00:29	61	4%
Tib/fib fixation/nail	02:33	00:33 – 04:32	01:01	60	4%
Distal humerus fixation	02:05	00:00 – 04:18	01:08	39	2%
Knee washout closed/open	01:55	00:20 – 03:29	00:48	38	2%
Olecranon fixation	02:03	00:50 – 03:15	00:37	31	2%
Prox. humerus fixation/nail	03:19	02:18 – 04:19	00:31	27	2%
Dislocated shoulder reduction	00:38	00:02 – 01:13	00:18	15	0.9%
Distal femur fixation	02:56	01:06 – 04:45	00:56	13	0.8%
Midfoot/hindfoot fixation	01:59	00:13 – 03:44	00:54	12	0.7%
THR revision	03:42	01:34 – 05:49	01:05	12	0.7%

Table 2

Application of surgical planning tool. In the post-intervention group, the data from Table 1 was used to populate the trauma list for each day to generate start and finish times for each trauma case and the total theatre end time.

Procedure		Predicted surgical time (hh:mm)	Example (hh:mm)
<i>First case</i>	Theatre start time	09:15	09:15
	Case		Distal radius fracture fixation
	Duration		01:35
	End time	(start time + duration)	10:50
	Start time	(1 st case end time + 15 mins)	11:05
<i>Second case</i>	Case		Hip hemiarthroplasty
	Duration		01:55
	End time	(2 nd case start time + duration)	13:00
	Start time	(2 nd case end time + 15 mins)	13:15
	Case		Ankle fracture fixation
<i>Third case</i>	Duration		01:51
	Theatre end time	(3 rd case start time + duration)	15:06

Table 3

Summary of demographic data for pre- and post-intervention patient groups.

	Pre-intervention group		Post-intervention group	
Dates	6-19.12.2014		1-14.06.2015	
Number of days	14		14	
Number of patients listed	103		105	
Average listed/day	7.4		7.5	
Age (years)				
Mean	59		48	
Range	5-95		5-94	
Number proceeding to surgery	75/103	73%	71/105	68%
Average/day	5.4		5.1	
Number cancelled	9	9%	10	10%
Number delayed	19	18%	24	23%
Delayed due to workload	10/19	53%	11/24	46%
Not fit	7	37%	8	33%
Imaging / specialist input needed	2	11%	5	21%
Patient not fasted	0		0	

Table 4

Day of surgery and total fast times for food and fluids in the pre- and post-intervention groups.

		Pre-intervention group		Post-intervention group		p value
Day of surgery food fast (hh:mm)						
	Known	55/75	73%	50/71	70%	
	Range	06:11-23:11		05:00-20:15		
	Mean	13:11		11:44		0.037
	Median	12:44		11:50		
Day of surgery fluid fast (hh:mm)						
	Known	55/75	73%	51/71	72%	
	Range	00:34-21:32		01:21-20:15		
	Mean	06:55		05:55		NS
	Median	05:30		04:50		
Total food fast (hh:mm)						
	Known	53/75	71%	50/71	70%	
	Range	06:11-47:15		05:00-47:31		
	Mean	16:25		14:41		NS
	Median	14:45		12:21		
Total fluid fast (hh:mm)						
	Known	53/75		51/71		
	Range	01:17-39:15		01:21-28:38		
	Mean	09:35		07:38		NS
	Median	07:30		06:02		

Table 5

Pre- and post-intervention day of surgery and total fast times for food and fluids for the hip fracture patient subgroup.

		Pre-intervention group		Post-intervention group		p value
Day of surgery food fast (hh:mm)						
	Known	15/18	83%	12/15	80%	
	Range	07:25-21:32		09:14-16:24		
	Mean	14:28		12:55		NS
	Median	15:01		13:19		
Day of surgery fluid fast (hh:mm)						
	Known	15/18	83%	13/15	87%	
	Range	00:34-21:32		01:21-09:57		
	Mean	08:25		04:28		0.02
	Median	05:25		03:16		
Total food fast (hh:mm)						
	Known	13/18	72%	12/15	80%	
	Range	10:43-30:58		09:14-19:16		
	Mean	18:32		13:40		0.01
	Median	16:55		14:18		
Total fluid fast (hh:mm)						
	Known	13/18	72%	13/15	87%	
	Range	03:04-30:58		01:21-09:57		
	Mean	13:00		04:31		0.0009
	Median	12:59		03:46		

Figure legends

Figure 1

Days fasted in the pre- and post-intervention groups

Patients in the post-intervention group were significantly more likely to fast for a single day than in the pre-intervention group ($p<0.05$).

Figure 2

Days fasted pre- and post-intervention in the hip fracture patient subgroup

Use of the surgical planning tool was associated with a significant increase in the number of hip fracture patients fasting for a single day ($p<0.05$) and a significant decrease in the number of hip fracture patients fasting for multiple days ($p<0.05$).