Shift working reduces operative experience for trauma and orthopaedic higher surgical trainees: a UK multicentre study

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ABSTRACT

INTRODUCTION In recent years there has been a rise in the number of trauma and orthopaedics trainees working on full shift patterns. Historically, most trauma and orthopaedics trainees worked 24 hours non-resident on-call shifts. The effect of this change in shift patterns has not previously been measured. As two trusts (one trauma unit, one major trauma centre) in our region underwent a change to full shift working, we assessed the impact on the trainees' operating experience.

METHODS Fifty-five logbooks were analysed across the two trusts over a two-year period, with comparisons made between pre- and post-shift working.

RESULTS Overall operating fell by 13% for trainees working full shift patterns, which was statistically significant. There was a loss of elective operating of 15% at the trauma unit and 32% at the major trauma centre for trainees doing shift work. The effect on trauma operating opportunities was mixed. Index operating was largely preserved.

CONCLUSIONS Shift working significantly impacts on surgical training opportunities. We explore approaches to minimising this effect.

KEYWORDS

Training – Surgery – Orthopaedics – Shift

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Introduction

Obtaining operative experience is a key goal for all craft-based surgical specialities. In the UK, surgical trainees must complete 1800 cases over their training, distributed pro rata between posts in different specialties. Particular attention is paid to 'index' procedures, which are intended to represent key skills in the specialty, and there are quotas for each index procedure. These requirements are produced by the Joint Committee on Surgical Training (JCST) and monitored by training programmes.¹ Some of this experience is curtailed by limitations in working hours and demands of service provision.²

Currently, higher surgical trainees in orthopaedics face certain challenges in meeting the requirements for minimum operative experience.^{3,4} Meeting these targets for operative procedures is one of the most important parts of an attachment for trainees, trainers and training programme directors.⁵ Consequently, it is imperative that rota design and implementation allow for dedicated operative training time to be used to its greatest potential.

Until very recently, orthopaedic trainees in the North West Deanery worked a 24-hour non-resident on-call shift pattern. However, due to non-compliance of these rotas with European Working Time Directive (EWTD) guidance while providing safe supervision for junior trainees, two of the busiest trusts in the region changed their working pattern to a 12-hour on-site resident shift systems.

The majority of research focusing on understanding the effect of hours of work on surgical trainees has arisen from North America and is of little relevance to the UK system of surgical training.^{6,7,8} The bulk of work done in UK and Ireland centred on changes seen when EWTD was first introduced and overall hours of work by surgical trainees fell. Bates demonstrated a fall in operating by general surgical trainees of 15% and Wilson showed a reduction in level of involvement of orthopaedics trainees in procedures after EWTD introduction.^{9,10} In 2010, Jameson used survey data to illustrate differences in the operating experience of trauma and orthopaedics trainees across the UK, but the study lacked clarity of data to demonstrate differences specifically related to shift work rather than

workload.¹¹ To date, there have been no studies looking at the effect of a changing pattern or type of work (e.g. shift work) within the same constraints on total hours of work as laid out by EWTD.

We aimed to determine the effects of this change in working pattern on orthopaedic higher surgical trainees operative experience.

Methods

Study period and design

This multicentre study analysed surgical logbook data collected over two years to assess changes in operative experience for surgical trainees following the implementation of shift work. The study was designed prospectively and the data were collected retrospectively at the end of each rotation from trauma and orthopaedic surgical trainees working at the two trusts in the north-west of England between February 2015 and February 2016 (24-hour non-resident working pattern) and August 2016 to August 2017 (full-shift working pattern) for a minimum of six months (one rotation or 'job'). Both trusts changed to shift working over the summer 2016. Data from the job rotation during this transition period (February 2016 to August 2016) were not collected.

Working patterns

A 24-hour non-resident on-call pattern of work in the pre-shift period constituted 24 hours on call (8am to 8am the following day). The trainees remained on call for emergencies overnight between 8pm and 8am. The day after an on-call would typically be truncated, with the afternoon off (zero hours). When not on call, a standard work day would be from 8am to 5pm and would involve either theatre or clinic work. A full shift pattern of work consists of standard work days (8am – 5pm) and 12 hour shifts on call either in the day (8am – 8pm) or night (8pm – 8am).

Exclusion criteria

Data were not collected from staff-grade doctors or non-training doctors working in the specialty trainee grade 3 (ST3) or higher, or registrar grade at the hospitals. Trainees data were excluded if they declared they had an extended period of absence (greater than two weeks) during the rotation of interest (e.g. sick leave, parental leave). It was assumed that trainees took annual leave and short-term study leave to a similar degree across their jobs.

Materials and methods

Trainees contributed a consolidation report downloaded from their mandatory surgical logbook, which summarised their operative experiences over the six-month job. Data were anonymised and extracted in relation to the procedure numbers over the rotation, types of procedures undertaken (trauma or elective and index procedures) and degree of involvement in cases: assisting, supervised by trainer; scrubbed or unscrubbed, performed or teaching.

The analysis focused on procedures completed by the trainee themselves or those when teaching a junior and

excluded those procedures for which they acted as an assistant (i.e including trainer supervised; scrubbed and unscrubbed, performed and teaching). Cases where the trainee was an assistant were not analysed further. Definitions of index cases were drawn from the JCST regulations.¹

Descriptive analyses were undertaken using SPSS version 24. The data were tested and found to be plausibly normally distributed. Independent sample t-tests were performed to compare the number of procedures undertaken by the pre- and post-shift groups at the two trusts, using a 5% significance level.

To assess for overall changes in workload across the trusts, we obtained data from the National Joint Registry.^{12,15} We identified the number of joint arthroplasties reported to the registry at both trusts between pre- and post-shift study periods.

Results

Characteristics

Data from 61 six-month jobs were collected (32 at the trauma unit, 29 at the major trauma centre) ranging from ST3–8. Data from only one eligible job could not be obtained as the trainee had left the rotation. Data were excluded for six jobs – four where trainees were absent for over two weeks and two where the trainees gained their Certificate of Completion of Training and left the training programme during the study period. Both trusts each hosted between seven and nine trainees during one rotation period.

The grades of trainees whose data were included is represented in Figure 1. The trauma unit hosted trainees at a lower grade when compared to the major trauma centre as demonstrated in Figure 1. This relationship was consistent throughout the study period.

Both hospitals hosted trainees completing rotations focusing electively on lower limb arthroplasty, foot and ankle, upper limb and hand and wrist surgery. The trauma unit had one paediatric orthopaedics job and the major trauma centre had one spinal surgery job. All jobs involved trauma operating.

We identified a reduction in the number of joint arthroplasties reported to the registry at both trusts between pre- and post-shift study periods: 749 to 641 procedures (14.4% drop) at the major trauma centre, 894 to 806 procedures (9.8% drop) at the trauma unit).

Effect on operative experience

The results of the analysis and comparison of the values for the pre- and post-shift operative experiences are shown in Table 1 and Figure 2. Overall, there was a total reduction in the number of procedures completed by the trainees at both trusts after shift work was introduced, which proved statistically significant when the data were combined, with about 22 fewer procedures completed by trainees working on shifts (13% drop, $P = 0.04$). There was a fall in elective operating by

trainees overall. Combining these data across both trusts, this reduction was statistically significant but the reduction seen was much greater at the major trauma centre. The major trauma centre trainees experienced a drop of almost one-third in elective work (mean reduction of 27.8 procedures (32%) over six months ($P = 0.04$)). The trainees at the trauma unit lost on average 13 elective procedures (16%) over their post shift rotations compared to previously and this was not statistically significant with the numbers available.

The effect on trauma work was less consistent and less marked. The trainees at the major trauma centre working on shifts completed on average 5.8 more trauma procedures (5% rise); however, at the trauma unit there was a fall in trauma operating after shifts were introduced (mean reduction of 8.8 procedures, 11%). With the numbers available, neither of these differences was statistically significant.

When focusing on the index procedures, the effect of shift work was again variable across the trusts. Index elective procedures (e.g. hip and knee arthroplasty, arthroscopy, bunion surgery) were broadly preserved post-shift

Table 1 Procedures (unscrubbed, scrubbed, performed and teaching) logged by trainees over a full six-month rotation and the standard deviation.

Centre	Pre-shift		Post-shift		Change ^a		P-value ^b
	(mean)	(SD)	(mean)	(SD)	(mean)	(%)	
Major trauma centre: ^c							
All trauma	77.0	19.0	80.8	14.7	3.8	4.9	0.58
All elective	86.0	39.3	58.3	22.5	-27.8	-32.3	0.04 ^d
Index trauma	30.4	11.0	29.1	5.2	-1.3	-4.2	0.72
Index elective	44.0	26.6	35.8	21.4	-8.3	-18.8	0.40
Total	163.0	39.1	140.3	26.3	-22.8	-14.0	0.10
Trauma unit: ^e							
All trauma	82.3	32.0	73.5	12.6	-8.8	-13.0	0.38
All elective	82.4	24.6	69.4	34.5	-13.0	-15.8	0.38
Index trauma	30.1	12.7	28.1	6.7	-2.0	-6.6	0.66
Index elective	38.7	12.0	40.1	22.0	1.4	3.6	0.65
Total	164.7	47.1	143.7	37.1	-21.0	-12.8	0.31
Both trusts combined:							
All trauma	79.7	26.2	76.8	13.8	-20.4	-3.2	0.62
All elective	84.1	32.0	63.8	29.6	-20.4	-24.2	0.02 ^d
Index trauma	30.2	11.7	28.6	6.0	-1.6	-5.4	0.52
Index elective	41.3	20.2	37.9	21.4	-3.4	-8.3	0.58
Total	163.9	42.7	142.1	32.0	-21.9	-13.4	0.04 ^d

^a Change in the mean values between the pre- and post-shift period are shown, together with this value as a percentage of the pre-shift procedure mean values.

^b Calculated from the independent t-tests comparing the pre- and post-shift work.

^c Pre-shift, $n = 14$; post-shift, $n = 12$.

^d Statistically significant change.

^e Pre-shift, $n = 15$; post-shift, $n = 14$.

implementation at the trauma unit (1.4 more procedures logged post shift) whereas the major trauma centre saw an 18.8% fall in index elective procedures with shifts (mean 8.3 fewer procedures). The index trauma numbers (e.g. hip and ankle fracture surgery) only fell marginally after shift work began at the two trusts (by 4.2% at the major trauma centre and 6.6% at the teaching hospital). None of these differences was statistically significant.

While we have demonstrated a drop in overall operating with shift working, these trusts have still maintained a level of trainee operating that exceeds the requirements of the JCST (involvement in 300 operations per year) when including cases where the trainee assists.

Discussion

We have demonstrated an overall reduction of 12–14% in operating experience by orthopaedic surgical trainees working in a full shift system, compared with 24-hour non-resident on calls. The burden of this reduction was seen in elective operations, which fell between 15% and 32% at the two trusts. There was large subject variability seen, illustrated by the standard deviation values in Table 1. This variability was expected, given the breadth of levels of the trainees and variety of different jobs undertaken at both trusts and part of our rationale for including two jobs in each study period. We believe this large variability is responsible for the lack of statistical significance seen in some of the comparisons.

This study provides evidence for the hypothesis that shift work reduces operative opportunities for trainees working

in full shift systems as compared with traditional on-call systems. For example, on a 1 : 12 rota such as that at the trauma unit studied, trainees lost one week of routine activity per rota cycle (12 weeks) to complete a week of night shifts, which rarely now involve out of hours operating.¹⁴

As illustrated in Figure 3, standard and long days on-call constituted 71% of the days in the 24-hour non-resident on-call pattern (pre-shift period) and 59% of days in the post-shift period. A similarity in the proportion of the fall in overall operating (12–14%), with the fall in the number of days worked in which those operating opportunities arise (12%) provides us with some confidence that the effect seen on operative experience can be attributed, at least in part, to shift working.

However, we cannot completely exclude other influences. The fall in arthroplasties reported to the National Joint Registry in the study period after shift working commenced at both trusts (14.4% drop at the major trauma centre, 9.8% drop at the trauma unit) probably demonstrates the wider influences on the trusts studied (e.g. elective cancellations, changes to commissioning) manifesting in a reduced number of joint replacement procedures. While arthroplasty data are not entirely representative of overall elective work at the trusts, this reported reduction in activity, in contrast to a national increase in arthroplasty in 2017, provides an important lens through which to view our findings.¹² We believe that the design of this study was optimised as far as pragmatically possible to minimise the effect of the wider healthcare system on our results.

The introduction of shift work for trauma and orthopaedic specialist trainees required fundamental changes in the rota for the entire departments. After the shift work was introduced, the specialist trainee on-call daytime duties at both trusts involved work in trauma theatre. We suspect that this programmed opportunity for trauma work explains the disproportionate drop in the elective operating seen at the introduction of shift work, as elective work was left to be completed on standard work days, of which there are markedly fewer in a shift system.

Factors impacting the effect of shift work on trainees operating experience

Both trusts studied have multiple hospital sites, with trauma admissions and trauma operating located on a 'hot site' and elective operating largely based in the 'cold site'. This model is one echoed widely nationally. It often has the advantage of protecting elective activity from the wider trust's acute pressures. It does pose challenges, however, to attempts to limit loss of elective work secondary to on-call commitments, for which the on-call team need to be located at the 'hot site'. It may be that rotas in single-site trusts could be designed to lessen the disproportionate impact of shift work on trainees' elective exposure with continued involvement in elective activities while on call during the day. Shivji demonstrated an approach to protecting training opportunities by splitting rotations in their larger trust into elective and trauma focused jobs to good effect.¹⁵ Similarly, expanding the number of doctors covering the rota reduces the impact of shift work on trainee operating but is financially challenging.

Both trusts studied share a large number of similarities (geography, hot and cold sites, two consultants on call together, large number of deanery trainees) but there are some differences, which we have identified and explored in an attempt to inform and guide other trusts contemplating switching to shift work.

One major difference was the consultant on-call rota. At the trauma unit, consultant on-calls duties fell on a certain

day a week, on average every fortnight, with no disruption to their usual elective operating and therefore also that of their trainees. In contrast, the consultants at the major trauma centre have two weeks of every consultant rota cycle covering acute duties, thus removing them with regularity from elective work. If these consultant on-call shifts could be made to coincide with those of their specialist trainees, the impact on trainees' elective work was minimised; however, this was not always possible and we suspect was a significant reason behind the larger drop in elective work seen in shift-working trainees at the major trauma centre.

A further adaption within the constraints of a EWTD-compliant full shift working pattern is the facility to move trainees non-fixed zero days to avoid them coinciding with regular theatre days. While zero days following nights are fixed, a rolling rota will contain numerous zero days to maintain rota compliance, which can be taken at any time over a rota period or divided into half days. For trusts implementing shift working, we would advocate exploring the options for flexible zero days to be scheduled to avoid theatre or clinic days, so as to avoid disruption in training opportunities as far as possible.

One final point relates to the rise in index elective procedures (e.g. arthroplasty, carpal tunnels, scopes) seen at the trauma unit post shift work commencing, despite the overall fall in overall elective operating done by trainees and reduction in National Joint Register reported arthroplasties at the trust. This could suggest there was some channelling of appropriate training cases for elective lists when trainees were present. Certainly, the authors have experience of this being the case in the trusts investigated and more widely in our region, but we did not monitor this activity directly. Such modifications can limit the negative influence of shift work on training but are sometimes difficult to marry with other pressures and would be a fruitful area of further study.

Limitations

We assumed that the logbook data were accurate and complete. The trainees were aware of the nature and goals of the study. Technically, this could have influenced the accuracy of the logbooks submitted to us; however, given that there is an obligation within the training programme to maintain accurate logbook records, we think this would be unlikely.

We captured data from all but one trainee at the trusts over the study period. We did have to exclude data from six trainees but we do not believe that this exclusion had a significant effect on the findings. The balance of seniority of the remaining trainees was maintained after the exclusions.

Any study of trainee experience within the NHS is influenced by the wider changes occurring across the organisations. While we were keen to collect large amounts of logbook data to minimise the effect of subject variability, the counterbalance was that a longer study period exposed us to the wider influence of systemic changes occurring over time. This study included two jobs either side of the

change to shift work for trainees, so we could include and compare full calendar years, to control for seasonal variations in work load and minimise the effect of subject variability. We acknowledge that potential changes to the overall trauma workload, but particularly elective workload, within the trusts may have an influence on our findings. Both trusts experienced bed and trauma workload pressures, elective cancellations and alterations to commissioning of elective procedures (e.g. some cessation of procedures of limited clinical value). The trusts will have experienced these to differing degrees, not least in part due to their differing trauma centre status.

This was a quantitative assessment of the effect of shift working on the operating experience of orthopaedics trainees. We made no assessment of the quality of the experiences we measured, the effect on other surgical trainees (core or foundation doctors) and non-training doctors, nor the trainees' and trainers' evaluations of the new working conditions, which would be interesting further work. It would be valuable to measure the effect on patient care and outcomes in orthopaedic departments with specialist trainees now undertaking resident shift work.

Conclusion

This study provides the surgical community, for the first time, with a measure of the effect of shift working on training opportunities and experience. Through the analysis of the changing composition of training opportunities at multiple trusts, we have explored some important considerations for any trust or deanery faced with shift working for higher surgical trainees, particularly in trauma and orthopaedics.

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References

1. Joint Committee on Surgical Training. Certification Guidelines for Trauma and Orthopaedic Surgery. <https://www.jcst.org/key-documents> (cited October 2018).
2. Harris JD, Staheli G, LeClere L *et al*. What effects have resident work-hour changes had on education, quality of life, and safety? A systematic review. *Clin Orthop Relat Res* 2015; **473**(5): 1,600–1,608.
3. McAlinden MG, Dougherty PJ. Orthopaedic education in the united kingdom. *Clin Orthop Relat Res* 2014; **472**(6): 1,697–1,702.
4. Morris DL, Bryson DJ, Olivere BJ, Forward DP. Improving core surgical training in a major trauma centre. *Injury* 2016; **47**(6): 1,202–1,205.
5. Banks LN, Cashman J, Mohil R *et al*. Irish (republic) versus British (North West) orthopaedic trainees: What are the differences? *Surgeon* 2010; **8**(5): 259–261.
6. Zahrai A. Quality of life and educational benefit among orthopedic surgery residents: a prospective, multicentre comparison of the night float and the standard call systems. *Can J Surg* 2011; **54**(1): 25–32.
7. Baskies MA, Ruchelsman DE, Capeci CM *et al*. Operative experience in an orthopaedic surgery residency program: the effect of work-hour restrictions. *J Bone Joint Surg Am* 2008; **90**(4): 924–927.
8. Barrack RL, Miller LS, Sotile WM *et al*. Effect of duty hour standards on burnout among orthopaedic surgery residents. *Clin Orthop Relat Res* 2006; **449**: 134–137.
9. Bates T, Cecil E, Greene I. The effect of the EWTD on training in general surgery: an analysis of electronic logbook records. *Bull R Coll Surg Engl* 2007; **89**(3): 106–109.
10. Wilson T, Sahu A, Johnson DS, Turner PG. The effect of trainee involvement on procedure and list times: a statistical analysis with discussion of current issues affecting orthopaedic training in UK. *Surgeon* 2010; **8**(1): 15–19.
11. Jameson SS, Gupta S, Lamb A, Sher J, Wallace W, and Reed M. Operative experience in trauma and orthopaedics: effect of changes to trainees' working patterns. *Bull R Coll Surg Engl* 2010; **92**: 1–5.
12. 14th Annual Report 2017. National Joint Registry for England, Wales, Northern Ireland, and the Isle of Man. Available from: <http://www.njrcentre.org.uk>. Accessed on 23 November 2017.
13. National Joint Registry data. Available from: <http://www.njrcentre.org.uk/njrcentre/Healthcareproviders/Accessingthedata/StatsOnline/NJRStatsOnline/tabid/179/Default.aspx>. Accessed 23 November 2017.
14. The NCEPOD Classification of Interventions 2004. National Confidential Enquiry into Patient Outcome and Death. Available from: <http://www.ncepod.org.uk/classification.html>. Accessed on 08 January 2018.
15. Shivji FS. Effects of delivering 24-hour major trauma care on the operative experience of orthopaedic trainees. *Bull R Coll Surg Engl* 2015; **97**(9): 393–6.