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ORIGINAL ARTICLE

How time flies: a prospective analysis of theatre efficiency during elective gynaecology lists

M. A. Lewis · R. D. Hall · S. Okolo · W. Yoong

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Abstract The aim of this study was to assess the time patients spend at the various stages of the surgical journey and identifying factors that lead to "bottlenecks". A prospective, observational study of 70 patients over 23 consecutive elective gynaecology lists. Timelines of patients' surgical journey were recorded and various outcomes such as room turnover and patient turnaround intervals calculated. Of the 70 patients (23 major and 47 intermediate), 32 were managed by one anaesthetist and 38 cases by two. The mean arrival in the operating theatre—knife-to-skin interval for major cases was significantly longer than intermediate (17.9 vs. 12.05 min, p=0.001), but there were no statistically significant differences in other time intervals between major/intermediate cases. The mean patient turnaround and room turnover times for the 70 cases were 44.2 and 60.0 min, respectively, and only 60.3% of theatre time was actually spent on surgery. Having two anaesthetists reduced the arrival in the operating theatre—knife-to-skin interval by a mean of 4 min (11.4 vs. 16.63 min, p=0.045) but had no positive effect on other variables. Prolonged patient turnover leads to significant delay, resulting in impaired efficiency. Factors in individual cases which affected patient turnaround time include inadequate preparation of equipment and delays in preparing the patient before anaesthesia. Deploying extra personal at the appropriate time can lead to efficiency savings but adequate planning of both schedules and equipment will lead to the best outcomes.

Keywords Efficiency · Turnaround time · gynaecology · Elective lists

M. A. Lewis
Royal Free and University College Medical School,
London, UK

R. D. Hall · S. Okolo · W. Yoong (✉)
Department of Obstetrics and Gynecology,
North Middlesex University Hospital,
London, UK
e-mail: wai.yoong@nmh.nhs.co.uk

Introduction

Operating theatres assume a substantial portion of hospital resource in terms of facilities, equipment, drugs and staffing. The Audit Commission Report for Operating Theatres involving 70 National Health Service (NHS) Trusts in the UK in 2002 [1] identified that while an ideal, elective theatre unit can work 41 h/week, its average output is only 24.3 h (range 8.3–57 h), with only 70% of available theatre time being utilized for scheduled lists. Furthermore, only 73% of the time allocated for planned lists was actually used for surgery. Equally disappointing is that up to 40% of booked elective cases may be cancelled for various reasons including patients being medically unfit, non-attendance and ironically, to poor utilization of theatre time leading to overrunning of lists [2–4].

Reductions in the NHS budget in the region of £20 billion over the next 4 years, alongside forecasts of increasing service demands and the need to maintain standards mean that hospitals must find ways of undertaking more elective cases within diminishing resources. Operating teams will therefore need to identify inefficiencies and "bottlenecks" which prevent quicker throughput and find innovative ways in order to improve their pattern of work. To that end, the aim of this study was to develop an understanding of how much time is spent during transitions in patients' surgical journey and to assess which factors directly influence the individual breakdown of

theatre times, looking especially at the microenvironment in theatre.

Methods

Data was collected prospectively between June and October 2010 for 70 cases performed over 23 consecutive theatre lists by a single consultant gynaecologist (whose specialty was urogynaecology, vaginal surgery and pelvic reconstruction) at North Middlesex University Hospital (NMUH), London. In the operating theatre complex of NMUH, all patients were admitted directly to an admission bay located at the end of the theatre corridor in order to reduce any potential portering delay.

Time points of the patients' journey through theatre was recorded and these included time sent, time of arrival at anaesthesia room, time of induction, time of arrival in operating theatre, knife-to-skin time, end of procedure, time of anaesthetic reversal and time of leaving theatre. From these each times, seven intervals were calculated, reflecting the different transitions through theatre, i.e. pre-anaesthesia, anaesthesia, surgery, exit (Table 1). Type of surgery (major/intermediate) and anaesthesia used as well as the number of anaesthetists present were also documented. Secondary outcome measures included late starts, theatre overruns and cancellation, and reasons for these were prospectively recorded. Late starts were defined as a greater than 15-min delay to the scheduled knife-to-skin time of 0900 hours for morning lists and 1400 hours for afternoon lists.

Along with this data, theatre lists were analysed noting the *room turnover time* ("time interval of patient entering to leaving theatre"), duration of operation and *patient turnaround time* ("completion of one case to knife-to-skin of the next"). Free text was documented for any additional factors which may contribute to improvement or prolongation of various time points. At all times during the patients' surgical journey, many different disciplines were involved and the roles of the porters (getting the first patient off the table and on the next), anaesthetists (handover of first patient, induction of next), surgeons (preparation for next patient) and theatre staff (disposal of soiled instruments and preparation of new instruments) were assessed.

Statistics

All data collected were normally distributed when subjected to Kolmogorov—Smirnov test and parametric tests (independent sample T and univariate ANOVA tests, SPSS) were used for statistical analysis.

Results

Data from 70 patients were collected prospectively (23 major and 47 intermediate cases) from 23 consecutive theatre lists over a 4-month period. Each list comprised between two and five patients (two patients=7, three patients=10, four patients=4, five patients=2) and cases were predominantly either urogynecological, pelvic reconstruction or vaginal hysterectomy for menorrhagia (Table 2). Thirty-two cases were managed by one anaesthetist and 38 by two; in this study, the second anaesthetist was always a junior trainee (ST1-2) grade. Sixty procedures were performed under general anaesthesia, five cases had regional anaesthesia, four cases intravenous sedation and one used local infiltration. Senior trainees were the main surgeon in 56% of the procedures (mean time 45.62 min) and remaining 44% were performed by the consultant (mean time 40.7 min).

Theatre utilization

The 23 lists amounted to a total of 75 h (4,500 min) of scheduled theatre time. Apart from the 70 patients analysed, a further 4 had been cancelled (5.44%) over the study period on the day itself for reasons which included uncontrolled hypertension, chest infection and shortage of theatre time. The total room turnover time ("the total time when a patient was in theatre") for the remaining 70 patients comprised 99.1% of the total scheduled theatre time (4,469/4,500 min).

Table 1 Time points of patient's surgical journey

Interval	Start time	End time	Compound times
1	Time sent	Arrival at anaesthetic room	Pre-anaesthesia
2	Arrival at anaesthetic room	Induction	
3	Induction	Arrival at theatre	Anaesthesia
4	Arrival at theatre	Knife to skin	
5	Knife to skin	Operation finish	Surgery
6	Operation finish	Reversal of anaesthesia	Exit
7	Reversal of anaesthesia	Leave theatre	

Compound time points reflect the different transitions

Table 2 Type of cases and numbers

Cases		Number
Major	Intermediate	
Vaginal hysterectomy±pelvic reconstruction with mesh		21
Abdominal hysterectomy/open myomectomy		2
	Operative laparoscopy procedures	18
	Operative hysteroscopy procedures	12
	Transobturator tapes	9
	Others	8

There was a mean delay of starting the list of 26.67± 10.12 min (only 2 of the 23 lists commenced on time) and this amounted to 91.3% late starts with the longest delay being due to inadequate preparation of the theatre tray. Only three lists finished within 5 min of the scheduled time, seven lists under-ran (mostly due to last-minute cancellations) and the remaining 13 over-ran (by a mean time of 46.17±37.13 min).

Analyses of time intervals

The time in minutes spent by patients at various stages of their journey are shown in Fig. 1a, b. It is relevant to note that intermediate cases spent 40% of their times coming to and from theatre.

The mean interval time between arrival in operating theatre—knife-to-skin for the 70 cases was 13.94± 10.33 min, and the longest interval of 45 min was due to inadequate preparation of the theatre tray. The mean arrival in theatre—knife-to-skin interval for major cases was significantly longer than intermediates/minors (17.9 vs. 12.05 min, p=0.001, Fig. 2), and this was attributed to a higher proportion of comorbidities in the former group.

The mean patient turnaround time ("interval between previous case leaving theatre and knife-to-skin of the next case" or "waiting time between cases") was 44.2 min and this interval was not statistically different between major and intermediate cases. Interestingly, two of the outlier cases with particularly long turnaround times (108 and 125 min, respectively) were associated with anaesthesia delays: one, a very difficult spinal block in a woman with an arthritic spine and the other, a patient who had not been appropriately pre-assessed prior to theatre.

The mean room turnover time ("time interval of patient entering to leaving theatre") was 72.08 min and only 56.5% (5.7–91.4%) of theatre time was actually spent on surgery. The proportion of time that the surgeon spent operating was significantly greater in major operations than intermediate (68.0% vs. 51.0%, p=0.002).

The mean duration of the 70 operations was 42.48 min, and as expected, major cases took longer to complete compared to intermediates (mean 65.3 vs. 33.9 min, $p<$ 0.05) although this is of little clinical significance.

Does having two anaesthetists improve efficiency?

There were two anaesthetists in 38 of 70 cases (54.3%) but the second anaesthetist was always a junior trainee (ST1-2) grade who required direct supervision. Cases with two anaesthetists had a shorter mean arrival in theatre—knife-to-skin interval (11.4 vs. 16.63 min, p=0.045) but having a second anaesthetist did not have any effect on other time parameters (Fig. 3).

Discussion

In the current financial climate, strategic operating theatre management can increase revenue for NHS trusts, while poor turnaround times [5] and late starts [6] can negatively impact on efficiency (and thus income generation).

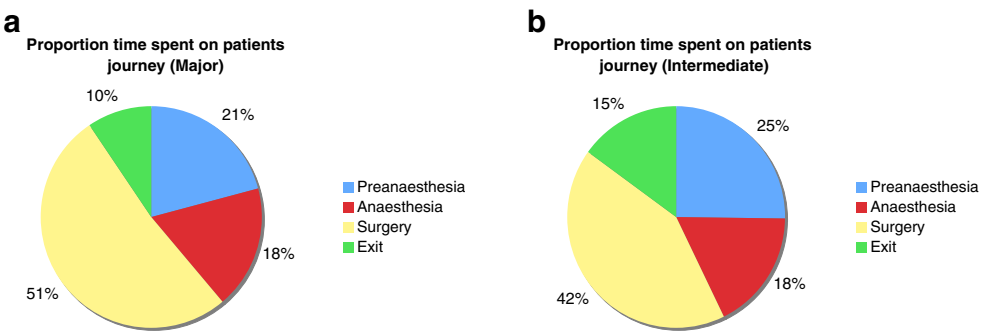

Fig. 1 **a**, **b** Pie charts showing proportion time spent on patient journey (*Major*) and (*Intermediate*)

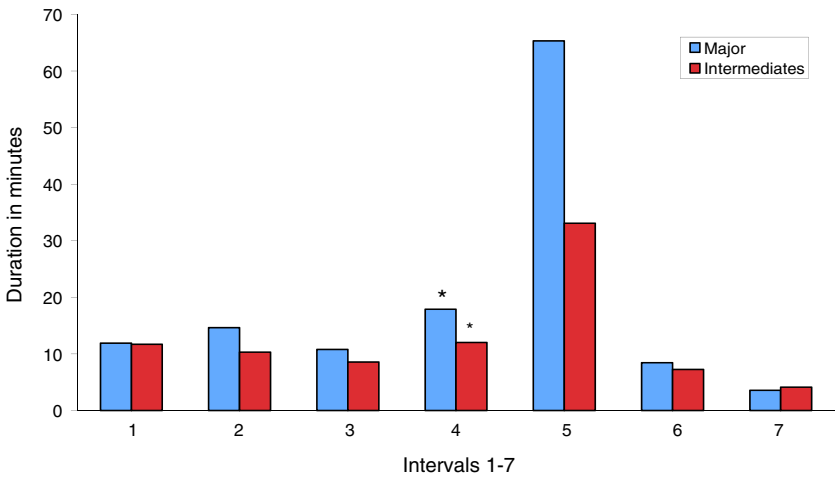

Fig. 2 Bar chart showing time intervals of 23 major and 47 intermediate cases (*$p<0.05$)

Analyses of theatre efficiency and time utilization depend on being able to capture reliable data and many earlier studies have relied on retrospective data based on operating theatre staff's completion of patients' surgical times [6, 7]. More recently, Saha and colleagues [5] from the Royal Free Hospital, London, have recorded prospective data to demonstrate how patient turnaround time can constitute 25% of allocated theatre time and suggested that using two anaesthetists may help streamline patient flow in between cases. In our study, the first author (MAL) and two of his medical student colleagues were delegated to record prospectively various time lines in order to obtain accurate data and more relevant, to document causes of delays and "bottlenecks".

The fact that only 2 of the 23 lists started on time (91.3% late starts) was disappointing and inevitably contributed to the eventual outcome that 13 of the 23 lists overran. This, however, was not that different from contemporaneous gynaecology theatre data [6] and indeed in the early 1990s, Ricketts [8] and Narain [9] noted 94% and 97% delayed starts respectively in elective orthopaedic and general surgery lists, thus showing that the problem of late starts has not been resolved in the intervening 20 years. The mean delay in starting the list of 26.67 min, when extrapolated to 23 elective sessions in our study, means that 613.3 min were "wasted", during which between eight and nine additional cases could have been performed. Late starts therefore lead to a double loss of income, i.e.theatre maintenance cost of £1,000 per hour and staff wage of £4 per minute in addition to the potential revenue gained from the additional cases. Interestingly, Collantes and colleagues [10] in a 2008 review of 1,241 trauma cases, was able to reduce the late starts from 97% to 68% by sending for the patient 26 min before the list is due to start.

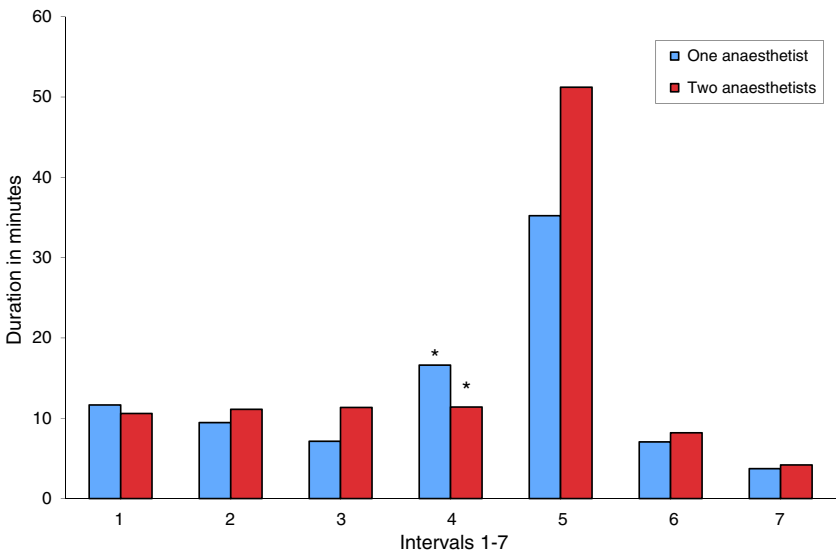

Fig. 3 Time intervals stratified by number of anaesthetists (*$p<0.05$)

The day cancellation rate of 5.44% in this study is similar to the national mean reported 7 years ago by the Audit Commission [1] but the irony was that two of the four cancellations were due to theatre overrunning. Cancelled cases have financial implications as national contracts require trusts to rebook cancelled patients within 28 days, thus creating extra pressure on existing scheduled lists. It is equally important to recognize socioeconomic impact on patients who have undoubtedly arranged their work and family commitment around operation dates [11].

This study highlights several practical points which must be overcome in order to streamline patient flow through theatre. Timely preparation of the instrument trays preoperatively, ensuring adequate staff in the recovery bay to maintain turnover, as well as early "sending for" of the patient prior to the list start time, are simple measures which can facilitate patient flow. Unlike data from Saha and colleagues [5], we argue that having two anaesthetists does not necessarily improve efficiency (as most time intervals were not improved) if the second member of the anaesthetic team has limited experience and require constant direct supervision. The concept of a mobile "recovery" anaesthetic team which will transport the patient to the recovery bay, thus enabling the anaesthetist to induce the next case, should be considered: this would reduce patient turnaround time.

Lastly, it is important to be aware that the Royal College of Obstetricians and Gynaecologists 2009 Trainees Survey had noted that while supervision in the theatre remains "good", trainees' experience in operative teaching has declined consistently over previous surveys ("due to the decline in operating volume"). It is certain that this will be compounded by the current efficiency drive to optimise theatre utilization which pressurise many consultants into performing the elective cases themselves in order to avoid overrunning [12].

Thus, such changes must be accompanied by a need to rationalize and rethink our approach to operative training by including learning opportunities as training lists, simulation and self-directed "adult learning".

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Conflict of interest The authors declare no conflict of interest.

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References

1. Commission A (2003) Operating theatres: review of national findings. CW Print Group, London. ISBN 1862404453
2. Lacqua MJ, Evans JT (1994) Cancelled elective surgery: an evaluation. Ann Surg 60:809–811
3. Rai M, Pandit JJ (2003) Day of surgery cancellations after nurse-led pre-assessment in an elective surgical centre: the first 2 years. Anaesthesia 58:692–699
4. Pandit JJ, Carey A (2006) Estimating the duration of common elective operations: implications for operating list management. Anaesthesia 61:768–776
5. Saha R, Pinjani A, Al-Shabibi N, Madari S, Ruston J, Magos AL (2009) Why are we wasting time in the operating theatre. Int J Health Plan Man 24:225–232
6. Walsh U, Alfhaily F, Gupta R, Vinayagam D, Whitlow B (2010) Theatre sending: how long does it take and what is the cost of late starts? Gynecol Surg 7(3):307–310
7. Haiart DC, Paul AB, Griffiths JM (1990) An audit of the usage of operating theatre time in a peripheral teaching surgical unit. Postgrad Med J 66:612–615
8. Ricketts D, Hartley J, Patterson M, Harries W, Hitchin D (1994) An orthopaedic theatre timings survey. Ann R Coll Surg Engl 76 (3):200–204
9. Narain P, Tackley R, Lee M, Clyne C (1992) A computer audit of the use of theatre time by a surgical team. Ann R Coll Surg Engl 7:166–168
10. Collantes E, Mauffrey C, Brewster M (2008) A review of 1241 trauma cases: a study of efficiency in trauma theatres. Injury Int J Care Injured 39:742–747
11. Sanjay P, Dodds A, Miller E, Arumugam PJ, Woodward A (2007) Cancelled elective operations: an observational study from a district general hospital. J Health Organ Manag 21(1):54–58
12. Yoong W, Lewis MA, Hall RD (2011) The drive to improve theatre efficiency in the NHS: are there implications for the obstetrics and gynaecology trainees? J Obstet Gynaecol 31(2):104