Ann R Coll Surg Engl 1994; **76**: 200–204

An orthopaedic theatre timings survey

David Ricketts FRCS
Registrar

John Hartley MB BS
Senior House Officer

Department of Orthopaedics, The Central Middlesex Hospital, London

Marc Patterson FRCS
Consultant Surgeon

Department of Orthopaedics, Princess Royal Hospital, Haywards Heath, West Sussex

William Harries FRCS
Registrar

Department of Orthopaedics, Northwick Park Hospital, Harrow, Middlesex

David Hitchin BA(Hons)
Statistician

Computing Service, Arts B, University of Sussex, Brighton

Key words: Medical audit; Orthopaedics

The efficient use of operating lists is important to clear waiting lists and because they are expensive to run (at 1988 prices, £151 per hour). Of general surgical theatre session time, 49% is used for performing operations, but no survey of orthopaedic theatre sessions has been published. In light of this we surveyed 151 elective orthopaedic lists at three hospitals. Our aims were to determine the use of operating rooms and the reasons for inefficient use of time.

We found 60% of elective list time was used for operating and 21% for turnover. No useful activity occurred during the remaining 19% of theatre time. An average start delay of 26.5 min and average early finish of 14.5 min contributed to this.

Only 9/151 (6%) of lists started within 5 min of the scheduled time. Of unnecessary delays contributing to this, 63% involved anaesthetic staff and 24% theatre staff. Surgeons were implicated in 10% of start delays. There were less start delays if senior anaesthetic staff were present. During lists, turnover times were quicker if a consultant surgeon was present ($P = 0.0022$).

We conclude that more efficient use of elective orthopaedic theatre sessions is possible and could be achieved if more detailed preparation was undertaken by the anaesthetic, theatre and surgical staff concerned. If a consultant surgeon is present the list is likely to proceed with fewer delays.

Correspondence to: Mr D Ricketts, Senior Registrar, Department of Orthopaedics, The Bristol Royal Infirmary, Bristol BS2 8HW

The efficient use of operating theatre time is important for several reasons. First, financial considerations. At 1988 prices, and excluding 'consumables', the 2564 operating theatres in the NHS cost £484 million to run—an average of £151 per hour *(1)*. Operating sessions are plainly an expensive and limited resource.

In addition, more efficient use of operating theatres may help in clearing waiting lists. Finally, throughput in the operating theatre is often used as an index of surgeons' performance *(2)*, sometimes in the popular press *(3)*.

Despite the above, reports concerning general and vascular surgery have concluded that surgeons spend only about half of their scheduled theatre time operating *(4,5)*. No recent survey of theatre use by orthopaedic surgeons is available.

In the light of this we undertook a prospective survey of the timing of events during elective orthopaedic lists. These lists are particularly important; they can produce significant financial renumeration for the hospital concerned. Our aims were to determine the current use of operating list time and the reasons for inefficient use of time.

Methods

We surveyed prospectively the timing of events in the operating room during orthopaedic operating lists at

Table I. Details collected for each list

1	Date of list.
2	Day of week.
3	Scheduled start time of list.
4	Grade of surgeon performing operation (consultant, registrar, senior house officer).
5	Grade of anaesthetist (consultant, senior registrar, registrar, senior house officer).
6	Details of each case on list (name, age, planned procedure).
7	Time the list started (knife to skin).
8	Duration of the first case in minutes (knife to skin until patient off table).
9	Turnover time between end of first case and beginning of second case.
10	Duration and turnover times of all subsequent cases on list.
11	Actual time of list finish.
12	Scheduled time of list finish.

three hospitals; each had a theatre manager and similar case mix and staffing levels. At each hospital an orthopaedic registrar or senior house officer recorded details of each patient and timed events within the operating suite (Table I).

Only routine elective orthopaedic lists were surveyed; the use of operating theatre time during trauma lists was more inefficient and formed a separate study. We did not distinguish between day case and other patients, as in all three hospitals lists contained a mix of such cases. We did not record data concerning cancelled sessions or cases. In all three hospitals, academic meetings took place on Wednesday afternoons and no operating was scheduled.

For the purposes of this study, each case started with the application of knife to skin and finished when the patient left the operating table. Any event more than 5 min later than expected during the list was marked 'delayed'. Delays were further subdivided into unnecessary or appropriate. An unnecessary delay was defined as forseeable, avoidable or due to deviation from routine practice for no good reason. If an unnecessary delay occurred the reason was entered by the surgeon recording data in one or more of the following categories: surgeon, anaesthetist, theatre, ward. The reasons for appropriate delays were not noted.

The following are examples of appropriate delays: emergencies related to patient care causing delays in the ward or with portering and anaesthetic staff, difficult intubation, resterilisation of equipment between cases. The following are examples of unnecessary delays: late arrival of anaesthetic or surgical staff, planned general anaesthetic changed to regional block (without any alteration in patient condition) leading to delay while the block was instituted, delay due to essential surgical instruments not prepared for procedure.

We defined turnover time as the time interval between the end of one case and the beginning of the next. During turnover time many staff had a role to play, including the porters (getting the first patient off the table and the next on), anaesthetists (handover of first patient, induction of next), surgeons (preparation for next procedure) and theatre staff (disposal of soiled instruments and preparation of new instruments). Often minor procedures (eg manipulations, removal of K-wires) took place in the anaesthetic room during the course of long operations. If this overlapped the end of the major case, the turnover time was entered as 0 min.

Regarding statistical analysis, all P values quoted relate to Kruskal–Wallis analysis of variance by ranks, since the data distributions are too skewed for the usual analysis of variance procedure.

Results

Number of cases on list

A total of 458 operations on 151 elective operating lists was surveyed, an average of three cases per list (hospital 1, 152 operations on 58 lists; hospital 2, 228 operations on 66 lists and hospital 3, 78 cases on 27 lists). There was no significant differences between hospitals regarding duration of operations (mean 43 min, range 1–220 min, $P = 0.8417$) or mean turnover times (mean 22 min, range 0–66 min, $P = 0.3629$).

Each list had at least one operation scheduled; none was left vacant. One operation was performed on 26 lists (17%), two on 44 lists (29%), three on 30 lists (20%), four on 23 lists (15%), five on 11 lists (7%), six on 15 lists (10%), seven on two lists (1%), eight on one list (0.5%) and nine on one list (0.5%).

Time spent operating

During the 151 lists surveyed, the actual time spent operating constituted 60% (19 534/32 460 min) of the total scheduled session time. If the turnover time was included this figure rose to 81% of the list (26 297/32 460 min). During 19% of the scheduled operating time (6163 min) no useful activity occurred (ie neither operating nor turnover time).

From the beginning of the first case to the end of the last case, surgeons spent 74% of the time operating (19 534 min) and 26% awaiting turnover (6763/26 297 min). The turnover time was used to write operation notes and perform coding.

Starting and finishing times

The average delay in starting lists was 26.5 min (24 min for 75 morning starts and 29 min for 76 afternoon starts). Lists finished on average 14.5 min early (morning lists 13 min, afternoon lists 16 min).

Delays

Of the 151 lists surveyed, 9/151 (6%) started on time, 61/151 (40%) were delayed appropriately and 81/151 (54%) were delayed unnecessarily. The reasons for unnecessary delay are given in Table II.

Of all unnecessary delays, anaesthetists were implicated in 78/132 (59%). At the start of the list they were involved in 51/81 (63%) of unnecessary delays and were the sole reason for delay in 40/81 (49%). Additionally, during the lists, 26/51 (51%) unnecessary delays were noted as anaesthetic in origin. Overall, the two most common reasons for delay in the anaesthetic category were late arrival and unsupervised junior staff experiencing difficulty with anaesthetic procedures.

Theatre staff were involved in 33% of all delays, 27/81 (33%) of start delays and 16/51 (32%) of delays during lists. In this category unfamiliarity with equipment was a common reason for delay. Surgeons were implicated in 9/81 (11%) of start delays and 4/51 (8%) of delays during the list. Late arrival in the operating room was the most common reason for delay. Problems with the ward caused 5/81 (6%) of start delays and 5/51 (10%) delays during the lists. Incomplete preparation of the patient for theatre was the most common cause for delay.

Day of week

Table III shows that 232/458 (51%) of all operations were performed on Mondays and Tuesdays. On Friday the number of operations performed was smaller and the operations tended to be shorter with a longer start delay. None of 18 Friday afternoon lists started on time, but the lowest rate of late finishes was on Friday.

Grade of surgeon

Table IV shows 309/458 (67%) of elective orthopaedic operations were performed with a consultant surgeon scrubbed. Consultant surgeons and registrars took similar times to perform procedures. It was likely that more complex procedures were performed by consultant surgeons, but that this was compensated for by their faster speed of operating. We noted that turnover time was

Table II. Frequencies of reasons for unnecessary delays

Reason given	*Late start*	*During list*
A	40/81 (49%)	26/51 (51%)
T	19/81 (24%)	15/51 (29%)
S	8/81 (10%)	4/51 (8%)
A + T	8/81 (10%)	1/51 (2%)
W	3/81 (4%)	5/51 (10%)
A + W	2/81 (2%)	0/51 (0%)
A + S	1/81 (1%)	0/51 (0%)
Total	81 (100%)	51 (100%)

A = Anaesthetic reason for delay. S = Surgeon caused delay
W = Ward caused delay. T = Theatre staff caused delay

Table III. Data by day of week

Day	*No. of operations*	*Duration (range)*	*No. of turnovers*	*Duration (range)*	*No. of starts*	*Late starts*	*Lateness: starts (range)*	*Late finishes*	*Lateness: finishes (range)*
Monday	109/458 (24%)	46 min (1–150)	72 (24%)	24 min (0–66)	37 (24.5%)	32 (86%)	25 min (0–60)	14 (38%)	15 min (0–92)
Tuesday	123/458 (27%)	36 min (3–210)	93 (30%)	19 min (0–90)	30 (20%)	29 (97%)	27 min (0–70)	16 (53%)	16 min (0–60)
Wednesday	76/458 (16%)	59 min (5–165)	41 (13%)	28 min (5–55)	35 (23%)	35 (100%)	30 min (7–55)	12 (34%)	11 min (0–100)
Thursday	95/458 (21%)	41 min (3–220)	64 (21%)	22 min (0–60)	31 (20.5%)	28 (90%)	21 min (0–60)	11 (35%)	11 min (0–80)
Friday	55/458 (12%)	32 min (3–185)	37 (12%)	22 min (0–65)	18 (12%)	18 (100%)	31 min (15–70)	5 (28%)	11 min (0–60)
Total	458 (100%)	43 min (1–220)	307 (100%)	22 min (0–90)	151 (100%)	142	26 min (0–70)	58	13 min (0–100)

Durations differed significantly between the days of the week ($P < 0.0001$). Longer cases tended to be done on Wednesday and shorter on Friday
Turnover time differed significantly between the days of the week ($P = 0.001$)
Late starts differed significantly between the days of the week ($P = 0.0402$)
Day of the week was not significantly associated with a late finish ($P = 0.5031$)

Table IV. Data by grade of staff

Grade	*Number of operations*	*Duration of operations (range)*	*Number of turnovers*	*Duration of turnover (range)*
Surgeon				
Cons	252/458 (55%)	42 min (1–220)	176 (57.5%)	20 min (0–90)
Reg	118/458 (26%)	42 min (4–150)	75 (24.5%)	26 min (3–65)
SHO	30/458 (7%)	48 min (5–150)	16 (5%)	27 min (15–50)
Cons and Reg	57/458 (12%)	44 min (3–110)	40 (13%)	23 min (5–65)
Reg and SHO	1 (0%)	115 min	0 (0%)	—
Total	458 (100%)	43 min (1–220)	307 (100%)	22 min (0–90)
Anaesthetist				
Cons	341/458 (75%)	42 min (1–220)	232 (75.5%)	21 min (0–66)
SR	3/458 (1%)	29 min (17–45)	2 (0.5%)	37 min (20–53)
Reg	93/458 (20%)	43 min (4–170)	60 (20%)	27 min (10–90)
SHO	6/458 (1%)	32 min (12–100)	4 (1%)	26 min (20–30)
Cons and Reg	15/458 (3%)	55 min (12–110)	9 (3%)	20 min (20–28)
Total	458 (100%)	43 min (1–220)	307 (100%)	22 min (0–90)

Cons = consultant, SR = senior registrar, Reg = registrar, SHO = senior house officer
Variation of duration by surgeon grade was not significant ($P = 0.1090$)
Turnover time was significantly linked to surgeon grade ($P = 0.0022$)
Turnover time did not vary significantly with grade of anaesthetist ($P = 0.0809$)
Variation of duration ($P = 0.1118$) did not differ significantly with grade of anaesthetist

significantly linked to the grade of surgeon ($P = 0.0022$) and was shortest for consultants.

Grade of anaesthetist

Table IV shows that consultants administered 75% of anaesthetics. Turnover time was not significantly shorter with senior anaesthetists ($P = 0.0809$).

Anaesthetic delays were analysed by grade of anaesthetist. For consultant anaesthetists, unnecessary delays at the start of lists were attributed to anaesthetic reasons in 88/174 (51%) of cases. For registrars and SHOs the figures were (43/59) 73% and (3/3) 100%, respectively.

Discussion

Delays in start of lists

Of the lists surveyed, 142/151 (94%) started more than 5 min late. This figure is similar to the 76/78 (97%) late starts noted in general surgery *(4)*. In the current study there were two principal reasons for late starts, anaesthetic problems and non-standardisation of the start time.

Anaesthetic problems were implicated in 64% of unnecessary late starts and 51% of unnecessary delays during lists. Some appropriate delays were due to anaesthetic problems, but reasons for these were not recorded.

Regarding start times, staff concerned with the operating theatre had different ideas of what the start time meant. For example, to the surgeon a 0900 start was the latest time the patient should be ready for the operation to begin. Others had different ideas. For example, porters aimed to have the patient within the theatre complex by 0900 and ward staff aimed to have the patient out of the ward by 0900. Similarly, theatre staff had experienced difficulty in readying complex instrumentation by the start time (Table II). Clearly, a standard routine needs to be agreed in the hospitals studied.

To minimise delays at the start of the list it is important to agree the time at which the first patient will be placed anaesthetised on the operating table and this should be overseen by the theatre manager. A senior member of the anaesthetic staff should ensure the process of anaesthetising patients is begun appropriate to the scheduled start time of the list. Also, the presence of a consultant surgeon at the start of the list will likely decrease delay, both at the start of the list and during it. Often, anaesthetists are unhappy to start anaesthetising a patient unless they know a surgeon is at hand.

In the current study surgeons were not blameless. They directly caused about 10% of all theatre delays. Poor communication by surgeons may also have led to some delays attributed to others in this study. In general surgical practice 94% of start delay time and 73% of delays during lists were attributed to surgeons *(6)*.

Activity during the list

During 19% of scheduled operating time, no useful activity took place, neither operating nor turnover. This is similar to 23% of time wasted during general surgical lists *(6)*. Poor scheduling of lists by surgeons, with overestimation of the time needed may have contributed to this. In the current study, the actual time spent operating (60%) was better than for general surgery (49%) *(4)*.

Lists on Fridays did not run well. Starts were later and turnover longer than during other days of the week. We

suggest two solutions to this problem. First, elective orthopaedic lists should, if possible, not be scheduled on Friday afternoons. Second, Friday lists should only proceed with consultant anaesthetists and surgeons. Despite the 100% late start rate it is interesting to note that the lowest incidence of late finishes (28%) was seen on Fridays.

Conclusion

In the current survey of 151 elective orthopaedic operating lists, 19% of theatre time was unused. This has important consequences for hospital expenditure, hospital income and the clearing of waiting lists. To maximise use of theatre time we suggest that more detailed planning by the surgeons, anaesthetists and theatre staff would be helpful. In addition a consultant surgeon should ideally be present at each list, particularly on Fridays.

References

1 NHS Management Executive (P Bevan, Chairman). *The Management and Utilisation of Operating Departments.* London: HMSO, 1989.

2 Opit LJ, Colloins REC, Campbell G. Use of operating theatres: the effects of case mix and training in general surgery. *Ann R Coll Surg Engl* 1991; **73**: 389–93.

3 Forbisher J, Lightfoot L. A suitable case for treatment: time wasting NHS surgeons. *The Sunday Times* 11 October 1992: 3.

4 Narain PK, Tackley R, Lee M, Clyne CAC. A computer audit of the use of theatre time by a surgical team. *Ann R Coll Surg Engl* 1992; **7**: 166–8.

5 National Audit Office. The use of operating theatres in the national health service in England. Report by the comptroller and auditor general. London: HMSO, 1989.

6 Haiart DC, Paul AB, Griffiths JMT. An audit of the use of operating theatre time in a peripheral teaching surgical unit. *Postgrad Med J* 1990; **66**: 612–15.

Received 6 October 1993