Measuring General Surgical Workload in the Day Surgery Unit

O Faiz[a], AJ Mcguire[b], P.Tekkis[c], JA Rennie[a], S Papagrigoriadis[a], P Baskerville[a], AJM Leather[a]

Abstract

Introduction A reliable complexity-adjusted measure of operative workload could facilitate monitoring of service delivery in day surgery units (DSUs).

Methods A complexity-adjusted scoring system -the Operative Score of Complexity Index(OSCI)- was developed and used to measure changes in theatre workload, case complexity and session productivity over a seven year period at an ambulatory centre.

Results OSCI scores correlate well with caseload markers of performance (i.e. counts of operations performed) when case mix is consistent. This relationship fails however when case-mix is broad. The OSCI system was able to detect changing case complexity over time as well as large differences in list productivity on individual consultant surgeons' sessions($p<0.001$).

Conclusions – The OSCI system potentially offers an easily developed tool that could facilitate operational decision making and service monitoring in ambulatory centres.

Keywords: General surgery; Day case; Day surgery unit.

Authors' addresses: [a]Department of General Surgery, Kings College Hospital, Denmark Hill, London SE5 9RS, United Kingdom. [b]Department of Health and Social Care, Cowdray House, London School of Economics and Political Science, Houghton Street WC2A 2AE, United Kingdom. [c]Department of Surgical Oncology and Technology, St Mary's NHS Trust, Praed Street, London W2 1NY, United Kingdom.

Correspondence: O. Faiz *E-mail:* omarfaiz@aol.com

Introduction

The number of patients waiting for National Health Service (NHS) operations has, until recently, exceeded one million [1]. The current government have set ambitious targets regarding the reduction of inpatient hospital waiting lists to a maximum wait of 6 months by the end of 2005 and then to 3 months by 2008 [2]. The principal mechanism by which the government intends to limit the elective surgical burden placed on inpatient hospital resources involves a promotion of elective day surgery [3]. However, a recent national survey carried out by the Healthcare Commission cites that the transfer of appropriate elective patients from inpatient to day centre settings has, so far, achieved only limited success [4].

In order to estimate the genuine progress of the government's intended day surgery plans a reliable method of quantifying the workload and productivity rates achieved by day surgery units (DSUs) is fundamental. Historically, qualitative measures of theatre time usage, such as utilization, have been used as descriptive markers of theatre performance in addition to providing estimates of apparent residual system capacity. The recent Healthcare Commission audit suggested that across NHS DSUs, 'end utilisation' rates averaged only 55% [4]. As such it was suggested that significant existing day surgery capacity is currently under-employed. It is essential to note that utilization measures convey no information regarding the actual 'output' or workload achieved by a given day surgery (DS) theatre unit. In the case of slow procedure completion it is possible for theatres to be well utilized but unproductive. Quantitative methods of measuring workload and productivity in ambulatory centres are essential if genuine changes in local and national DS service performance are to be evaluated. Recent government plans to move away from historical block funding mechanisms towards performance related reimbursement [5] further emphasises the need for accurate quantification of service delivery.

The need to adjust for case mix complexity represents the principal barrier to effective quantification of operative workload. Use of case load measures (i.e. counts of operations) for service performance estimation in the DSU is routinely carried out for managerial purposes but its reliability in this context has not been verified. When applied to inpatient procedures the use of case loading has proven an inaccurate measure of workload due to its failure to adjust for heterogeneous case mix complexity [6,7]. Various systems have been used to attempt to overcome this problem. Firstly, a crude weighting system that distinguishes between local and general anaesthetic day case procedures was used by the Healthcare Commission to quantify DSU workload. The latter tool detected a significant fall in monthly workload between 2000 and 2004 amongst DSU's where direct comparison was possible [4]. The most widely applied case mix adjusted methods of surgical workload quantification are the Intermediate Equivalent (IE) [8-11] and, more recently, the Healthcare Resource Group (HRG) systems [12]. The former is based historically upon operative private sector fees and the latter upon the hospital resource consumption associated with specific procedures. Importantly, neither of these systems are reliant upon operative procedure time as a marker of complexity. In fact, attempts to validate the IE system against operative procedure time demonstrated a tendency towards underestimation of workload when the IE's have been applied to measure complex general surgical procedures [13].

Aims

The principal aim of this study was to develop a complexity adjusted scoring system that would enable quantification of DS general surgical theatre workload on the basis of operative procedure time. The secondary aims of the study were to use the scoring system to retrospectively investigate quantitative changes in annual departmental ambulatory workload carried out over a seven-year study period and to analyse differences in the productivity rates associated with specific consultant surgeons' operative sessions.

Methods

Data sources

The Kings College Hospital theatre database (Surgiserver © McKesson HBOC), pertaining to all elective general surgical operations carried out in the DSU between 1st April 1997 and 1st April 2004, was used for this study. Key procedure timings, participating personnel and Office of Population Census and Statistics (OPCS-4) procedure codes for all study operations were entered onto the database prospectively at the time of each patient's theatre journey. The theatre data were transferred to Excel 2002 (Microsoft Corporation, USA) and SPSS ("Statistical Package for the Social Sciences" version 12, Chicago, Illinois, USA) formats for subsequent data handling and statistical analysis respectively. Individual operations were amalgamated into theatre lists. The latter were coded according to consultant surgeon and their respective sub-specialties. Consultant surgeons were afforded an individual code if more than 100 database procedures had been assigned to them. Operations where no consultant code was assigned were amalgamated into a miscellaneous category. Procedure time represented the combined anaesthetic and surgical time utilized for a given operation. The procedure time was defined as the time between the start of anaesthesia and the removal of the surgical drapes at the end of the operation.

Developing the Operative Complexity Index in order to quantify theatre output and productivity

Operations had been assigned OPCS-4 codes in 79.1% of all database procedures. The latter procedures were coded to 79 respective OPCS-4 procedure categories in the database. A case score represents a term that was given to the complexity-adjusted 'size' of a given procedure. The numerical calculation of a case score (OSCI units) was performed by dividing the median duration (in seconds) of all database operations coded to a specific OPCS-4 category by 30. The latter calculation was performed to simplify and reduce the numerical score to a tangible figure. As such, a case score represents a complexity adjusted score that is based upon the historical time taken to perform a procedure when all database surgeons performing that procedure in the DSU were considered . The size of individual operating lists was consequently determined by summing the case scores of constituent list procedures. The latter score was termed a list score and was similarly measured in OSCI units. On lists where a case lacked an OPCS-4 identifying code the median procedure score for all database procedures was assigned to it in order to permit the calculation of a list score. The median procedure time (score) for all database procedures was 26 minutes (52 case score units). Theatre list productivity was calculated by quantifying the list score achieved per hour of allocated theatre list time (i.e. OSCI units per hour).

Study outcomes

The potential use of case scoring, as a complexity adjusted descriptive marker of annual DS theatre performance, was compared to annual case load and cumulative total departmental procedure time measures of theatre activity. Differences in productivity rates between consultant surgeons' DS operating sessions were investigated.

Statistical analysis

Data were described as mean values (+/- standard deviation, n) for parametric data distributions. One-Way ANOVA was used to determine significant differences between theatre workload and productivity rates across the study years and consultant general surgeons' sessions. Spearman's correlation was used to investigate the relationship between session case load and session list score markers of workload. $P<0.05$ was considered statistically significant.

Results

Patient and database characteristics

In total, 8,314 general surgical operations were performed on 2,092 operating lists in the DSU between April 1997 and April 2004. At the time of operation the median patient age was 44 years (34-58years, n=8,073) and a marginal excess (50.2%) of females was observed (4171/8283 cases) in the study group. Nearly all (99.2%) general surgical lists carried out in the day surgery department were 4 hour operating sessions.

A) Measurements of complexity adjusted general surgical theatre workload in the DSU (See Table 1)

Analysis of trend changes over the study period suggested that increases in the annual provision of operating lists to the general surgery department were generally accompanied by concomitant proportional increases in the annual numbers of procedures (case load) performed. However, in Year 2 a greater number of procedures were carried out than in Year 6 despite the provision of a similar number of operating sessions. The latter is suggestive of a changing case mix towards more complex operating throughout the study period The disproportionately high total annual departmental procedure time consumed in Year 6, compared with the relatively similar number of cases performed in the earlier study years, further corroborates the probability of changing case mix.

In this study the use of the OSCI as a method of quantifying complexity adjusted general surgical DSU theatre output was investigated. Table 1 illustrates the annual cumulative departmental workload achieved throughout the study period expressed in terms of OSCI units. Comparison of the latter scores with annual caseload indices confirmed some discrepancy in apparent performance. When

Table 1 Markers of annual General Surgical DSU theatre performance.

Year	No. of lists	No. of Procedures	Total Procedure time (hours)	Cumulative OSCI scores (units)
1	389	1250	705	80,400
2	329	1431	820	94,400
3	262	1118	725	79,700
4	290	1185	743	85,400
5	291	1143	763	83,900
6	326	1172	856	87,700
7	305	1015	764	78,800

the performance measures of the first two study years were combined and compared to those of the last two years, falls in caseload and OSCI scores of 18.4% and 4.7% were noted respectively (Table 1).

The latter disproportionate drop in workload, as measured by case load markers, confirmed an increase in operative complexity throughout the study period. At the same time some genuine diminution of general surgery theatre output from the DSU also occurred.

A trend towards increasing case mix complexity was further confirmed when mean procedure case scores were plotted against study year (Figure 1).

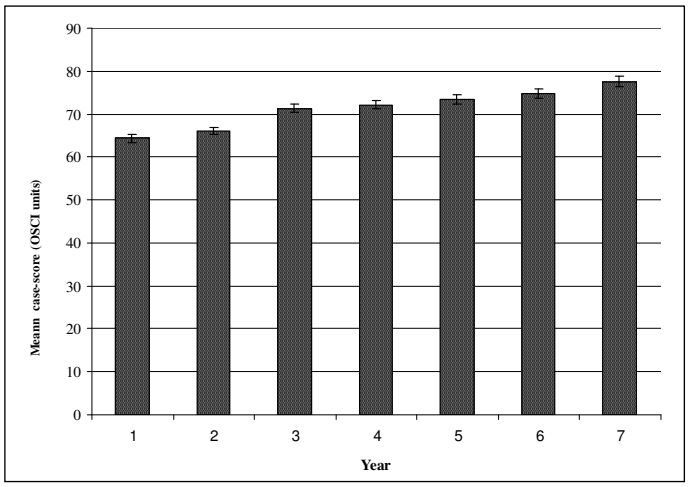

Figure 1 Mean procedure case score (OSCI units) +/- standard error per study year.

Average procedure complexity in Year 7 was significantly higher than the average complexity recorded in the first four study years (One-Way ANOVA, $p<0.05$). One significant factor contributing towards the increasing operative complexity noted above was the phasing out of endoscopy procedures in the DSU over the study period. Endoscopies were performed under sedation in the day surgery department in the early study period but were later transferred to a dedicated endoscopy unit. This change is visible, in part, by the complete absence of procedures performed under sedation (Table 2) in the second half of the study. In consequence, case mix shifted towards operative procedures requiring general anaesthesia in the later study years.

Table 1 Type of anaesthesia in the early and late study years

	Years 1 & 2		Years 6 & 7	
	No. of operations	%	No. of operations	%
General anaesthesia	1200	44.76	1637	74.85
Local anaesthesia	803	29.95	538	24.60
Sedation	639	23.83	0	0.00
Regional anaesthesia	39	1.45	12	0.55
Total	2681	100.00	2187	100.00

Overall, the case-load on general surgical lists carried out in the DSU correlated well with the list-scores (OSCI units achieved per corresponding session, Spearman's correlation, $r = 0.580$, two-tailed significance < 0.01 level). A scatter plot of session case load versus list scores (with lowess curve insertion) demonstrated that the correlation between the two markers approximated best on lists where the case load was 4 operations or fewer (Figure 2).

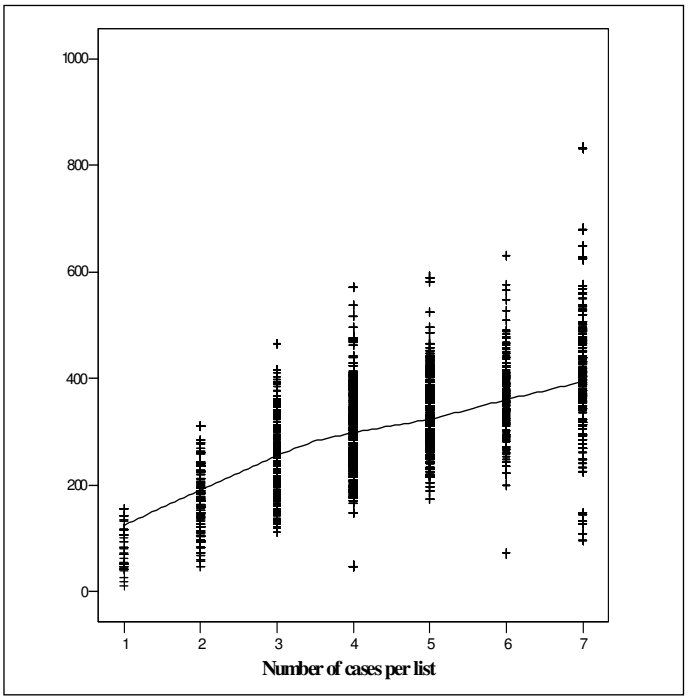

Figure 2 Scatter plot of the number of cases per DS operating session (x-axis) versus the list scores measured in OSCI units (y-axis) achieved per session (with lowess curve fit)..

Beyond this operative volume a visible plateau of the curve occurred. The latter is highly suggestive of differing case mix between small and high case load sessions respectively. Importantly, the operating lists where extremely high numbers of procedures were carried out all represented sessions performed either under local anaesthesia or sedation. As such, due to the lower procedure complexity of cases on high case-load sessions a proportionate increase in list scores achieved on these sessions was not observed.

ii) Operating session productivity in the day surgery department

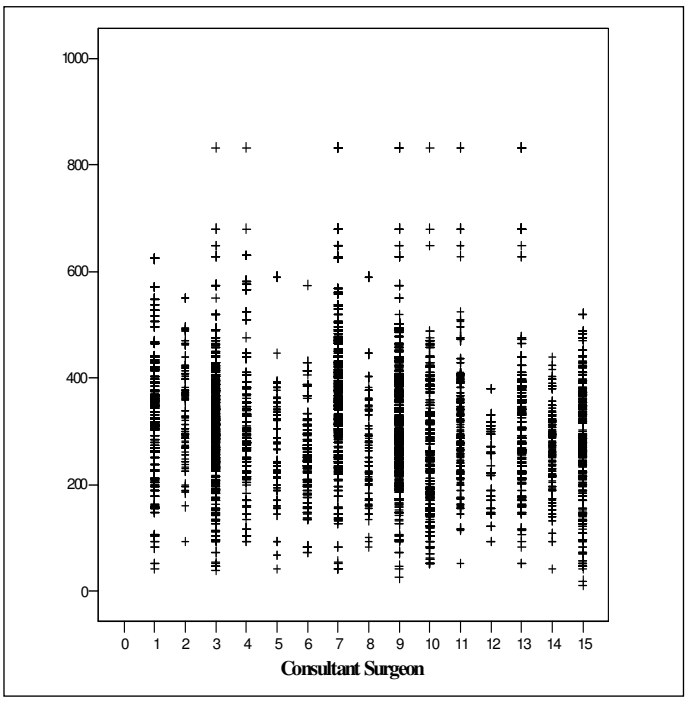

Figure 3 Operating list output i.e. list-scores in OSCI units per 4 hour session (y-axis) in the DS unit according to Consultant Surgeons operating session (x-axis) between 1997 and 2004.

Operating lists were classified according to individual consultant general surgeons. Figure 3. illustrates the workload (in OSCI units) achieved on the individual consultant surgeon's day surgery operating lists throughout the study period. Obvious differences and wide variation in output achieved between respective surgeon's operating sessions were observed. Figure 4. illustrates the mean hourly productivity rates of each individual consultant surgeon's day surgery operating list when all database procedures were considered. Significant differences were noted between consultant surgeon's respective list productivity rates (One-way ANOVA, F:79.351, $p<0.001$). Specifically, the mean OSCI score per hour of the most effective session (that coded to Breast & Endocrine Surgeon 2) was over 50% more productive than the least effective (that coded to Colorectal Surgeon 4).

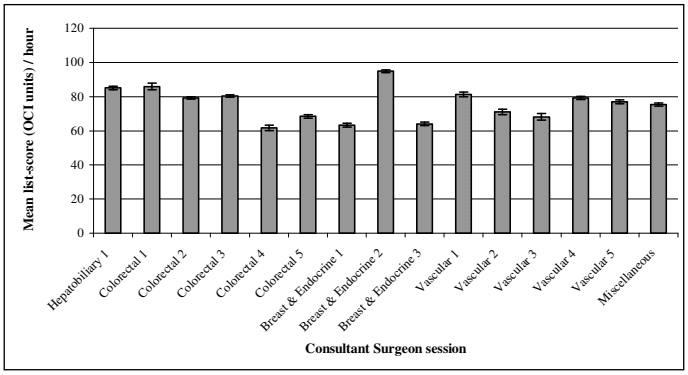

Figure 4 Mean productivity (list scores in OSCI units per hour of allocated session time) +/- standard errors on Consultant Surgeons' operating lists in the day surgery department between 1997 and 2004.

Discussion

Throughout the study period a small genuine decrease in the operative workload carried out by the general surgery department in the DSU was observed. Caseload estimation significantly overestimated this reduction in workload due to its failure to adjust for an increase in case mix complexity that occurred throughout the study period.

Previous investigators have noted the potential use of historical procedure times for operating list planning [14]. This study demonstrated that historical procedure times could also be used effectively to quantify operative complexity and consequently to develop a local tool that enabled accurate case mix adjusted measurement of DS service delivery.

For general surgery procedures performed in the DSU case load estimation of workload can offer a broad indication of performance where case mix is uniform. Certainly, a positive correlation between session case load and complexity adjusted session OSCI scores was observed in the study when similar lists were compared. Importantly, departments where heterogeneity of operative case mix is broad should expect significant inaccuracy from case load measures of activity. Reliance on the latter marker will consequently fail to meaningfully convey changes in the workload achieved by the department or individual clinician.

Two principal factors underlie the increasing average case complexity that occurred throughout the study period at our centre. In the first instance the removal of endoscopy sessions represented a major contributor towards finding greater average complexity amongst the residual procedures. In addition the successful implementation of the day surgery agenda [3] has resulted in the transfer of an increasing number of intermediate complexity patients from inpatient waiting lists to the DS unit. Recognition of this changing case mix throughout the study period would not have been possible without the application of the OSCI scoring system.

The finding that large differences exist between the productivity rates of individual consultant surgeons requires caution in its interpretation, especially at a managerial level. Firstly, without correlation to clinical outcomes, quantification of service delivery lacks clinical meaning. Certainly, the benefits of a 'low productivity' session, where clinical excellence and training are offered, are not captured by pure quantification of service delivery. In addition, many factors unrelated to the surgeon almost certainly determine the productivity achieved in a given session. Caution should be exercised in the managerial interpretation of individual consultant's session productivity rates. Furthermore, extreme clinical risk might result from attempts to enhance surgical productivity in specific sessions. Despite this, estimation of productivity rates might have significant practical uses for list scheduling and planning if consultant specific list optimisation, as opposed to enhancement, is intended. It is acknowledged that the latter assertion requires further investigation.

A complexity adjusted tool that is based upon historical procedure time, such as the OSCI system described in this study, represents an easily developed local method for measuring operative output and detecting changes in operative complexity. Examples of the specific operational uses of such a system might include measurement of the annual departmental (or surgeon) contribution towards total ambulatory activity, benchmarking for appropriate session activity within specialties and even the application of incremental economic analyses to determine which procedures to favour regarding financial reimbursement. Importantly, in some healthcare systems eliciting genuine differences in performance could result in incentivisation of individual personnel or departments. In addition to the described managerial applications of the OSCI system, potentially it could also facilitate clinical audit. Specifically the quantification of an individual surgeon's operative output could serve to add relevance to markers of poor clinical performance such as wound infection rates, return to theatre and failed discharge rates where numbers of specific operations are too small for meaningful analysis. As such, poor performers in the ambulatory environment might be identified more easily. Prospective validation of the OSCI system for the managerial and clinical purposes described above is required and these studies are underway to determine the full remit of its practical efficacy.

Conclusions

Case mix adjusted markers of DS operative activity are necessary to accurately quantify workload, productivity and to detect changes in case mix complexity over time. Tools that estimate complexity adjusted workload in ambulatory centres could faciliate operational and strategic decision making through optimisation of list scheduling and improved clinical and managerial service monitoring respectively.

References

1. Department of Health. Hospital Episode Statistics. London: Department of Health, 2003. Available at: http://www.dh.gov.uk/PublicationsAndStatistics/Statistics/HospitalEpisodeStatistics/fs/en [Accessed 13th July 2005].
2. Department of Health.***The NHS Plan: a plan for investment – a plan for reform***. London: Department of Health, 2000.
3. Department of Health. Thousands of NHS patients to benefit from day surgery expansion – Hutton. London: Department of Health, 2002. Available at: http://www.dh.gov.uk/PublicationsAndStatistics/PressReleases/PressReleasesNotices/fs/e n?CONTENT_ID=4014344&chk=rR%2B7wg.[Accessed on 13th July 2005].
4. Healthcare Commission. Acute Hospital Portfolio review – Day Surgery, July 2005. Available at: http://www.healthcarecommission.org.uk/assetRoot/04/01/83/90/04018390.pdf. [Accessed 7th September 2005].
5. Department of Health. ***Reforming NHS Financial Flows: Introducing Payment by Results***. London: Department of Health, 2002.
6. Jaffe V, Chadwick L, Tomkins M, Galland RB. General surgery with a special interest in vascular surgery: an audit of relative workload. ***Ann R Coll Surg Engl.*** 1991 Sep;**73(5 Suppl)**:90 –3.
7. Pozo JL, Jones CB.What is a reasonable orthopaedic surgical workload? An analysis of elective and trauma workloads using two different complexity scoring systems. ***Ann R Coll Surg Engl.*** 1993 Sep;**75(5 Suppl)**:152 –7.
8. Jones SM, Collins CD. Caseload or workload? Scoring complexity of operative procedures as a means of analysing workload. ***BMJ***. 1990 Aug 11;3**01(6747)**:324 –5.
9. Goonewardena SA, Abeygunasekera AM, Ketheeswaran T. An audit of the surgical work-load in a urology unit. Ceylon Med J. 1997 Dec;42(4):164 –6.
10. Curley PJ, Spark JI, Kester RC, Scott DJ. Audit of vascular surgical workload: use of data for service development. ***Ann R Coll Surg Engl.*** 1996 May;**78:3(Pt 1)**:209 –13.
11. Potter MA, Nixon SJ, Aitken RJ. A 10-year analysis of case load and weighted workload in a single Health Board. ***Ann R Coll Surg Engl.*** 1995 Jul;**77(4 Suppl)**:191 –4.
12. NHS Management Executive. ***Healthcare resource groups consultant document***. London: NHS Management Executive, 1993.(EL(93)91.)
13. Senapati PS, Barry JD, Edwards P, Hodzovic I, Shute K, Lewis WG. Surgical time and motion: the intermediate equivalent revisited. ***Ann R Coll Surg Engl.*** 2003 Jan;**85(1)**:40 –3.
14. Zhou J, Dexter F. Method to assist in the scheduling of add-on surgical cases – upper prediction bounds for surgical case durations based on the log-normal distribution. ***Anesthesiology***. 1998 Nov;**89(5)**:1228 –32.