Original article

Surgical time and motion: the intermediate equivalent revisited

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The relationship between operative time, the intermediate equivalent value (IEV) and the complexity of common general surgical operations was examined. Correlation was found between the BUPA schedule values for procedures categorized as intermediate and major, but complex major vascular reconstruction and oesophagogastric resection for cancer occupied significantly more theatre time than the four intermediate equivalents allocated by the Collins or BUPA schedule. Moreover, anaesthetic preparation time for complex major surgery in the latter surgical subspecialties contributed at least one further intermediate value. Re-evaluation of the ideal IEV weighting of all surgical operations including anaesthetic input from larger similar audits would allow more accurate audits of surgeons' work-load, and also facilitate transparent intensive management of operating theatre resource.

Key words: Surgery – Anaesthesia – Work-load

Surgeons' operative work-load has by tradition been assessed by weighting individual operations for complexity on the basis of the BUPA schedule of procedures.¹ Each operation can be given an intermediate equivalent value (IEV), or hernia equivalent, in order to convert the case-load to a work-load.

It has been suggested that a consultant surgeon in a district general hospital might perform 3–4 intermediate equivalents per operating list, which would amount to a total operative work-load of 900 intermediate equivalents per year.² However, our own prospective audit over a period of 3 years has raised questions regarding the accuracy and correlation between the weighting given and certain common complex major operations by the BUPA schedule,³ and the actual time taken to perform the surgery.

The aim of this study, therefore, was to determine whether a relationship exists between the intermediate

equivalent weighting of a surgical operation, anaesthetic preparation time, operative time, and the complexity of commonly performed general surgical operations. A clear and consistent relationship between the intermediate equivalent rating of an operation, and the actual theatre time required to complete the procedure, would allow transparent planning of operating lists with regard to available operating theatre time, and facilitate accurate audits of a work-load.

Methods

The operative work-load of 9 consultant surgeons working in a district general hospital serving a population of 480,000 was studied retrospectively. General surgical services are provided by 8 general surgeons, two vascular,

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two colorectal, two breast/endocrine, and two upper gastrointestinal surgeons.

The cases operated upon in the period under review have been classified according to the BUPA schedule. The volume of work has been calculated with respect to the complexity of the operation, and also as intermediate equivalent values according to the BUPA schedule. The time taken to perform a primary inguinal herniorrhaphy (Lichtenstein technique),⁴ by 5 consultant surgeons was measured in 25 consecutive cases and compared with 25 consecutive commonly performed general surgical operations of varying subspeciality and complexity. All operations were performed by consultant surgeons, and all anaesthetics were administered by consultant anaesthetists. An inguinal herniorrhaphy was allocated an IEV of one, as described by the BUPA schedule. The comparative equivalent values of more complex procedures are illustrated in Table 1. The median time taken to perform an inguinal hernia repair (X) was compared with the median time to perform each of the other consecutive series of operations (Y). An operative time ratio (Y/X) was then calculated to facilitate comparison with the IEV weighting as set out in the BUPA schedule.

Similarly, the anaesthetic preparation and induction time (Z) for each patient was measured and the median time for each operative category was also calculated. An anaesthetic time ratio (Z/X) was also calculated to facilitate comparison with the IEV weighting of the

Table 1 Comparative times of the surgical procedures

	Operative time	IEV	Total theatre time ratio
Inguinal herniorrhaphy	48	1	1
Breast lumpectomy	40	1	0.83
Unilateral VVs + avulsions	45	1	0.94
Breast lumpectomy + ANC	95	1.75	1.98
Laparoscopic cholecystectomy	53	1.75	1.10
Mastectomy + ANC	110	2.2	2.29
Thyroid lobectomy	100	2.2	2.08
Right hemicolectomy	110	2.2	2.29
Sigmoid colectomy	128	2.2	2.67
Anterior resection	165	4	3.44
APER	175	4	3.65
Total D2 gastrectomy	280	4	5.83
Oesophagectomy	360	4	7.50
Femoro-popliteal bypass	195	4	4.06
Femoro-distal bypass	250	4	5.21
AAA repair	160	4	3.33

Time median minutes

ANC, axillary node clearance

APER, abdomino-perineal excision of rectum

AAA, abdominal aortic aneurysm.

surgical procedures and finally a total time ratio was calculated by combining the anaesthetic and surgical time in the equation $([Y + Z]/X)$.

Figure 1 Comparative operative times for the surgery. Median and interquartile ranges. ANC, axillary node clearance; VV, unilateral varicose vein high saphenous tie; APER, abdomino-perineal excision of rectum; AAA, abdominal aortic aneurysm repair.

Figure 2 Comparative anaesthetic preparation and induction times for the surgery. Median and interquartile ranges. Abbreviations as in the caption to Figure 1.

Statistical analysis

All data were described as median (interquartile range). Statistical analysis for non-parametric data was used.⁵ Data analysis was carried out with the Statistical Package for Social Sciences (SPSS) version 10 (SPSS, Chicago, IL, USA).

Results

The comparative operative times of the surgical procedures measured are shown in Figure 1, and the median anaesthetic preparation and induction times in Figure 2. The ratios of the operating theatre times required for each surgical procedure compared with the IEV weighting are shown in Table 1. There is a clear similarity between the operative time ratio and IEV weighting for intermediate and major cases in all specialities, although there was no statistical correlation between the operative times for intermediate operations (inguinal hernia versus breast lumpectomy Pearson coefficient -0.209 , $P = 0.315$, Spearman rank coefficient -0.25 , $P = 0.227$, inguinal hernia versus unilateral varicose vein surgery Pearson coefficient -0.25 , Spearman rank coefficient -0.31 , $P = 0.131$). In contrast, there are clear and large discrepancies for complex major vascular reconstructive procedures and for upper gastrointestinal cancer surgery. This latter discrepancy is emphasized further when anaesthetic preparation time is taken into account (Table 1).

Discussion

The work programme of a consultant general surgeon has been agreed by both the Association of Surgeons⁶ and The Royal College of Surgeons of England.⁷ Comparisons of work-loads have been facilitated by agreeing recommended values for use in analyses.⁸ For the purposes of such planning, one intermediate equivalent value approximates to one hour of operating theatre time, which includes anaesthetic and turnover time in addition to surgical operating time. The principal findings of this study, however, suggests that such planning across the board may be too simplistic, and that the subspecialities of vascular surgery, and in particular upper gastrointestinal surgery, require further and more detailed consideration.

The results of this study suggest that the concept of the intermediate equivalent value appears to work well for most operations. Indeed, almost all of the intermediate and major operations fitted in well with the Collins/BUPA IEV weighting. Moreover, in the subspecialities of breast, endocrine, and colorectal surgery, complex major operations also appeared to be weighted appropriately. In contrast, complex major vascular reconstructive surgery appears to merit 5–6 intermediate equivalents, and major oesophago-gastric resection for cancer merits 6–8 intermediate equivalents, rather than the 4 allocated.

Two issues deserve consideration here. Firstly, the technical surgical aspects of the operations concerned which is self-evident, and secondly the physiological

fitness of the patients undergoing surgery. Clearly, some individual patients require more intensive anaesthetic preparation than others, which may also include invasive monitoring procedures by a consultant anaesthetist prior to the surgeon being able to put knife to skin. Anaesthetic work-loads have not been assessed in this regard previously, but from the findings of this study alone the preparation for major upper gastrointestinal resections would appear to account for at least one intermediate equivalent value, and on occasion two, in addition to its current weighting of four intermediate equivalent values. This additional theatre time is clearly significant and merits inclusion when auditing the utilization of operating theatre resource. Moreover, surgical procedures being performed by anaesthetists and surgeons in training may well occupy even more theatre time, with considerable implications for surgeons with limited numbers of operating lists and trainees to teach.

Conclusions

The concept of the ideal surgical service continues to be the subject of much discussion. The guidelines published in 1990² regarding an acceptable workload for general surgeons working in a district general hospital suggested that a standard surgical team with a service equivalent value of 1.6 could expect to see 1000 new patients per year and carry out an operative work-load (including elective, emergency and day cases) of about 900 intermediate equivalents per year. The results of this study suggest that the concept of the intermediate equivalent value works well for intermediate and major operations, but those

complex major procedures in the subspecialities of vascular and upper gastrointestinal surgery should have their intermediate equivalent rating increased by 25–50%. Operating theatres, as indeed the NHS as a whole, will require intensive management in the near future if limited resources are to be utilized efficiently. Re-evaluation of the ideal intermediate equivalent weighting for all surgical procedures from larger similar audits would allow more accurate audits of surgeons' work-loads, and also facilitate transparent intensive management of operating theatre resource.

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