What is the relation between number of sessions worked and productivity of radiologists—a pilot study?

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Abstract Increasing workloads and the current austerity measures are putting UK radiology departments under considerable stress. We need to look at the most efficient ways to manage radiology departments in order to cope with increasing demand. Consequently, a system is needed that can compare productivity between radiologists with different jobs. We measured workload in a UK radiology department and compared the productivities of consultants working different numbers of sessions, which are called programmed activities (PAs), to identify the optimal job plan structure for reporting productivity. Reporting data was gathered from electronic records for 14 consultants working different numbers of PA during the period April 2010–March 2011. These were converted into relative value unit (RVU) scores using a modified RCSI RVU system. Crude and net workloads were calculated for each consultant by dividing their total RVU score by the number of PAs they were contracted for and how many they spent reporting. The consultants reported 118,001 imaging studies. There was statistically significant variation in productivity between consultants working different numbers of PAs on χ^2 analysis ($p < 0.05$). Consultants working 12 PAs were more productive than consultants working 11 PAs, with net workloads of 7636 RVU/PA/year versus net 6146 RVU/PA/year, $p < 0.05$. Although UK consultants working 12 PAs per week are more productive than their colleagues, the reasons why are unclear. We have identified a method that can be

developed further to identify efficient working practices in UK radiology departments. However, a UK-specific RVU system would make this productivity analysis more accurate.

Keywords Radiology workflow · Productivity · Health services research · Efficiency · Cost-effectiveness

Introduction

NHS England is going through an efficiency drive to squeeze out £20 billion savings over a 5-year period. British radiology departments face a difficult conundrum in this austere environment. Firstly, their workload is increasing [1–3]. Secondly, there are fewer resources available to them as the NHS deals with austerity measures [4]. Additionally, there is the impending provision of 24/7 radiology service. As a result, the NHS must seek to optimise its working practices and improve cost-efficiency whilst maintaining standards and quality of patient care [5]. It has been shown that increased use of technology, i.e. PACS [6] and voice recognition software [7], and ergonomics [8] can increase reporting productivity. The focus of the efficiency is moving into the consultant contract, productivity and value for money.

Background

A standard full-time contract for radiologists in the UK consists of ten sessions called programmed activities (PAs). This consists of 7.5 direct clinical care activities (DCC) and 2.5 supporting professional activities (SPA), each of 4-h duration [9]. The DCC involves clinical work directly related to patient care, including reporting, attending multi-disciplinary team meetings (MDTs), vetting and protocoling scans, and advising

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clinicians and family doctors, and SPAs are activities that enhance the quality of clinical care, including activities such as teaching, continuous professional development, audits and research. The number of scan radiologists are expected to report per PA varies from hospital to hospital based on local workload agreements [10]. In our hospital for example, 18 MRI/CT scans or 14 US scans per PA is the expected output. The contract is time based and not on the numbers reported as is common in many countries. Also, there is a significant component of the consultant work that cannot be counted such as MDTs, providing telephone advice, vetting, supervising juniors including radiographers that is provided within the job plan as DCC but not easy to keep track of or count. Despite this, productivity of radiologists in our hospital is significantly higher than international benchmarks [11]. The productivity is policed and aligned with the departmental objectives by annual job plans and appraisals.

Consultant pay is set nationally and the pay increases in 5-year increments for length of service. The consultant's pay may be increased by clinical excellence awards, but these are heavily weighted towards the SPA activities of teaching, research, innovation of practice and leadership in health care rather than productivity [9, 10].

To deal with increasing workload, some radiology departments offer extra PAs to existing radiologists rather than appoint new radiologists and others prefer to employ new radiologists. It is not clear which approach is the most cost-effective. All consultant job plans are currently supposed to include

2.5 SPAs [9], so we might assume that contracts with more PAs would be more clinically productive. Excessive total workload, however, might actually limit productivity per session.

Most radiology departments have consultants on contracts on various mixes of PAs [10]. Substantial numbers of radiologists work more than 10 PAs. At this time, there are no published studies evaluating the productivity of radiologists working different number of sessions or PAs. This is mainly because of the variable mix of work done by various radiologists depending on the subspecialisation and other roles undertaken such as managerial, teaching or audit leads. This also makes it difficult to compare productivity on a like for like basis.

Relative value unit (RVU) systems are used in various countries and assign a value to radiologist's activity depending on the intensity, duration and complexity of the work. These systems are evolving but are not perfect in assigning a value to every radiology activity [11–16]. The Royal College of Surgeons and Physicians, Ireland (RCSI) devised a system which incorporates activities such as MDTs, teaching, audit and administration in net workload calculation [13]. This is the nearest system that reflects the workload of UK radiologists [11]. A recent study adapted this system to evaluate the UK workload. This RVU system has been expanded and used to evaluate the productivity of radiologists in a large district general hospital (DGH). This will allow different case mixes to be analysed on an even footing, which enables radiologist

Table 1 RVU scoring chart for RBH

Study type	Location	Relative value units
Plain film	Extremity	1.5
	Spine	2.5
	Chest or abdomen	1.5
	Skeletal survey	5
	IV urography	5
Mammography	Any	5
Ultrasound	Any	5
CT	Brain	5
	Spine	7
	Chest	10
	Neck	10
	Abdomen and pelvis	13
	Chest, abdomen and pelvis	27
	Any	20
MRI	Any	20
Nuclear medicine (NM)	Any	2.5
Interventional radiology (IR)	Any	20
CT/MR angiography	Any	10
Fluoroscopy	Any	10
Image-guided biopsy/injection	Any	10

Adapted from RCSI survey [10]

Table 2 Categories of non-reporting work from RCSI survey

- Formal administration
- Formal teaching (tutorials)
- Inter-site travel
- Management duties
- Multidisciplinary team meetings (preparation/attendance)
- SPAs

From [10]

workload to be more accurately calculated. This system has flaws, but a pilot study to evaluate the workload at our department could give some insight into productivity and the relationship to sessions worked.

Aim

The aim of this study is to evaluate whether or not RVUs can be used as a tool to assess reporting productivity in radiology consultants with different work patterns and job plans.

Materials and methods

Data collection

Reporting data for consultant radiologists at a large DGH was retrospectively collected using local electronic records for the period April 2010–March 2011. Only radiologists working in the department for the entire period were included in the study. As such, data for 13 full-time consultants and one part-time consultant were collected.

The job plans of each consultant included in the study were reviewed. This produced data about how many PAs each consultant was contracted for, as well as how many the consultants were timetabled to spend on radiology service delivery

each week. Job plans also demonstrated how much time consultants devoted to activities other than reporting.

Workload calculation

We have adapted the RCSI's RVU system [13], itself based on the Pitman-Jones system [15, 16] (Table 1). A major criticism of these systems has been the lack of scoring for key activities such as interventional radiology and nuclear medicine [11, 13, 16]. We have included five new categories with RVU scores to update the system and increase its accuracy when assessing the workload of modern UK radiologists. Each imaging study in the data was given a score according to the categories in our RVU system. Imaging studies in existing modality categories that were not given a specific score were awarded the same score of the most similar/appropriate imaging study in the table.

Crude workload was calculated by dividing the number of RVUs scored by the number of PAs worked by each individual consultant. This demonstrates the total workload processed by the consultant, but does not account for non-reporting activities. Net workload was calculated by dividing each consultant's RVU score by the number of PAs devoted to 'reporting' activities in their job plan, giving us a measure of efficiency (workload per PA). All activities counted as 'non-reporting' work are listed in Table 2. To preserve anonymity, individual consultant's scores were averaged with their colleagues' in the same PA group.

Statistical analysis

Net workload data for each PA group was categorical and underwent a χ^2 test to refute the null hypothesis that consultants in all PA bands would be as productive per PA as those working the standard 10 PA contract. $P < 0.05$ was considered statistically significant. Median scores for each group were used where possible. Mean net workload data for each PA

Fig. 1 Crude and net workloads by PA group

Table 3 Mean workload data by pay group

Pay group (PAs)	Consultants per group	Crude workload (RVUs)	Net workload (RVUs)
5	1	2466.2	3131.7
10	2	3562.0	5984.5
11	3	3842.2	6146.68
12	8	4993.9	7636.0

group was then compared graphically, $\pm$ standard error of the mean (SEM).

Results

Fourteen consultant radiologists worked in department for the period being studied, one worked 5 PAs, two worked 10 PAs, three 11 PAs, and eight 12 PAs.

When a χ^2 test was applied, it was found that there is statistically significant variation between the net workloads of consultants in different PA groups ($p < 0.01$, $\chi^2 = 1877.6$, 13 degrees of freedom), refuting the null hypothesis. Net workload is significantly higher in the 12 PA group than in the 10 PA ($p < 0.01$, $\chi^2 = 469.5$, 9 degrees of freedom) or 11 PA groups ($p < 0.01$, $\chi^2 = 516.8$, 10 degrees of freedom). However, there was no significant difference in net workload of the 10 PA and 11 PA groups.

Mean crude and net workloads for each group are represented in Fig. 1 and Table 3. The error bars are based on the standard error of the mean (SEM) for each PA group. There is no crossover between the error bars for the 12 PA group and the other groups. This suggests that the workload done per PA in this group is higher than that done by consultants in the other PA groups. The statistical significance of this was interrogated using a method devised by Cummings, which is applicable to studies with sample sizes as small as ours [17]. This involves SEM, which allows us to determine how close the mean value of a sample group is to the true (parabolic) mean, and this is also a measure of reliability of the result. Our gap is 2.25 arms, indicating that $p < 0.05$ for consultants working 12

PAs being more productive than those working 11 Pas (Appendix).

There was considerable variation in case mix between the different PA groups. This is shown in Table 4 and Figs. 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11. Some radiologists reported very few examinations in certain modalities, whilst others spread their reporting more evenly between them. There was a trend for radiologists working 10 PAs to report proportionally fewer plain films than their colleagues working 11–12 PAs, and proportionally more ultrasound (US) and computed tomography (CT) scans. Magnetic resonance imaging (MRI) reporting was at a similar rate between the groups but was slightly more by those working on 11 PAs (Fig. 6). None of these differences are significant, due to the very large variation in case mix reported by radiologists in the 12 PA group.

Discussion

Most radiology departments have consultants working varying number of PAs, although 10 PAs is the standard full-time consultant contract [10]. Some radiology departments have increased the number of PAs offered to consultants to tackle increasing workloads. Our findings that consultants working 12 PAs are more productive per PA than their counterparts working fewer PAs seem to support this practice. However, this is not reflected in increased productivity for those on 11 PAs. The complexity of measuring productivity of radiologists, who are providing a wide range of services in various subspecialist interests, makes it difficult to identify the reason for this difference in productivity. This difficulty is reflected in

Table 4 Differences in reporting case mix percentages between our radiologists

Modality	Range (%)	Median (%)	Mean (%)	Standard deviation
XR	5.22–82.14	48.04	46.32	21.76
Mammography	0.00–30.34	0.00	2.17	8.11
US	4.15–34.20	13.93	16.60	9.20
CT	0.00–8.54	13.75	14.06	7.46
MR	0.00–20.74	12.89	11.49	6.15
NM	0.00–16.93	0.01	3.32	5.97
IR	0.00–24.23	0.05	2.76	6.69
CT/MR angiography	0.00–8.54	1.17	1.84	2.45
Fluoroscopy	0.04–4.38	1.26	1.49	1.37
Injections/biopsy	0.00–6.51	0.45	1.03	1.70

Fig. 2 Proportions of different modalities in case mix

the recently published document on workload by the Royal College of Radiologists [18]. However, our study confirms that RVU systems can be used to identify efficient working practices in UK radiology departments, and our finding suggest that consultants working a greater number of PAs were more productive over all, and were significantly more efficient, getting through more workload per PA than colleagues doing fewer PAs.

It is possible that differences in productivity between radiologists are the result differences in case mix. We identified a large amount of variation in reporting case mix between different consultants (Table 4 and Figs. 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11). This is most marked in relation to plain films. Newer consultants, usually the ones with 10 PA contracts, seem to

report fewer plain films than those with 11 or 12 PA contracts, whilst reporting more CT and US studies. This may partly explain the differences in productivity between the groups. Older consultants, having spent more of their careers focused on reporting plain films, are likely to be more comfortable and faster when reporting plain films than younger colleagues, an opinion the authors have heard expressed in multiple departments. This could give them an inflated net workload. It could also indicate that CT and US scans are underscored and plain films have an overly high score on the RVU. If this were true, 12 PA consultants may be fulfilling the same core reporting obligations as their 10 PA colleagues, with extra sessions allowing them to rack-up RVUs by reporting plain films.

Fig. 3 Proportions of plain film reporting per PA group

Fig. 4 Proportions of US reporting per PA group

There are, however, two flaws to this explanation. Firstly, there is considerable overlap between the interquartile ranges of the 11 and 12 PA groups for all modalities despite the 12 PA group having a significantly higher net RVU/PA score. Case mix cannot be the main factor in reporting efficiency if the case mixes of the two groups are so similar. Also, whilst the majority of 12 PA consultants report similar levels of each modality, there are outliers with drastically different results in each modality. Roughly half of the group has an extreme value in one modality or another. Although differences in case mix do not fully explain the differences in productivity between the different PA groups,

it does highlight a potential problem with a poorly designed RVU system. In an unbalanced RVU system, it would be possible for radiologists to report ‘over-scoring’ examinations preferentially, thus inflating their figures. This would be a problem if other radiologists were left appearing to underperform, or less well-scored examinations were neglected as a waste of time. However, in a well-balanced RVU system, all examinations would be scored appropriately compared to others, eliminating the problem. A perfectly balanced system is unlikely to be developed straightaway, and regular review of scores would be necessary to minimise these issues.

Fig. 5 Proportions of CT reporting per PA group

Fig. 6 Proportions of MRI reporting per PA group

Another possible reason for increased productivity in the 12 PA group could be their increased salary. In the USA, remuneration has been suggested to have impact on productivity in radiologist reporting. This can skew workload figures, as radiologists may “cherry-pick” easy cases to boost productivity and increase their earnings [19] or report excessive numbers of scans [20]. However, increased productivity in reporting per PA does not increase radiologists’ salaries in the UK, so this is unlikely to be a major factor affecting our results. It could be suggested that members of staff who are prepared to take on extra PAs of work are more driven than their colleagues, which may lead to increased reporting rates. However, there is no evidence to support this view point and the lack of incentivisation for higher productivity in reporting would make this less likely. It is not possible to determine the

remuneration of each radiologist in the study and would be difficult to apply due to the small sample size. However, using the standard payment for each PA in the standard UK consultant contract, it can be extrapolated that 12 PA radiologists are more cost-effective than those on less number of PAs.

Notably, the part-time radiologist working 5 PAs was almost as productive as those working 10 and 11 PAs. This correlates with findings that part-time radiologists are as productive as full-time radiologists in academic radiology department in the USA, accounting for 14 % of reporting workload whilst comprising 13 % of the staff complement [21]. The members of our radiology department are mixed in terms of time spent working both as a consultant and in the department, and in their PA group. Increased experience, therefore, does not explain our results.

Fig. 7 Proportions of NM reporting per PA group

Fig. 8 Proportions of IR procedures per PA group

A possible deterrent to increasing the number of PAs worked by radiologists is reporting fatigue. It has been shown that problems such as visual fatigue and cognitive overload can result from reporting high volume and high-complexity images [22, 23]. This can reduce productivity and increase stress levels in radiologists. Complex imaging studies inherently require more effort to report, and in particular reporting CT scans can increase eye strain ($p < 0.04$) [24]. By reporting more CT scans our 10 PA radiologists may be at a disadvantage compared to our 12 PA radiologists, who report fewer eye strain-inducing images and are as a result may be less fatigued and more productive. Departments reporting more high-complexity images might benefit from job planning, to ensure spread of work through

the week, mixed with simpler sessions, to counteract fatigue and associated risk of error.

Study limitations

Despite the statistically significant results, our sample size is small, at only 14 consultants and a single organisation. A larger sample size, looking at the workloads of consultants in several hospitals, would lend weight to our findings. At present, the sample size is too small to identify the reasons behind the trend, there being too much variation in the experience and duties of the consultants in each PA group. Further work expanding this analysis to other radiology departments may shed light on the matter.

Fig. 9 Proportions of MR/CT angiogram reporting per PA group

Fig. 10 Proportions of fluoroscopy reporting per PA group

Also, our workload calculations are based on the RCSI model [13], which was in turn based on a modified Pitman-Jones system [16] and has not been validated in its own right. The scores for this system were originally based on time-and-motion study, but are now out of date, having been developed in 2003, and imaging studies have become more complex since then, making the weightings inaccurate [13, 15, 16]. Also, the case mix in Ireland and Australia are different to that of the UK, meaning that different studies are worth more to UK radiology departments, making the scoring less accurate.

Activities classified as ‘non-reporting’ time are another potential source of inaccuracy. We have attempted to improve upon the RCSI model by including scores for IR and NM, reducing the

number of activities without scores. Net workload calculation attempts to account for the rest by only calculating workload per PA on time spent doing reporting. This allows us to compare the reporting workloads and efficiency of radiologists doing different amounts of non-reporting activities more fairly. This could be further improved by giving RVUs for images reviewed for MDTs. ‘Academic’ RVUs for non-reporting activities have been previously suggested [25]. These would be even more controversial to develop, whilst still failing to account for issues such as interruptions or time spent giving advice to colleagues. The above issues limit the accuracy of our workload calculations. However, a current, UK-specific RVU system could eliminate many of these problems.

Fig. 11 Proportions of injection/biopsy procedures per PA group

Conclusion

This pilot study found that consultant radiologists at a large DGH working 12 PAs were significantly more productive than those working 5, 10, or 11 PAs. This might suggest that increasing more consultants to 12 PAs would increase productivity and therefore cost-effectiveness in the department as a whole. However, on closer scrutiny of the workload, productivity gain on higher PAs was not straightforward due to the complexity of work done by radiologists. Further research is necessary to see if this was true in other hospitals, fully analyse it, and reach a definitive conclusion. The reliability of these findings is reduced by our small sample size and limitations to the scoring system. However, this study demonstrates that it is feasible to use RVUs to assess productivity in UK hospitals. This is possible using the system presented above but would be even better with a UK-specific RVU system. This should be based on a time-and-motion studies of reporting practice and ideally developed with input from the Royal College of Radiologists.

Appendix

If $n=3$ for all data groups, a gap of 2 arms between the error bars means that $p \approx 0.05$. If $n \geq 10$ for all groups, $p \approx 0.05$ with a gap of 1 arm. In our datasets, $n=3$ for 11 PAs and $n=7$ for 12 PAs. This would make $p \approx 0.05$ with a gap of somewhere between 1 and 2 arms.

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