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**Title: Measuring radiologist workload: progressing from
RVUs to Study Ascribable Times (SATs)**

Running Head: Measuring radiologist workload

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Abstract

Introduction: The need to measure reporting workload in teaching departments remains a current pertinent need. In Australia, the Pitman-Jones reporting RVUs have been in the public domain since 2003 (revised in 2009). These are expressed in arbitrary units. In New Zealand, single-site Christchurch Hospital reporting times have been validated and placed in the public domain. Concurrently, the RANZCR has been developing a formulaic descriptor lexicon for imaging studies (the Body System Framework). There is a need to bring these three strands of work together into a common public resource.

In 2015, under the auspices of the Chief Accreditation Officer, RANZCR convened the Radiologist Workload Working Group. The goal of the group was to develop a robust method of measuring radiologist workload in teaching departments in Australia and New Zealand for the RANZCR accreditation processes of teaching departments as training sites. This paper concerns itself with one aspect of the group's work, namely reaching a consensus on radiologist study ascribable times for common imaging studies.

Method: The BSF examination descriptors were reduced to a smaller, generic dataset of descriptors at the expense of loss of specificity. BSF study ascribable times had been previously obtained by stopwatch observation. The dataset was harmonised with the Christchurch descriptors, to ensure commonality of case mix. The

two lead authors reached an approximate consensus study ascribable time for each descriptor in agreement with the BSF and Christchurch data. Specifically, the Christchurch reporting times were relied on extensively to validate the new dataset's study ascribable times. The first draft of descriptors and times was tabled at the meetings of the RANZCR Radiologist Workload Working Group, and was progressively refined by iterative consensus.

Results: The output of the Radiologist Workload Working Group comprises a simplified modality-based table of robust descriptors and 'best estimate' corresponding study ascribable times. These can be used with the extant Pitman-Jones methodology in order to estimate the reporting workload of a medical imaging teaching department in units of time. As a first for Australia and New Zealand, nuclear medicine and PET study ascribable times have been incorporated and balanced against radiology study ascribable times.

Conclusion: The RANZCR 2016 study ascribable times are ready for use by the Australian and New Zealand radiologist and nuclear medicine specialist community. We hope these times will also stimulate further data collection in our two countries towards a robust, bi-national study ascribable times database.

Five key words

radiologist workload, study ascribable times, nuclear medicine workload, body system framework, reporting workload

Text

Introduction

The need to measure reporting workload in teaching departments remains a current pertinent need. In Australia, the Pitman-Jones reporting Relative Value Units (RVUs) have been in the public

domain since 2006 (1), revised in 2009 (2). These are expressed in arbitrary units.

In New Zealand, the Christchurch group developed a robust academically defensible method for extracting actual reporting and associated times from a departmental RIS, enabling large scale objective measurement for the first time. The methodology and the single-site Christchurch Hospital reporting times have been placed in the public domain in 2013 (3). The Christchurch reporting times are median reporting times, based on a dataset of over 170,000 reports by consultants and by independently reporting senior trainees. Combining the Christchurch values with measured time for non-reporting activities has since been used for departmental workflow planning.

Concurrently, the Royal Australian and New Zealand College of Radiologists (RANZCR) has developed a formulaic descriptor lexicon for imaging studies (the Body System Framework (BSF), (4)). There is a need to bring these three strands of work together into a common public resource.

The original Pitman-Jones methodology clearly separates measurement of radiologist workload in a teaching department into measuring the workload of diagnostic imaging study reading with its associated tasks (e.g. examination protocoling, phone calls); and capturing the time spent performing interventional procedures, taking meetings, and similar long-duration tasks.

The workload of reporting and associated activities is calculated in RANZCR RVU, expressed as both 'crude' and 'net' RVU per consultant radiologist FTE. The original Pitman-Jones guideline from 2003 (1) recommends 40,000 crude RVU per consultant radiologist

FTE being an appropriate benchmark for a teaching department so as to allow sufficient capacity for registrar teaching and training.

The workload of meetings, procedures, and similar is captured by the 'logbook' method, whereby rosters or activity logbooks are used to calculate total consultant radiologist full time equivalents (FTE) expended in these activities per unit time such as a week.

The Body System Framework (BSF) terminology (RANZCR 2014) provides a clear classification of radiologist work into three categories: patient related study ascribable tasks; patient related non study ascribable tasks; and non patient related tasks. The full definition of each category of work is given in Methods.

In 2015, under the auspices of the Chief Accreditation Officer, RANZCR convened the Radiologist Workload Working Group. The goal of the group was to develop a robust method of measuring radiologist workload for the purpose of RANZCR training site accreditation in Australia, New Zealand and Singapore. At direction from the Chief Accreditation Officer and (through his office) from the Faculty of Clinical Radiology, the Working Group made the decision to move from RVU measured in arbitrary units to SAT (see below for definition) measured in units of time. While discussion of the reasons for this transition are beyond the scope of this work, it is line with national and international trends towards the use of time.

This paper concerns itself with one aspect of the Group's work, namely the generation of a consensus set of common study descriptors and study ascribable times to allow a teaching department to measure its reporting workload.

Methods

Definitions

Study Ascribable Time (SAT)

Study ascribable time includes all the time expended by a radiologist interacting with one specific diagnostic imaging study through all the steps of its diagnostic journey.

These steps (Patient Related Study Ascribable Tasks) commonly include:

- interpretation and clarification of request;
- prescription of the examination protocol for that particular study;
- case related discussion with the referrer, with other medical and technical staff at the protocol prescription and scheduling stage;
- supervision and direction of technical, nursing and clerical staff in tasks directly related to performance of the diagnostic imaging study;
- personal attendance on the patient during a study (both procedural and non-procedural e.g. US, CT coronary angiography);
- supervision of technical staff in post-examination dataset preparation (e.g. post-processing);
- direct patient interaction for any consultation, pre-procedure and post-procedure care;
- locating the examination in the RIS and PACS, confirmation of its completeness, opening and downloading the examination;
- systematic review of the study dataset ('reading the examination');
- QA activities as apply to the study (cross checking, textbook and literature access, corrections, recalls, second opinion consultations, etc);
- dictation of report;
- any associated study-specific direct staff contact (e.g. phone call to referrer);

- any associated direct patient contact (e.g. recalls for additional sequences, emergency contact);
- proofing and authorisation of the final report (either typed or contemporaneously generated by voice recognition);
- dispatch of report to referrer/HIS.

SATs encompass a considerably wider range of radiologist activities than simply reading the study and dictating the report. This notwithstanding, study reading and report dictation consume the greatest amount of time for the majority of routine diagnostic studies read and reported by radiologists.

Only some of these activities occur with each and every study read and reported; yet each of these activities occurs (more or less frequently) in the normal daily course of radiologist work.

Patient Related Non Study Ascribable Tasks

These include:

- long interventional procedures, sometimes multi-day, with their workload not readily captured in the framework of diagnostic study reading;
- case presentation at multidisciplinary meetings and associated preparation (e.g. cancer MDM's);
- structured quality assurance activities (e.g. radiation dose measurement and audit; safety drills, resus kit preparation);
- examination/procedure protocol setup and review, technical document input, PACS and communications setup and input; modality protocol and technical development or QA;
- dealing with unplanned incidents, emergencies and complications;
- patient followup, referrer followup, clinical audit, and similar.

Non Patient Related Tasks

These include:

- didactic teaching and supervision of trainees;
- research and related academic activity;
- administrative work;
- dealing with complaints and queries, managing intra-organisational and external relations;
- governance, advocacy, hospital based committee participation, etc.

The SATs developed by the working group have been explicitly developed for the setting a teaching Department, where non study ascribable tasks and non patient related tasks consume a significant proportion of staff radiologist time. The SATs are not intended for use in other settings. Please see discussion.

Modality clusters

Five modality-based descriptor clusters were chosen as the most common generic groupings of modalities. These were (with relevant abbreviations):

- i. radiography (XR);
- ii. ultrasound (US);
- iii. computed tomography (CT);
- iv. magnetic resonance imaging (MR); and
- v. nuclear medicine and positron emission tomography (NM PET).

Mammography, orthopantomography and fluoroscopy were grouped with radiography.

Descriptor and SAT derivation process

In each modality cluster, anatomical structures and regions of the BSF were reviewed to group these into minimally ambiguous

generic descriptors. A balance was attempted in each descriptor between specificity of meaning and inclusivity of descriptor variation.

For example, 'radiography of the pelvis' (abbreviated to XR pelvis) implies a relatively homogeneous group of radiographic images in Australia and New Zealand. On the other hand, multiple variations exist for names of examinations of (for example) the upper limb. These include names of the joints; the bones; the regions ('upper arm', 'forearm', 'hand') and various technical protocols ('stress views AC joint').

Merging of the BSF and Christchurch descriptors and times
The original list in each modality cluster was a long list of specific yet unambiguous BSF-derived descriptors with a cross reference to less frequent examination names subsumed within. For example, 'XR wrist' subsumed 'XR scaphoid'.

The original long list of descriptors was still BSF based. It was cross-referenced against the Christchurch set of descriptors to ensure that a corresponding descriptor with a similar meaning (and case mix) was available in the Christchurch dataset.

At this stage, each descriptor had its BSF SAT and its Christchurch reporting time. BSF SATs for BSF examination descriptors had been originally derived from stopwatch observation of reporting, with a further time allowance added for a component of the other patient related study ascribable tasks. Christchurch Department of Radiology is VR equipped. Christchurch reporting time had been operationally defined in the earlier work as 'pick-up-study timestamp until send-report-to-RIS timestamp'. The Christchurch reporting time ordinarily includes study ascribable telephone calls,

QA, consultation, literature review, etc, all tasks normally undertaken during this time interval. Thus, Christchurch reporting times and BSF SATs encompass a comparable range of study ascribable radiologist tasks and could be expected to be comparable.

In over three-quarters of the examinations, the BSF SATs and Christchurch reporting times agreed to within 10-15% of each other. Descriptors with differences of a greater degree were systematically reviewed by the two lead authors looking for explanations. The explanation usually resided in different examination case mix contained in each of the two descriptors. The differences were resolved by consensus and by concise exclusion and inclusion of examination types from the descriptors. The end result was a long list of common examination descriptors with closely aligned SATs. The SATs were then rounded up to the nearest minute by consensus, unifying the SAT for the pair of (simplified BSF descriptor):(simplified Christchurch descriptor).

Reducing the number of descriptors ('reduction pass').

The unified long list then underwent a reduction pass. In the reduction pass, examination descriptors with the same (or very similar) SATs were united into a new overarching unambiguous descriptor wherever logically feasible. For example, the consensus SAT for each of 'XR wrist' and for 'XR elbow' and for 'XR ankle' (and others, see tables) was sufficiently close to 2 minutes to allow all of these descriptors to be amalgamated into one unambiguous yet flexible descriptor 'XR extremity one area'.

Iterative expert review

The resulting short list of descriptors for each modality cluster was then iteratively reviewed by the full Working Group looking for

expert consensus. Specifically, the Working Group was charged with the ultimate decision of whether the 'grouping' versus the 'splitting' of descriptors achieved a reasonable balance; and whether the descriptor was sufficiently simple yet self-explanatory to allow ready comprehension in the setting of multiple vendors' and multiple departments' radiology information systems (RIS). The Working Group then had the ultimate sign-off on the consensus rounded SAT for each descriptor.

Results

The output of the Radiologist Workload Working Group comprised five modality-based table of robust descriptors and 'best estimate' corresponding SATs. These can be used with the extant Pitman-Jones methodology to estimate the reporting workload of a medical imaging teaching department in units of time. As a first for Australia and New Zealand, nuclear medicine and PET SATs have been incorporated and balanced against radiology SATs.

The RANZCR 2016 descriptors and their SATs are presented as Tables 1-5 (one for each modality cluster).

Please note that a read-only, time stamped electronic version of these tables is available free of charge from the RANZCR website. Access is available for private personal and institutional use on conditions of acknowledgement of RANZCR copyright; and citation of this article in any academic or institutional use of the tables.

Discussion

Descriptors and SATs-specific issues in each modality cluster

The radiography cluster was the first cluster to be addressed, and presented the least problems in its compilation either in the BSF-Christchurch comparison and merging or in the reduction pass. Of

note, however, 'XR cervical spine' had a substantially different SAT from 'XR thoracic spine' and 'XR lumbar spine', and it was not possible to further amalgamate the spine descriptors.

A 'catch-all' descriptor 'XR one area not otherwise specified (NOS)' was established, and was given the nominal commonest single-area SAT of two minutes.

A numerical minority of examinations that was still sufficiently significant to be addressed was radiography of multiple areas in the same extremity. By comparison of datasets and by consensus it was concluded that SAT for two contiguous areas (e.g. shoulder and elbow) in general does not differ sufficiently significantly from one area to justify modification in units of whole minutes; on the other hand, SAT for two non-contiguous areas does.

Mammography (meaning projectional, diagnostic mammography and not tomosynthesis) was included in the XR cluster. Screening mammography (i.e. Breastscreen reading) was excluded. SAT for orthopantomography (OPG) was assigned two minutes; this implies a full dental characterisation report. The Working Group considered reports stating 'dentition as demonstrated' (or similar) to be professional non-engagement, deserving zero minutes. In the setting of a department which routinely issues reports stating 'dentition as demonstrated', the study associated time consumed in producing such a report can be measured locally.

Performance of fluoroscopy by radiologists was included in the XR cluster. It is acknowledged that the times expended by radiologists on fluoroscopic procedures vary enormously from examination to examination; department to department; and patient to patient. Overall numbers of fluoroscopic examinations performed in teaching

departments are also steadily declining. The Working Group considered it more robust to measure radiologist time expended in performing fluoroscopy by direct logbook method (see further in discussion). Nonetheless, the Working Group chose to include three catch-all standardised descriptors for fluoroscopy to allow standardisation of time measurement. These standardised descriptors are of particular utility when historical comparisons and cross-department comparisons are undertaken, and it is not possible to prospectively capture a particular department's types of fluoroscopic procedures nor the average times expended on these.

The US cluster has a profile different from any other cluster. Comparison of BSF SATs to Christchurch reporting times showed a systematic difference, with BSF SATs greater. On closer analysis by the two lead authors, the systematic difference was due to a difference in trans-Tasman US practise. In Australia, a proportion of US examinations include a component of radiologist physical attendance on the patient, particularly in musculoskeletal ultrasound. The difference was resolved mostly in the direction of the Christchurch dataset. As with CT and fluoroscopy, the Working Group adopted a small number of procedural times in the acceptance that procedures are most accurately captured by recording the radiologist time expended ('the logbook method').

The CT cluster presented its own difficulties. CT examinations are characterised by a much wider heterogeneity of dataset volume and complexity than radiography. Nomenclature varies considerably between coding systems; acquisition and reconstruction protocols also vary widely from department to department. The variation is sufficient to produce significant differences in radiologist workload for an identically named CT examination from department to department.

414

415 The CT long list of descriptors generated from the granular and
416 specific BSF table was considerably longer than the radiography
417 long list. Consensus when merging the BSF SATs and Christchurch
418 reporting times showed good agreement for formulaic examinations
419 with conventionally little variation, for example CT
420 chest/abdomen/pelvis in the setting of oncology restaging or of
421 trauma.

422

423 Several examinations showed significant discrepancies in BSF SATs
424 vs Christchurch times on initial comparison. The two lead authors
425 looked for the likely cause of the difference. In most instances the
426 cause was a fundamental difference in case mix underlying two
427 superficially similar descriptors. The Christchurch reporting time for
428 each descriptor was derived from the entire case mix lumped into
429 that descriptor, usually a large number of cases contained in the
430 hospital RIS. The case mix was not necessarily defined by similarity
431 of examination technical protocol, but often by similarity of
432 indication. In contrast, each of the BSF anatomical structure -
433 modality cells can contain more than one examination descriptor if
434 more than one major technical protocol exists.

435

436 The most discrepant data point was 'CT KUB' in the BSF and 'CT
437 hematuria' in the Christchurch descriptor system. The time
438 difference is almost double for the Christchurch descriptor. Deeper
439 data analysis showed that 'CT hematuria' subsumed many cases
440 where the protocol involved a multiphase contrast enhanced CT of
441 the urinary tract looking for urothelial carcinoma. In the same
442 example, the BSF anatomical structure row 'kidneys-ureter-bladder'
443 intersecting with modality column row 'CT' contains two descriptors:
444 'dedicated renal tract non contrast CT' and 'renal tract multiphase
445 ('CT-IVP')'. The combined overall reporting time for the Christchurch

descriptor agreed reasonably with a weighted mean of the BSF SATs for each of the two major technical protocols weighted by their prevalence in the Christchurch RIS.

This particular discrepancy was resolved by explicitly limiting the combined descriptor to the indication which implies a non-contrast, single phase examination ('CT KUB for renal colic'). The lead authors noted reasonable similarity of times in both the BSF and Christchurch databases between 'CT-IVP' and other multiphase abdominal examinations (for example, multiphase liver CT for characterisation of masses). Although not perfect, the choice was made to group 'multiphase renal tract CT' with 'multiphase other abdominal organ CT' to create an unambiguous albeit heterogeneous descriptor 'CT multiphase abdopelvis (including CT IVU)'. This descriptor and the workings behind its creation were taken to the working group who discussed and ratified it.

CT angiography was simplified to only three major types of examination: CT pulmonary angiography; CT coronary angiography; and all other CT angiography ('CT angiography NOS'). The reasons for this simplification were several. CT angiography of areas other than pulmonary vessels and coronary vessels is very variable; common areas are cerebral circulation; carotid circulation; carotid and cerebral circulation; thoracic aorta; abdominal aorta; renal circulation; visceral circulation; lower limb runoff; upper limb runoff; and any combination of contiguous anatomical areas. Reporting time expended is proportional, in the first instance, to the number of images presented for reading (crudely, the z-axis anatomical coverage) of the CT angiogram. Case mix of most departments is weighted towards one-area examinations (cerebral in isolation, abdominal aorta in isolation, etc.). In addition, descriptors and coding of CT angiography is very variable from

department to department. Pragmatic difficulties of cross-department and cross-examination comparisons were acknowledged, and a SAT adopted weighted heavily towards a single-phase, single anatomical area angiography.

A 'CT NOS, any protocol, one structure' descriptor was agreed on as a pragmatic catch-all single anatomical area descriptor, and given a consensus SAT by the Working Group.

In a process analogous to the treatment of fluoroscopy, the Working Group acknowledged that time expended by radiologists in CT-guided procedures is highly variable from procedure to procedure and is best captured by direct recording of the time taken. However, to allow retrospective and cross-department comparisons, three basic descriptors were agreed for CT procedures (CT biopsy, CT injection, CT drainage).

The MR cluster presented few problems in the descriptor comparison and merging stage. Most MR descriptors are anatomical and comparable across the datasets. BSF SATs and Christchurch reporting times for most of the conventional MR examinations have also shown excellent agreement.

Reduction pass proved difficult. Similar to CT, the greatest differences and ambiguities occurred for examinations covering adjacent anatomical areas, and often ambiguously coded (e.g. MR 'ankle or foot'). Once again, an acceptable balance was struck between specificity and inclusivity. Several small volume, high complexity specific examinations were reviewed by the Working Group; consensus SATs were debated and adopted. Examples include breast MR, prostate MR, MR abdominal angiography. MR spectroscopy was treated as an 'add-on' descriptor. The reason is

that MR spectroscopy was considered not a part of any one anatomical protocol, yet able to be added to almost any anatomical protocol. The Working Group adopted a generic (and first approximation) SAT of 20 minutes for MR spectroscopy of any body area. This time is added to the SAT of the anatomical MR examination that precedes MR spectroscopy. As with other modality clusters, a 'catch-all' descriptor was devised and allocated a nominal SAT.

The NM PET cluster has its own unique specificity. This is the first time in Australia and New Zealand that NM and PET SATs have been balanced against and incorporated into radiology SATs. Christchurch data is radiology data only, and the NM PET data has been derived solely from the BSF SATs.

For a generic radiologist audience (who do not have training in NM or PET), a number of everyday processes and techniques impacting NM PET SATs need to be defined and explained to be understood. The explanations have been included below and in the explanatory notes to the NM PET table.

The NM PET cluster is characterised by a multiplicity of radiotracers, each specific to a particular physiologic process (for example, FDG, PSMA, DOTAtate in PET; or osteoblastic activity tracer such as HDP or MDP and an autologous white cell label in nuclear medicine). Regardless of the radiotracer used, the anatomical coverage is similar, producing, in the first approximation, a comparable volume of imaging information to read. Oncology PET in particular conventionally covers the whole body regardless of the radiotracer.

In the BSF, 'whole body' or 'whole skeleton' is considered an anatomical structure for the purpose of study descriptors. This convention has been retained in the current work.

In NM (but not in PET) any anatomical area can be examined with planar emission imaging (analogous to radiography which is planar transmission imaging) or with single photon emission computed tomography (SPECT, analogous to transmission computed tomography, traditional CT). By convention, in all areas except for brain and heart, SPECT is added to planar imaging rather than replacing it. Thus, the Working Group has accepted an additional modifier for SPECT reporting, additive to the SAT for planar imaging undertaken in the same examination. This modifier does not apply to SPECT-only studies (myocardial perfusion imaging and brain).

PET indications are oncologic and non-oncologic. However, the anatomical coverage (and hence the total imaging volume to be read) is not constrained by the radiotracer. In this regard PET descriptor coding is anatomical and similar to XR, CT and MR. This uniformity allowed the creation of a small number only of uniform PET descriptors.

In NM there exists a moderate number of unique non-uniform indications. These could not be simplified beyond a moderately extensive list. NM radiotracer labels are specific. Their specificity determines what applications exist and what anatomical coverage is required for each indication. The simplified descriptors have continued the BSF convention of naming the studies by anatomical region covered, rather than by the radiotracer which constrains the coverage.

Unlike most radiographic or CT examinations, a small yet definite number of NM studies extend to a repeat examination at 24 hours. A modifier descriptor provides for such 'next day' reporting.

Doctor-performed procedures in NM are largely diagnostic, rather than therapeutic. The most common is stress testing (exercise or pharmacologic) for myocardial perfusion imaging. The time expended in stress testing is not included in the imaging study SAT, but should be captured by the logbook method. Another example, much less common, is lumbar puncture for introduction of CSF radiotracer for CSF transit or CSF leak studies. Elsewhere, lymphoscintigraphy injections for melanoma or breast cancer are most commonly undertaken by the doctor. The time taken to inject is included in the lymphoscintigraphy SAT.

Use of SATs in calculating a Department's workload

The teaching department workload calculation methodology has first been presented in (1). In that methodology, radiologist reporting and related study ascribable work was expressed in RVUs rather than in minutes.

The methodology of (1) captures consultant radiologist time expended on non reporting work (patient related non study ascribable tasks and non patient related tasks) by the logbook method. The logbook method involves direct documentation of time expended by the radiologist doing the work. Alternatively, radiologist time expended in such tasks can be reconstructed from weekly or daily rosters.

In a typical teaching Australian or New Zealand teaching department, non-reporting work consumes a large proportion of

603 radiologist time, of a magnitude comparable to time consumed in
604 reporting and other study ascribable tasks. For example, the 2012
605 RANZCR Radiology Workforce Census Report (Australia) has found
606 that 45.7% of the average radiologist's time is spent on activities
607 other than reporting (5).

608
609 The same pattern has been reported in other countries. In the
610 Republic of Ireland, the Faculty of Radiologists of the Royal College
611 of Surgeons in Ireland conducted a 2009 nationwide survey of
612 radiologist workload (6). The highlights of that survey were that a
613 mean of 32.47% of consultant radiologist time was consumed in
614 non-reporting activity (interventional and procedural work, nuclear
615 medicine, multi-disciplinary meeting preparation and conduct,
616 formal teaching and administration). This figure rose to 51.84% in
617 University Teaching Hospitals with trainees.

618
619 Reporting workload is captured fundamentally differently. A RIS
620 extraction is undertaken over an agreed data collection period. The
621 purpose of the extraction is to obtain a list of examinations
622 performed in that period, with their descriptors and total number of
623 examinations by descriptor. The list is then compared, descriptor by
624 descriptor, with the RANZCR descriptors in Tables 1-5. SATs are
625 then assigned to the department's examination descriptors based
626 on the basis of 'closest fit'. Where no such fit exists or it is not
627 possible to ascertain the nature of the examination, the 'not
628 otherwise specified' SAT can be used. The number of examinations
629 for each descriptor is then cross-multiplied by the assigned SAT,
630 and the subtotals added. The grand total represents the expected
631 study ascribable time required for the department's reporting
632 workload during the data collection period.

At the present time RANZCR does not have a prescriptive recommendation as to how measurement of reporting workload ought to occur. The Christchurch reporting times and descriptor dataset have been generated from real departmental data of the Christchurch Hospital radiology department. Academically most rigorous and administratively most defensible is to generate locally relevant examination descriptors and SATs by following the processes similar to Christchurch Hospital. Where this is not possible, or else high-level interdepartmental benchmarking takes place, this work's descriptors and SATs can be utilised. Their use is time efficient and requires relatively simple manipulation of departmental RIS reports.

Comparison with other work on reporting times

There is relatively little recent published comprehensive work on radiologist reporting times. Three strands of work originating from outside of Australia and New Zealand stand out.

The RANZCR RVU table first used in the Irish survey (6) has also been adapted to the United Kingdom environment for measuring radiologist reporting workload. It was used in 2011 by Khan and Hedges to measure radiologist workload and productivity in the district general hospital setting (7). The UK RVU scoring table is quite short, with little allowance for different types of examinations within a modality. It is also expressed in arbitrary RVU rather than in units of time. It however allows a measure of relativity between different examinations in the Irish and UK settings. Its strength has been two-country validation, not dissimilar to the work presented in this paper.

In the United States, a recent paper by Forsberg, Rospiko and Sunshine (8) directly measured radiologist reporting time for a

range of studies reported in 2015 within a system of several linked hospitals. The focus of the paper was radiologist reading time variability. The data analysis provides mean and median reporting times by examination type for a grand total of 57,881 reports covering 54 different types of procedures (XR, US, CT, MR).

Dora and colleagues (9) have conducted a comprehensive two-year analysis of CT reporting times in a single large academic institution in Brazil. Their survey has captured 42,382 reports for 24 different types of examination. The paper focuses on the mean times and variability in reporting CT so as to generate a local table of RVU. The statistical methodology of Dora's group is comparable to the methodology used by Cowan and colleagues in Christchurch (3). The two groups are however independent of one another. The work of Dora and colleagues was confined to CT; there was no capture of reporting times for other modalities.

Both Forsberg's group and Dora's group provide mean reporting times by examination descriptor, allowing a basic comparison of reporting times to our work's PReSAT times and to each other.

Table 6 presents a comparison table of RANZCR 2016 SATs and external reporting times for a number of XR and CT examinations for which data points are available in all the three streams of work. The examination types chosen are relatively unambiguous across time and across countries, with an implied anatomical coverage. Even so, comparison should be made with extreme caution. Casemix for each descriptor is not known; the amount of visual data to be read (particularly for CT) is not known; the variability of content and complexity (particularly for CT) is not known.

Perhaps the most illuminating is comparison of Dora's CT reporting times (in minutes, rounded to the nearest minute in Table 6) against the RANZCR SATs. The agreement is excellent. Similarly, there is excellent agreement between RANZCR SATs for radiography and Forsberg's data.

Where differences are evident (for example, Forsberg's CT reporting times against the other data), interpretation of the difference is not possible without the knowledge of the local casemix and of dataset volumes. Even then, the relativities between lesser anatomical coverage and greater anatomical coverage is maintained, and all the systems agree at least crudely.

Further interpretation of the comparison is not possible with certainty. It does however serve as an external validation of our work, with inevitable and expected variations and differences.

Limitations

The reader is reminded that the RANZCR 2016 SATs are specific to the setting of the teaching department, where a significant proportion of radiologist time is expended on non-reporting tasks. The application of these SATs in other settings has not been addressed and may lead to grossly erroneous results.

Ignoring non-reporting radiologist work in teaching departments will also lead to grossly erroneous results. As a cross check for realistic teaching department conditions, consider the SAT for a chest Xray, and for a single area radiograph NOS. Both SATs are two minutes. If we assume that an eight-hour radiologist workday consists of nothing other than reporting (and other study associated activities), then simple arithmetic leads us to expect that a radiologist working in a training department would produce 240 Xray reports every day.

Such scenarios clearly do not occur; and the fallacy lies in the presumption that radiologists do no work other than reporting (and study associated tasks). As discussed above, in the real world patient related non-study ascribable tasks and non-patient related tasks consume in the order of one half of all radiologist working time. Quite separately, environmental factors which routinely impact on radiologist productivity are numerous, and include interruptions; the need to multitask and therefore defocus from the current tasks; light, noise, distractions; suboptimal performance of workplace systems (particularly IT systems); many others. Human factors include mental fatigue in particular. Meal (and other) breaks consume time, but have not been included in this analysis.

This work, by its nature, has significant methodological limitations. The choice of examination descriptors is fundamentally arbitrary, an attempt to balance specificity and inclusivity, 'grouping' and 'splitting'. The 2006 Pitman-Jones RVU list had only 20 descriptors (no NM and no PET). The original Christchurch Hospital descriptor list included 382 unique descriptors. The granular BSF descriptors run into the hundreds. The published Christchurch list (2013) was of 219 unique descriptors (no NM and no PET). This work presents a total of 148 descriptors and SATs (XR and MG: 17; US: 37; CT: 33; MR: 35; NM and PET: 26).

These RANZCR 2016 descriptors will not perfectly match the descriptors of any one department, not even the source department used for their derivation (Christchurch Hospital).

The SATs are also averaged generalised SATs. They will not match the radiologist time expended on any one individual diagnostic study, except by chance. The RANZCR 2016 SATs have been derived from two sources with different collection methodologies.

They have been further generalised by expert consensus in a modified Delphi process. Because of their intended use, the variability of reporting times by examination descriptor has been discarded in the process. Such variability is commonly expressed as a range (for example, quartile range) or standard deviation for normally distributed reporting times. The RANZCR 2016 SATs do not have such variability by design.

Thus, the SATs will not have perfect applicability to any one department. It is for this reason that the authors draw the reader's attention to the Christchurch Hospital methodology as one means of generating locally valid reporting and study ascribable times.

Conclusion

The RANZCR 2016 study descriptors and study ascribable times are now available for use by teaching radiology (and nuclear medicine) departments in Australia and New Zealand. In a first for Australia and New Zealand, NM and PET study descriptors and study ascribable times have been agreed on and balanced against radiology times. Although a simplification and generalisation, these descriptors and times should provide a useful reference database for measurement of reporting and associated study ascribable workload.

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Appendices

Membership of the RANZCR 2015-2016 Radiologist Workload Working Group

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- Prof. Mark Khangure (CAO RANZCR FCR, SKG Radiology, WA)
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- A/Prof Murali Guduguntla (CRETC rep RANZCR, the Canberra Hospital, ACT)
- Prof. Alex Pitman (RANZCR FCR Council, Lake Imaging, VIC)
- Dr Ian Cowan (Christchurch Hospital, NZ)
- Dr Andrew Klava (Lakes District Health Board, NZ)
- Dr George McIvor (Westmead Hospital, NSW)
- A/Prof. Kevin Bell (Western Health, VIC)
- Dr Richard Floyd (Christchurch Hospital, NZ)
- Dr Leanne Du (Gold Coast Hospital, QLD)

Figure Legends

Tables

Refer to SAT tables 1 to 5.xlsx and SAT table 6.xlsx

Figures

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