

Benchmarking in Cardiovascular Imaging

British Society of Cardiovascular Imaging

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Dr Giles Roditi & Dr Tarun Mittal

Introduction -

The issue of benchmarking is coming to the fore in UK radiology - with the move to PACS and a time sensitive Consultant contract employers are keen to divorce scan performance from the reporting process and at the same time maximise reported examination volume as an easily measurable indicator of radiological performance. This kind of simple analysis is all too simply performed with modern Radiology Information Systems (RIS). However, this does not accurately reflect complexity of workload and the 'whole picture' of what clinical radiologists perform as part of Direct Clinical Care (DCC) activities. Already unrealistic estimates of how much reporting DCC activity can be accomplished in any given DCC period have been promulgated with little thought as to the complexity of different examinations let alone differing complexity of the same examinations for differing conditions and in different circumstances. It is clear that the profession should lead this process to ensure a fair and equitable benchmarking method that can allow equitable comparisons of radiological workload for radiologists working with different modalities in differing workflow environments, specialising in different body systems with differing support levels and different pathological case mix. As the special interest group of the RCR for cardiovascular imaging the BSCI could take a lead in this since the complexity of our work varies widely with many techniques on the 'cutting edge' of radiology, however, to be truly successful this should be replicated by the other special interest groups that advise the RCR.

A Workload Model -

The Royal College of Pathologists document 'Guidelines on staffing and workload for histopathology and cytopathology departments' is a useful starting point for discussion of this issue from an allied medical UK Royal College. These guidelines aim to provide a mechanism to support pathologists in ensuring 'reasonable, safe and practicable' workload while recognising differing complexity patterns. This is achieved by the use of a scoring system for specimens based on a variety of criteria including the nature and scope of the specimen concerned, how it is processed and the amount of special stains etc. required for diagnosis. The maximum score for a complex case with extensive macroscopic and microscopic work is 20 and the guidelines then go on to state that a reasonable workload rate would be 10 units per hour.

This approach could be usefully applied in our specialty, for example in radiology the following process analogous to Appendix 2 of the pathologist's document could be seen as generic to most radiological examinations, though clearly not all stages will apply in all circumstances –

Processes Involved in Reporting a Radiology case –

1. Vetting of request for appropriateness and against IRMER
2. Review of previous imaging reports
3. Review of previous imaging
4. Discussion of case with clinical referrer if required
5. Assign protocol to case
6. Assign priority to case
7. Clinical interaction with patient prior to radiological examination (e.g. explanation of procedure, consent, obtain intravenous access, premedication etc.)
8. Performance of examination
9. Supervision of examination during performance
10. Initial review of examination to ensure completeness prior to patient leaving
11. Post procedure clinical care
12. Retrieve images for review
13. Post-processing of images e.g. for quantitative analysis and 3D rendering
14. Check identity of images correlates to request
15. Reporting of images – may include direct comparison to previous images, measurements and 3D interaction on workstation
16. Discuss with colleagues as required
17. Teaching interaction
18. Dictate or type report
19. Mark key images (PACS)
20. Mark images as having been reported (PACS) &/or archive images to PACS
21. Receive transcribed report
22. Check identity of report
23. Review transcribed report, amending as appropriate – may require repeat image review
24. Authorise report
25. Discuss with clinical referrer

Benchmarking Examples -

Using this system we can tabulate workload for different examinations in different circumstances and some examples from cardiovascular imaging are given below –

Please note that item 17 teaching interaction is not included in the examples below and it is suggested that this would increase any given score by 25%.

Plain Films

Modality - Radiography
Examination – PA Chest
Clinical Scenario – Hypertension
Suggested score – 1

Score of 1 for a plain radiograph is taken as the simplest imaging procedure equivalent of time unit of 4 minutes to include reviewing the x-ray, comparison with previous ones, reporting, and verification. Some cases with clinical important findings may require contacting the referring team. It is anticipated that a radiologist would report 15 x-rays in an hour thus each hour allotted a score of 15.

Plain x-rays would attract a low score since many of stages 1 – 11 above would be delegated to radiographic staff and through referral pathways. Process item 13 would not apply, 15 would be limited to windowing and magnification as required on a PACS workstation and other items straightforward.

Cardiac CT:

These procedures can be thought of as comprising different 'blocks' or components (corresponding to elements of above points 1 through 25) with each block allotted an average time and equivalent score.

	Block	Average time taken	Score (rounded up)	Comments
A	Supervising, drug administration, ECG editing etc	15	4	In some circumstances may be delegated
B	Calcium Scoring, Lung parenchyma	10	2.5	Scoring may be delegated
C	Aorta, cardiac chambers, myocardium, pericardium, etc.	5	1	
D	Coronary artery analysis	15	4	
E.	Function analysis	10	2.5	Volume calculation may be delegated
F	Grafts Analysis	15	4	
G	Delayed Enhancement	10	2.5	
H	Archiving	5	1	

Example 1 –

Modality - CT

Examination – Cardiac CT for calcium score

Clinical Scenario – Asymptomatic – risk factor assessment

Score (Block B) – 2.5 if calcium-scoring determination not delegated, 2 if it is.

This procedure by itself would attract a low score for a cardiac CT examination since less post-processing is required (check score, correlate to normal age & gender values, review on lung and bone windows for incidental pathology) - in some centres the calcium quantification may be delegated to radiographic staff, if this is the case the reporting radiologist will still check that work.

Example 2 –

Modality - CT

Examination – Coronary CT angiography (including calcium score), no functional analysis (with or without prospective gating)

Clinical Scenario – Chest pain - low pre-test probability

If supervised (Blocks A, B, C, D, H):

suggested time taken = 50 min

score = 12.5

If un-supervised (Blocks B, C, D, H):

suggested time taken = 35 min

score = 8.5

Here the score would depend on the amount of interaction required by the radiologist in terms of patient interaction for drug premedication, direct scan performance & supervision etc. The reporting score would be higher than Example 1 above requiring large dataset image review and 3D workstation analysis.

Example 3 –

Modality - CT

Examination – Coronary CT angiography – including functional analysis

Clinical Scenario – Atypical chest pain and inconclusive ETT; multiple risk factors

If supervised (Blocks A, B, C, D, E, H):

suggested time taken = 60 min

score = 15

If un-supervised (Blocks B, C, D, E, H):

suggested time taken = 45 min

score = 11

The amount of time taken for functional analysis may be slightly reduced if volume calculation is delegated to a radiographer. However, in reporting terms functional analysis includes regional wall motion, myocardial thickness and valvular analysis.

Example 4 –

Modality - CT

Examination – Bypass graft study – including functional analysis and delayed enhancement (option).

Clinical Scenario – Graft patency review post CABG (inc. LIMA)

If supervised (Blocks A, B, C, D, E, F, G, H):

suggested time taken = 75 min

score = 19

If un-supervised (Blocks B, C, D, E, F, G, H):

suggested time taken = 60 min

score = 15

Example 5 –

Modality - CT

Examination – Adult Congenital Cardiac Disease including RV functional analysis

Clinical Scenario – Adult Congenital Cardiac Disease patient with previous operations and RV dysfunction

Supervised (Blocks A x 2, B, C x 4, D, E x 4, H):

suggested time taken = 120 min

score = 30

Cardiac MR:

Just like cardiac CT, cardiac MR can be thought of as comprising different 'blocks' or components with each block allotted an average time and equivalent score.

	Block	Average time taken	Score (rounded up)	Comments
A.1	Supervising a study (simple checking)	5	1	In some circumstances may be delegated
A.2	Supervising stress study	15	4	
A.3	Supervising a congenital study	60	15	This would vary depending upon the experience of a centre
B.1	Function analysis with volume calculation	20	5	
B.2	Function analysis without volume calculation	10	2.5	Where volume calculation has been delegated
C	Delayed Enhancement	10	2.5	
D	Flow (2 regions)	10	2.5	
E	Morphology, non-congenital e.g. ARVC	5	1	
F	Morphology, congenital including other extra sequences	20	5	
G	Stress (either Adenosine or Dobutamine)	15	4	
H	Archiving	5	1	

Example 6 –

Examination – Cardiac MRI with LV analysis and delayed hyper-enhancement

Clinical Scenario – Suspected HCM

Suggested total time and score:

Supervision & volume calculations	Blocks	Total time (min)	Total score
By Radiologist	A.1, B.1, C, H	40	10
Delegated	B.2, C, H	25	6

Example 7

Examination – Cardiac MRI with LV analysis, stress perfusion and delayed hyper-enhancement

Clinical Scenario – CAD with regional ventricular dysfunction

Suggested total time and score:

Supervision & volume calculations	Blocks	Total time (min)	Total score
By Radiologist	A.2, B.1, C, G, H	65	16
Delegated	B.2, C, G, H	40	10

Example 8 –

Examination – Cardiac MRI with LV analysis, morphology and delayed hyper-enhancement

Clinical Scenario – to exclude ARVC or other cardiomyopathy.

Suggested total time and score:

Supervision & volume calculations	Blocks	Total time (min)	Total score
By Radiologist	A.2, B.1, C, E, H	45	11
Delegated	B.2, C, E, H	30	7

Example 7 –

Examination – Cardiac MRI: morphology, flow and function

Clinical Scenario – Congenitally corrected transposition

In this example there will inevitably be a very high score with radiological involvement in virtually every stage.

Supervision & volume calculations	Blocks	Total time (min)	Total score
By Radiologist	A.3, B.1, C, D x2 F, H	120	30

Non-Cardiac CTA and MRA:

	Region	Average time taken	Score (rounded up)	Comments
i	Thoracic Aorta	15	4	With or without ECG gating
ii	Abdominal Aorta	15	4	
iii	Additional Aortic Region	10	2.5	
iv	Stent-graft planning	15	4	
v	Renal Arteries	20	5	Including kidneys, iliac arteries etc.
vi	Carotid Arteries	20	5	
vii	Aortoiliac & Lower Limb Arteries	30	7.5	
viii	Archiving	5	1	