



THE COLLEGE OF  
RADIOGRAPHERS



# CT Equipment, Operations, Capacity and Planning in the NHS

Report from the Clinical Imaging Board

June 2015

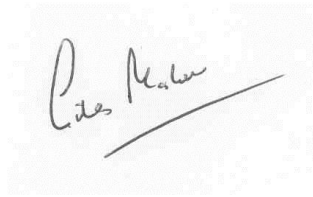
## Foreword

This report was commissioned by the Clinical Imaging Board, an intercollegiate Board representing The Royal College of Radiologists (RCR), the Society and College of Radiographers (SCoR) and the Institute of Physics and Engineering in Medicine (IPEM).

This report has been compiled collaboratively, by a small multidisciplinary working group comprising of Dr Nicholas Spencer, Clinical Radiologist and working party lead, Mrs Pam Black, Ex-officio SCoR President July 2013 – July 2014, Ms Maria Lewis, Physicist and Ms Paula Cunningham Lally, CT Radiographer, with essential input from Kim Cyrus, RCR Executive Officer, and Karl Drinkwater, RCR Audit Officer.

We would like to thank Dr Spencer and all those involved in the production of this report.

The Clinical Imaging Board accepted the recommendations of the working group, and these are set out in this report.

A handwritten signature in black ink, reading "Giles Maskell", with a horizontal line underneath.

**Dr Giles Maskell**  
**President of The Royal College of Radiologists**

A handwritten signature in black ink, reading "Karen Smith", with a horizontal line underneath.

**Mrs Karen Smith**  
**President of the Society and College of Radiographers**

A handwritten signature in blue ink, reading "Stephen Keevil", with a horizontal line underneath.

**Professor Stephen Keevil**  
**President of the Institute of Physics and Engineering in Medicine**

## 1. Introduction and background

The increasing use of advanced imaging continues across the UK and throughout the world. Within the NHS, computed tomography (CT), is long established as the mainstay of emergency and routine diagnostic cross-sectional imaging. The applications for CT are widespread, both for critically ill and ambulant patients, with all body parts being evaluated. The rapid development of CT technologies and of new specialist applications, combined with the post-processing powers of modality workstations and other tools within picture archiving and communication systems (PACS), continue to drive the pressure on CT services. Multidisciplinary teamworking, especially in the arena of cancer diagnosis, treatment, follow-up and survivorship, is also significantly affecting CT service growth, which continues to increase by over 10% per annum<sup>1</sup> for the last decade.

However, there is anecdotal evidence that in the UK, investment in CT equipment is declining, which may be due to NHS funding restrictions. There is much pressure to “sweat the assets”, operating services for longer hours and increasing throughput, to help make access to diagnostic tests ever more speedy. While all of these goals are clinically imperative, the UK operates CT scanning from a very low installed base of less than 9 scanners per million population<sup>2</sup>.

Against this background, the Clinical Imaging Board, representing The Royal College of Radiologists (RCR), the Society and College of Radiographers (SCoR) and the Institute of Physics and Engineering in Medicine (IPEM), requested that a working group be convened to evaluate the installed equipment and operations of CT services within the NHS across the UK. The purpose of this work has been to provide information about equipment specification and its utilisation, details of operational aspects of services, and to ascertain the planning intentions of NHS radiology services to maintain and develop CT capacity (*see Appendix 1. Terms of reference*).

This report builds upon the work of the National Audit Office (NAO) (England), which published a report<sup>2</sup> assessing the management of high-value capital equipment in the NHS in England. The NAO publication focused on a number of areas, around planning, acquisition and maintenance of high-value machines, plus meeting demand for services, and improving the management of such equipment. The NAO report also included magnetic resonance imaging (MRI) and linear accelerators, as well as CT. The work that furnished the NAO report was undertaken by a combination of survey and selected site visits, and took place following the conclusion of a centrally funded Department of Health “Cancer Equipment Programme developed as part of the NHS Cancer Plan”<sup>3</sup> That programme in turn, through significant investment, had increased the replacement and overall numbers of CT and MRI

machines, as well as linear accelerators, with the prime purpose of improved provision of cancer diagnostic and treatment capability in the NHS. From 2000 to 2007, that programme accounted for almost three-quarters of new and replacement machines purchased for the NHS in England.

## 2. Objectives

- 2.1 To produce a report detailing installed equipment and operations of CT services in the NHS across the whole UK.
- 2.2 To establish an overview of service forward planning intentions, in order to consider if sufficient future CT capacity will be available and to help quantify any shortfall.
- 2.3 To develop guidance that may be used by providers to assist in maintaining and updating CT equipment as well as those considering increasing their capacity.
- 2.4 To promote self-assessment by providers, through delivery of suitable audit template/s to the RCR's Clinical Radiology Audit Live([www.rcr.ac.uk/AuditLive](http://www.rcr.ac.uk/AuditLive)).

## 3. Methodology

- 3.1 All 183 NHS radiology departments were surveyed. A questionnaire was developed and distributed electronically (*see Appendix 2*), requesting the local CT lead radiographer respond to a series of questions and provide data about each installed diagnostic CT scanner at their NHS institution.
- 3.2 The survey was promoted through the Society and College of Radiographers' National Conference for Radiology managers meeting in May 2014. Clearly this targeted radiology service managers and CT superintendents. In addition, the survey was promoted through the SCoR *Synergy News* to all members and an online link to a survey questionnaire included.
- 3.3 After initial distribution of the survey, follow-up messages and reminders were sent before the survey closed to encourage response rates.
- 3.4 After the survey closed, a non-responders e-survey using an online tool was undertaken to identify any possible reasons for non-participation. This was directed at the lead radiologists in each of the institutions that did not participate initially.
- 3.5 The data generated has been subject to statistical analysis and those results are embedded within this report.

3.6 117 (64%) NHS organisations from across the UK and Channel Islands responded to the survey.

## 4. Data returns

The questionnaire structure enabled responses per CT machine within any NHS radiology service, the aim being to have a rich dataset by piece of equipment rather than by trust or service. Analysis of the data has been undertaken supported by the Audit Officer at the RCR.

### 4.1 Scanner numbers and locations

4.1.1 117 organisations from across the UK and Channel Islands NHS responded to the survey detailing information about 298 CT scanners. The information provided by these respondents alone forms the basis of the content of the remainder of this report.

4.1.2 This represents a response rate of 63.9% by NHS radiology services.

4.1.3 From English respondents, this represents approximately 59% of total CT installed base.<sup>3</sup>

4.1.4 Responses by region, shown in Table 1, show participation from all devolved nations.

**Table 1. Regional profile of respondents and number of scanners installed**

| Region        | London | Midlands and East of England | North of England | South of England | Scotland | Wales | Northern Ireland | Other (Channel Isles) | Total |
|---------------|--------|------------------------------|------------------|------------------|----------|-------|------------------|-----------------------|-------|
| Organisations | 19     | 25                           | 29               | 17               | 13       | 8     | 4                | 2                     | 117   |
| Scanners      | 41     | 68                           | 78               | 52               | 32       | 15    | 10               | 2                     | 298   |

4.1.5 Scanners range in ages from zero, ie, recently installed, to more than 15 years old. Ten per cent of scanners in the UK are more than ten years old.

4.1.6 Table 2 shows the number of scanners by age from within the survey respondents departments.

**Table 2. Age of equipment in years and scanner numbers**

|                    |    |    |    |    |     |    |    |    |    |    |
|--------------------|----|----|----|----|-----|----|----|----|----|----|
| Age in years       | 0  | 1  | 2  | 3  | 4   | 5  | 6  | 7  | 8  | 9  |
| Number of scanners | 21 | 27 | 29 | 29 | 39  | 22 | 29 | 31 | 22 | 15 |
| Age in years       | 10 | 11 | 12 | 13 | >15 | DK |    |    |    |    |
| Number of scanners | 10 | 10 | 6  | 5  | 2   | 1  |    |    |    |    |

4.1.7 The mean age of CT equipment is 4.8 years (mode = 4 years, median = 5 years). This suggests that average equipment age has improved in the last three years since the NAO survey in 2011. By contrast, a report published by the European Coordination Committee of the Radiological, Electromedical and Healthcare IT industry (COCIR) shows the age profile of CT in UK in 2013 to be worse than the average compared to all European countries.<sup>4</sup>

4.1.8 Previous data for England only from the National Audit Office shows that:<sup>4</sup>

- A total of 406 CT scanners were installed across the NHS in England, as of March 2012<sup>5</sup>
- The NAO survey also reported that the average purchase price of a CT scanner was £579,000, and that the lifespan of a CT scanner was expected to be 7–10 years<sup>†</sup>
- The average age of existing CT equipment at the time of the NAO survey in 2011 was 6.2 years.<sup>†</sup>

† It is not specified in the NAO survey report whether the average purchase price or age of the CT machine relates to the mean, median or mode.

## 4.2 CT equipment purchase method

4.2.1 Of 298 responses, 208 machines were declared to be owned by the NHS organisations, 30 were leased, 54 obtained as part of a managed equipment service, see 4.2.3, and there were six “don’t know” responses (see Table 3).

- 4.2.2 Capital purchase remains the most common funding methodology in the NHS at present for CT equipment, with two-thirds of CT scanners being owned and operated by NHS organisations.
- 4.2.3 The managed equipment service is a contractual model of partnership with a private sector partner to procure, manage and dispose of medical equipment over an agreed period, typically ten or 15 years. Some commentators believe that in the NHS, this can assist in managing maintenance and refreshment of medical equipment and is designed to offer financial benefits to the institution. Relative costs of ownership have not been compared within this paper.

**Table 3. The funding methodology and numbers of scanners**

| Owned     | Leased   | Managed equipment service | Don't know how funded |
|-----------|----------|---------------------------|-----------------------|
| 208 (70%) | 30 (10%) | 54 (18%)                  | 6 (2%)                |

4.2.4 The age profile outlined in Section 4.1 indicates a steady purchase rate of approximately 30 scanners per year, among responding organisations, which implies that if purchase plans are completed as planned in the future, that a typical CT scanner will have an expected clinical use of approximately ten years.

**4.3 Replacement planning**

- 4.3.1 Replacement of high-value capital equipment is complex. Typically, NHS trusts function independently and hence group procurement is not the norm. The use of NHS Supply Chain has increased significantly over the last four years, with 147 CT orders being processed through them during this period.
- 4.3.2 In Scotland, funding is carried out through Health Boards, who determine the needs for replacement or additional equipment across the country. Procurement in Scotland is managed by NHS National Procurement.<sup>7</sup>
- 4.3.3 Many (62%) NHS organisations have replacement plans in place – some of which include funds already committed. Where used, managed equipment services also provide clear timelines for future replacement procurement.
- 4.3.4 [NHS Supply Chain](#)<sup>6</sup> can assist with procurement and have agreed framework prices with the major manufacturers for equipment and optional extras.

4.3.5 With regards to group procurement, there remains the opportunity for collaboration between organisations, which may further leverage purchasing power between NHS organisations in the future.

**Table 4. Replacement plans by scanner within each region**

| Region                          | Yes, replacement plan in place | No replacement plan in place | Respondent did not know | If yes & replacement is also in organisation's financial planning | If yes & replacement NOT in organisation's financial planning or don't know |
|---------------------------------|--------------------------------|------------------------------|-------------------------|---|---|
| Wales                           | 3                              | 5                            | -                       | 1   | 2   |
| South of England                | 11                             | 6                            | -                       | 9   | 2   |
| Scotland                        | 9                              | 3                            | 1                       | 7   | 2   |
| Northern Ireland                | 3                              | 1                            | -                       | 2   | 1   |
| North of England                | 19                             | 9                            | 1                       | 19  | -   |
| Midlands and East of England    | 13                             | 10                           | 2                       | 13  | -   |
| London                          | 12                             | 6                            | 1                       | 10  | 2   |
| Other                           | 2                              | 0                            | -                       | 2   | 0   |
| Total                           | 72                             | 40                           | 5                       | 63  | 9   |
| Number of scanners this affects | 189 (60%)                      | 112 (36%)                    | 13 (4%)                 | 164 (52%)   | 25 (8%)   |

4.3.6 Survey respondents reported that there are *no* replacement plans in place for 112 scanners potentially, plus 13 don't knows (40% of scanners).

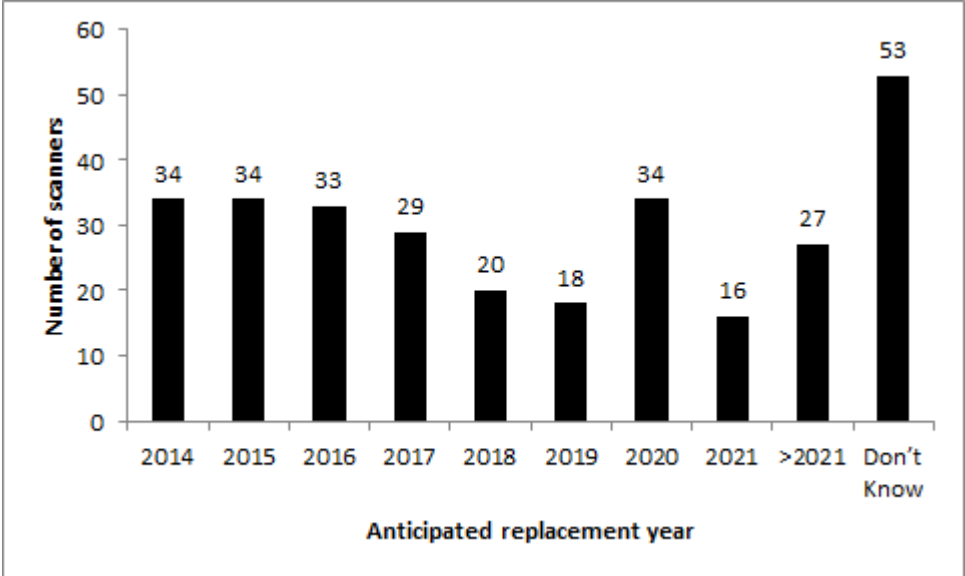
4.3.7 For a small group of organisations plans for replacements exist, but these are unfunded or will require a future business case; this affects up to 25 scanners.

4.3.8 There are no current or future planned central funding schemes for high-capital diagnostic equipment. Most CT scanners are now procured from local institutional capital funding, which accounts for 70% of scanners detailed in this survey's responses.



4.3.9 The survey also sought an indication for when each CT scanner might be replaced in the future. This mixes those with certain business plans with others less confident, to profile possible future NHS procurement needs. Figure 1, below, demonstrates that, where known, the procurement planning suggests a continued steady procurement rate of about 30 machines per year, from the survey respondent NHS organisations. There appears from the chart below, to be a decline in replacement in later years, although this is suspected to be due to less certain planning further into the future.

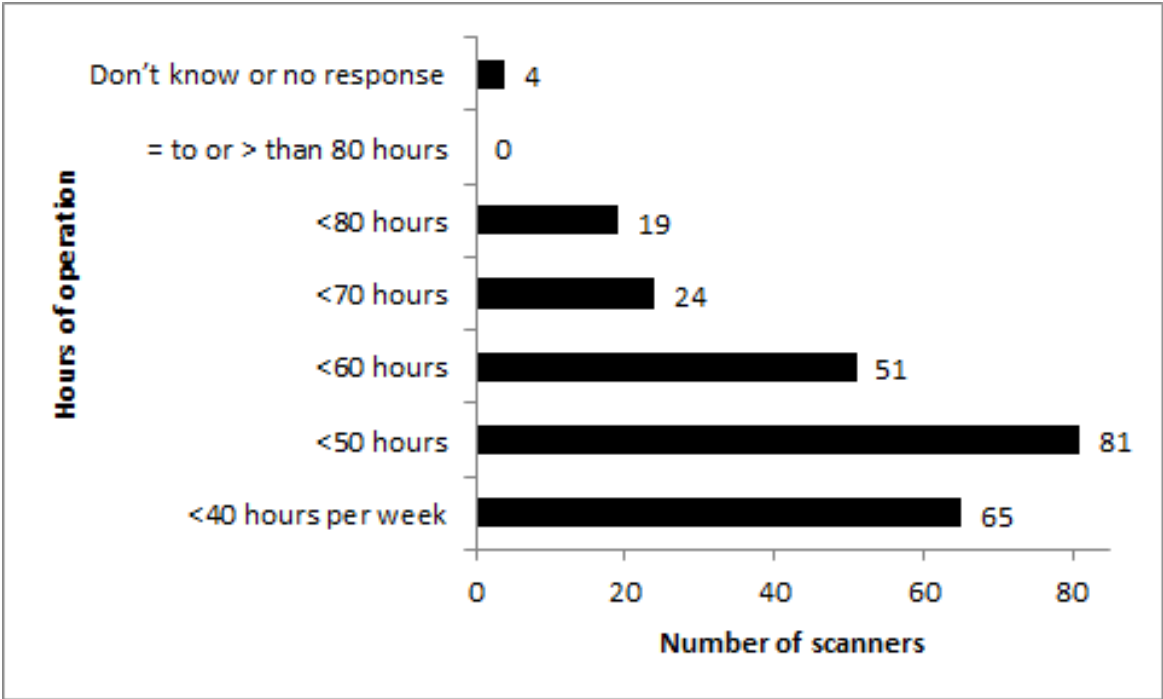
**Figure 1. Future replacement CT numbers planned by year**



## 4.4 Meeting demand

- 4.4.1 Both the National Audit Office data of 2011<sup>2</sup> and more recent data from the Diagnostic Imaging Data Set<sup>1</sup> clearly demonstrate that growth in CT activity continues apace. Average annual CT growth is 10.3% per annum since 2003. Overall, the diagnostic imaging modalities growth rate is 3.3%. Only MRI, growing at an average of 12.0% per annum since 2003, is increasing at a rate faster than CT.
- 4.4.2 CT use increased in England by 13.0% to 3,780,405 examinations in 2013–14.<sup>1</sup> Unusually, this growth outstripped MRI demand during this particular period. Based on annual mid-year population statistics published by the Office for National Statistics,<sup>9</sup> this equates to 71.3 CT studies per 1,000 population.
- 4.4.3 Comparing with the most recent Organisation for Economic Cooperation and Development (OECD) data available,<sup>10</sup> CT exams per 1,000 population elsewhere in the world range from 29.1 (Finland 2012), to 240.2 (USA, 2013). Across a basket of 18 OECD participant countries, mean CT usage rates in 2012 were 125.1 per 1,000 population. UK use is only 57% compared with the other countries.
- 4.4.4 There are a number of ways of increasing CT capacity, from a growth in the absolute numbers of pieces of equipment, to different staffing skillsmix and workload models, through to extending hours of operation both during a five-day week, and extending to seven-day working as well. The latter is already increasingly commonplace in the NHS, due to clinical demands and the requirement for 24-hour rapid availability for emergency CT scanning, such as trauma and stroke assessment.
- 4.4.5 To ascertain information about these, the survey asked for information about hours of routine operation by the scanner and the average patient throughput per day by scanner (see Figure 2 and Table 5).
- 4.4.6 The average hours of operation, excluding on-call emergencies = 48.8 hours per week.
- 4.4.7 The average number of patients scanned = 32 per day.
- 4.4.8 The survey did not specifically ask about emergency activity, nor out-of-hours standby availability.

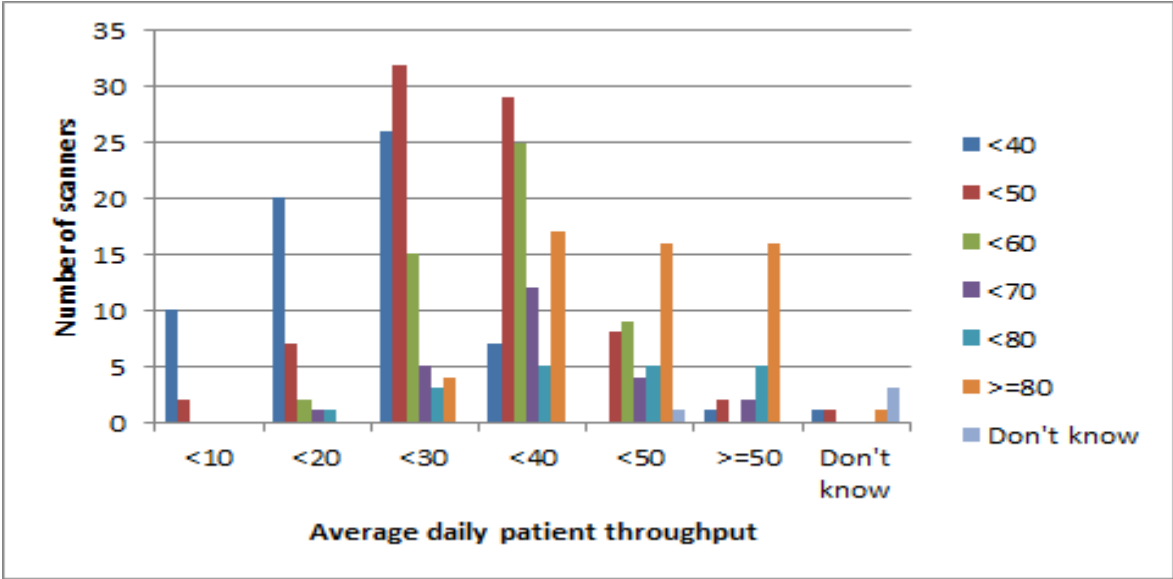
**Figure 2. Weekly hours of operation and frequency**



**Table 5. Average patient numbers scanned per day and frequency by scanner**

| Daily throughput          | Numbers of scanners | Percentage of total |
|---------------------------|---------------------|---------------------|
| <10 patients per day      | 12                  | 4%                  |
| 10-19                     | 31                  | 10%                 |
| 20-29                     | 85                  | 29%                 |
| 30-39                     | 95                  | 32%                 |
| 40-49                     | 43                  | 14%                 |
| ≥ than 50                 | 26                  | 9%                  |
| Don't know or no response | 6                   | 2%                  |
| Total                     | 298                 | 100%                |

**Figure 3. Average daily throughput by frequency, with additional colour coding for patients per day**



4.4.9 Figure 3 shows that there is a wide variation in throughput, not directly related to hours of operation. A small proportion of scanners appear to be used much less than others. This may relate to a particular case-mix, or to patient referral patterns, and so is a finding which must be viewed with caution.

4.4.10 It should be noted that ‘sweating the CT asset’ through the overuse of CT equipment will shorten its lifespan by several years, as this is typically measured in tube rotations.

4.5 Technical issues

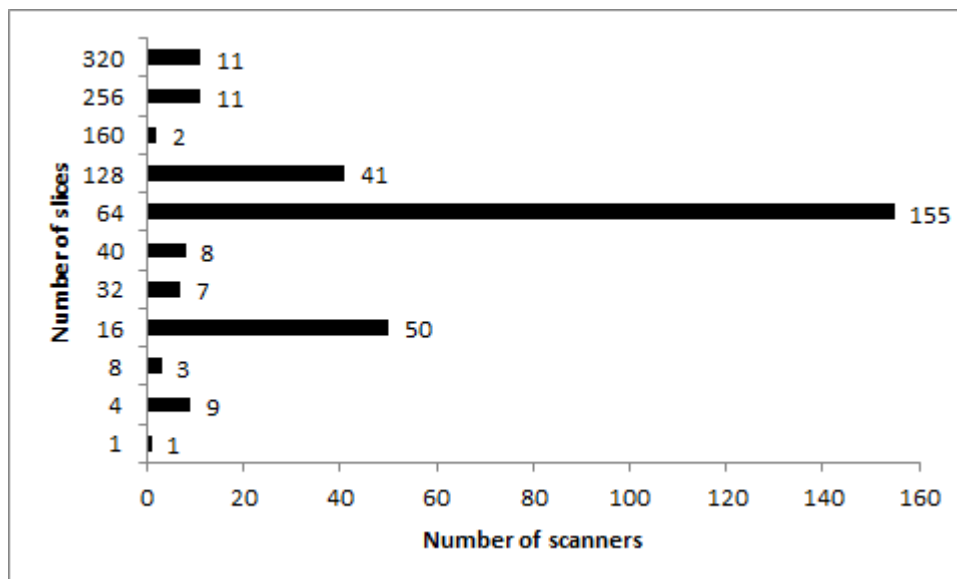
4.5.1 Scanner acquisition technology

CT scanners operate by acquiring a volume of imaging data as the scan gantry rotates. Scanner models are usually classified in terms of number of slices and this is assumed to give an indication of the scanner’s capability in terms of speed of coverage. However, for technical reasons, some manufacturers ‘double sample’ each detector row resulting in a doubling of the number of slices, but not doubling of volume coverage. Therefore, some scanners classified as ‘64-slice’ have half the volume coverage of other ‘64-slice’ models. In this report, the conventional classification of scanners by ‘number of slices’ has been adopted. However, users

and prospective purchasers should be aware of the distinction between ‘numbers of detector rows’ and ‘number of slices’ on a CT scanner.

For complex applications including cardiac CT, ‘higher slice’ technology is required so that a larger volume is acquired in a shorter scan time. This is, however, not the rate-limiting factor for overall scanner capacity in terms of patient throughput.

**Figure 4. CT scanners by frequency and slice technology**



*Further technical note - Readers to be advised that some technologies achieve higher slices by “double-sampling”. The maximum number of detector banks on a CT is currently 160. Both 256- and 320-slice technologies achieve this by double sampling.*

4.5.2 CT uses X-rays as the fundamental physical “tool” to enable image creation. X-radiation exposure for patients undergoing CT is relatively high, and in modern CT practice, accounts for a significant proportion of the radiation exposure for all patients.

4.5.3 There are a number of dose reduction methods in practice and the survey asked about the two most common of these, namely automatic tube current modulation (ATCM), and iterative reconstruction (IR) capability.

**Table 6. Frequency of dose reduction capabilities for CT scanners surveyed**

| ATCM      | IR      | Both      | Neither  | No response |
|-----------|---------|-----------|----------|-------------|
| 110 (37%) | 24 (8%) | 120 (40%) | 36 (12%) | 8 (3%)      |

- 4.5.4 The working group believe that it is likely that few responders were aware of the dose reduction terminology used in the questionnaire and may have given incorrect replies. The great majority of the installed CT base in the UK will have ATCM technology. Certainly all scanners with IR (which is a fairly recent development) will also have ATCM capability. Further work would need to be undertaken to show this.
- 4.5.5 Alongside the technical questions about scanner slice capability and dose reduction techniques, the survey also sought to ascertain case-mix and specialist applications, shown in Table 7.

**Table 7. Use of CT scanners for specific specialist applications**

| Used for        | Yes       | No        | Don't know |
|-----------------|-----------|-----------|------------|
| Cancer staging  | 282 (95%) | 15 (5%)   | 1 (0%)     |
| CT angiogram    | 263 (88%) | 33 (11%)  | 2 (1%)     |
| Lung nodules    | 223 (75%) | 66 (22%)  | 9 (3%)     |
| CT colonography | 197 (66%) | 101 (34%) | -          |
| Cardiac         | 98 (33%)  | 200 (67%) | -          |

## 5. Discussion of findings

### 5.1 Participation and scanner numbers

- 5.1.1 The response rate for this particular survey, given its methodology, is considered to be very good. This survey method was adopted, as being most likely to be the best at giving the widest opportunity to participate from services across the NHS.
- 5.1.2 The follow-up survey to non-responder institutions was directed at radiologist service leads. The prime reason given for non-participation was lack of awareness of the survey by the lead radiologist.
- 5.1.3 There is broad representation in the responses and data generated from across England and the devolved nations.

5.1.4 Recent OECD data shows the United Kingdom to have the lowest number of CT scanners related to population, at 8.95 CT scanners/million. (Range 8.95–53.65 (Australia), and mean of 25.53 CT scanners/million.<sup>11</sup>

## 5.2 Equipment procurement specification and replacement

5.2.1 The specification of installed CT equipment is high, with only 26% of equipment being below 64-slice capability.

5.2.2 This may be due to procurement exercises ensuring future proofing of technology when the rare purchasing opportunities present themselves, or procurement decisions related to buying current technology.

5.2.3 It is encouraging that replacement plans are in place for more than 50% of CT scanners and that in the main, the survey respondents believe that the replacement plan is already funded or funding plans are established. It is more concerning that for as many as 40% of scanners in use, there is no replacement plan in place. The median age of scanners at anticipated year of replacement is nine years, inter-quartile range of four to 14 years.

5.2.4 The European Society of Radiology (ESR) published a statement about renewal of radiological equipment in 2014.<sup>12</sup> It reported that radiological equipment has a definite lifespan. It recommended replacement of equipment more than ten years old, citing obsolescence and reduced image quality. Older equipment has higher risk of breakdown and increased operating costs.

5.2.5 The same ESR publication also gave clear recommendations about life expectancy of CT scanners based on high, medium and low usage.<sup>12</sup>

5.2.6 ESR also clearly recommends that every healthcare institution or authority should have a plan for medical imaging equipment upgrade or replacement, which should look forward a minimum of five years and be updated annually.

5.2.7 The ESR also strongly promotes the use of up-to-date equipment in the context of the EuroSafe Imaging Campaign.<sup>13</sup>

5.2.8 The Canadian Associations of Radiologists (CAR) has also recently published updated life cycle guidance for medical imaging equipment.<sup>14</sup> This indicates the CT equipment life cycle to be eight years.

### 5.3 Developing capacity

- 5.3.1 The utilisation rates of CT in the UK, measured both by hours per week of operation and by patient throughput per day, are widely variable. The link between hours of operation and patient throughput is non-linear.
- 5.3.2 Capacity can be increased significantly by growing equipment use, although this will be constrained by radiographic and other clinical staffing recruitment and retention issues. It may also be affected significantly by an individual institution's approach to the adoption of skills mix, teamworking,<sup>15</sup> complexity of the examination and patient condition, together with patient referral patterns. Further work is recommended in sharing best practice in terms of optimising patient throughput.
- 5.3.3 With the low numbers of scanners per head of population and CT workload growing at an average of 10% per annum, increased use alone is unlikely to bridge the capacity gap in the medium term.
- 5.3.4 With wide variations of usage within regions, opportunities to share capacity could be explored through radiology networks, although the complexities of patient travel, data sharing and varied protocols would need to be overcome. The report team is aware of a few examples of scan-only services being provided between selected trusts in England to assist with capacity provision at neighbouring institutions.
- 5.3.5 One of the challenges in any NHS institution when faced with the challenge of procuring a new or additional (as opposed to replacement) CT scanner to meet growing demands is finding suitable estate space on a trust site near the existing radiology facilities. This clearly requires significant forward planning, which needs to be recognised at an organisational and board level.
- 5.3.6 Where services are delivered across a wider geographic area, as happens in the devolved nations, even more challenges over location and patient travelling times may be faced. A co-ordinated country-wide approach to equipment replacement and additional capacity planning may be beneficial.

### 5.4 Horizon scanning and future work

- 5.4.1 CT technology is mature, and it is unlikely that there will be any major new advances in the near future. However, technical aids to improve clinical interpretation/reporting and display continue to emerge. Some interventional procedures, such as biopsy or tumour ablation, using CT guidance, and new applications, such as cardiac CT are increasing significantly, and these can reduce throughput on individual machines due to longer study or procedure times.



- 5.4.2 Sharing best practice in order to optimise service delivery, including both staffing arrangements and skills mix, merits further investigation. This may enable efficiency improvements to maximise capacity and usage rates. Examining referral patterns may enable patient flows to be adjusted to meet equipment capacity availability.
- 5.4.3 Future planning at NHS organisation/board level is needed to ensure replacement plans are in place, are funded and are regularly reviewed to ensure fitness for purpose and to meet changing and growing demand.
- 5.4.4 Much better and wider understanding and use of dose reduction and optimisation technologies is recommended. An educational tool or technical optimisation programme, such as within the e-Learning for Healthcare programme, should be developed to raise awareness and encourage adoption as widely as possible.<sup>16</sup>

## 6. Summary findings

- 6.1 The specification of installed diagnostic CT equipment in the UK is generally good.
- 6.2 UK has fewer CT machines per head of population than all other OECD countries that have made a declaration in January 2015. CT usage is at only 57% compared to a basket of OECD peer countries in 2013–14.
- 6.3 There is a small proportion of CT equipment (11%) still in clinical use well after its recommended end of life. NHS organisations should ensure this equipment is well maintained and that patients have alternative access to current technology equipment where needed within an NHS trust or across a network through partnership arrangements.
- 6.4 The mean age of CT equipment is just under five years, which is improved compared to the NAO survey in 2011. Nevertheless, the age profile of UK CT equipment still does not compare favourably with other European countries and there is a risk that due to current economic pressures within the NHS that equipment replacement may become more challenging.
- 6.5 Most equipment is owned by the operating NHS organisation (70%). Operating lease and managed equipment service were the alternate procurement vehicles reported.
- 6.6 While more than half of respondents indicated there was a funded replacement plan in place, for 36% of scanners, there is no plan. While this may be because equipment is new and future business planning intentions are not in place beyond five years, future operational risks must be anticipated.

- 6.7 The rate of CT activity growth continues at 10% per annum, but was higher in 2013. Weekly hours of operation and patient throughput varies widely between machines and organisations. This will demand additional equipment or working longer clinical hours. Additional staff will be required to support this both to undertake the imaging and to provide the requisite reporting.
- 6.8 Understanding of dose reduction technologies appears to be poor, and application of these important techniques may be incomplete.
- 6.9 Most scanners are used for a wide range of “specialist” applications from cancer scanning, through to angiographic and cardiac applications as well as virtual colonography. Utilisation of CT equipment to acquire cardiac imaging is lowest at only 33%.
- 6.10 CT is a mature technology, with developments now acting to refine the display and assessment of disease processes.
- 6.11 Readers should note that this report has only considered access to CT equipment and has not considered the workforce issues related to driving acquisition and delivering the required reporting of studies, nor the impact of increasing workload for referrers to receive radiological reports.

## 7. Recommendations

- 7.1 The Clinical Imaging Board believes that valuable overview information about CT services in the NHS has been gathered through this exercise, and that there may be value repeating this for other high-value diagnostic and therapeutic radiology equipment.
- 7.2 The CIB believes there is a need to raise awareness of the low numbers of CT scanners per million population compared to many other similar countries.
- 7.3 While many NHS radiology services clearly have future CT replacement plans in place, it is very concerning that a significant number do not. This requires action by NHS radiology services and all stakeholders.
- 7.4 All NHS radiology departments need a future equipment plan, looking forward at least five years. Professional bodies working together could produce a template or framework to assist these to be developed.
- 7.5 Education about dose optimisation and reduction technologies is needed. Formal programmes to ensure maximum adoption throughout the NHS may be needed and would help to address public concerns about radiation dosages.

7.6 The CIB notes that, with more than 10% of CT equipment being more than ten years old and not having dose optimisation capability, this creates inequity for patients and the Board recommends that this action is taken to address this.

Approved by the Faculty of Clinical Radiology of The Royal College of Radiologists (charity no. 211540): 27 February 2015

Approved by IPEM (charity no. 1047999): 20 April 2015

Approved by SCOR (charity no. 272505): March 2015

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## Appendix 1. Clinical Imaging Board Terms of Reference for Report working party

### Purpose

To produce a report for the RCR, SCOR and IPEM on the installed equipment base and operations of CT services within the NHS in the UK. To establish forward planning intentions of NHS providers to maintain and develop CT capacity in line with demand, including equipment replacement or increased provision; a collective review of those plans will be incorporated into the report.

The working party is to provide an overview of current services, and provide guidance to provider organizations on the importance of maintaining and updating existing CT equipment as well as considering increasing capacity to ensure services will continue to meet the needs of patients and referrers, whilst balancing radiation dose, image acquisition and capital and revenue costs optimally.

The working party is to establish current data in a number of key areas for NHS CT equipment and services:

- Scanner numbers
- Scanner ages
- Scanner specification
- Service operational hours for each scanner, and rationale for this
- Applications and case mix
- Anticipated replacement plans
- Horizon scan for key areas of future service development, applications and possible technology developments

The working party is to develop an understanding of provider organisations' anticipated plans for acquiring replacement and additional CT equipment to meet volume demand and developing applications; the possible impact on the replacement and maintenance cycles of, for example, extending operational hours.

This work will also build on the work of the National Audit Office in England in 2011 (<http://www.nao.org.uk/report/managing-high-value-capital-equipment-in-the-nhs-in-england/>) and reflect on the changes since that report, particularly from the perspective of the professions involved in delivery of CT services.

Services delivered in the independent sector are considered beyond scope, and only diagnostic CT services will be evaluated. Radiotherapy planning CT and PET-CT are also beyond scope.

### Objectives

This small, expert, tri-partite group will:

- develop and agree with the Clinical Imaging Board the detailed scope for the above work
- set out the necessary methodology
- carry out the work
- produce a final report for publication by the three organisations.

### Specific tasks

The Working Party is to convene an initial meeting at the RCR. Subsequent work will be via teleconference or email. A final meeting at the RCR may be required. Administrative support to be provided by Kim Cyrus (CR Executive Officer at the RCR).

It may be necessary during the development of this publication for the Chair of the working group to co-opt/appoint additional members as the group's work evolves. These may include representatives of other professional groups with whom the Clinical Radiology specialty works in close association – for example, radiographers, medical physicists, medical oncologists, clinical nurse specialists.

Nominations from the relevant professional body will need to be sought at this stage. If the working party are of the opinion that the document should become a joint document with another professional body, this would require formal ratification through CR Officers, with notification to the CR Professional Support and Standards Board.

The lead author should consider submitting an audit template, (if appropriate to the standard they have authored) to CR AuditLive either before or soon after the publication of the standard.

### **Membership**

The Working Party membership will include:

Nicholas Spencer, Clinical Radiologist

Maria Lewis, Physicist

Paula Cunningham Lally, CT Radiographer

Pam Black, Ex Officio SCOR President

### **Product**

The new guidance will be produced by the RCR, IPEM and the SCOR, and will be the property of, the "RCR, IPEM and the SCOR". The guidance will be available *in electronic format* and available on the RCR, IPEM and SCOR websites.

### **Costs**

Any meeting expenses and travel costs will be met by the RCR (Faculty of Radiology), IPEM (Institute of Physics and Engineering in Medicine) and the SCOR (Society and College of Radiographers) respectively for each member. All direct costs (for example, editorial and/or design costs) related to the production of the guidance will be met by the RCR, IPEM and SCOR equally.

### **Proposed circulation**

The guidance will be published on the RCR, IPEM and SCOR website(s). Members and Fellows will be notified when the publication becomes available.

### **Copyright**

The guidance will be published under the copyright of the RCR, IPEM and SCOR in all media now known or in future existing.

### **Timescale**

The work is expected to be presented in summary form to RCR and CIB by September 2014. Once the draft output is approved, final report will be completed by November 2014.

## Appendix 2: CT Equipment Survey Questionnaire

### CT Equipment Survey RCR/SCoR/IPEM Clinical Imaging Board

#### Notes:

1. Drop-down lists appear in some cells when the cells are selected. Click the arrow to the right of a selected cell to display the drop-down list.
2. Take care if copying and pasting or using the fill handle as these shortcuts overwrite rules that prevent invalid data being entered. If a cell contains a drop-down list, invalid data is anything you type in the cell that is not an item in the drop-down list. If invalid data are entered, the results for your department may be incorrect.
3. You may wish to contact your Medical Physics department for responses to Q7f. Examples of automatic tube current modulation (ATCM) are AutomA/SmartmA, CAREdose, DoseRight, SureExposure. Examples of iterative reconstruction (IR) software are ASIR/Veo, iDose/IMR, IRIS/SAFIRE, AIDR.
4. Check you have entered the data correctly before submitting them.
5. Please email completed questionnaire to [kim\\_cyrus@rcr.ac.uk](mailto:kim_cyrus@rcr.ac.uk) by 30th June 2014.

Thank you for participating in this survey.

|   |  |
|---|--|
| Q1. Home nation/ NHS region   |  |
| Q2a. NHS Trust/ Health Board  |  |
| Q2b. If 'other', please specify   |  |
| Q3a. Hospital (Scotland, Wales, Northern Ireland only)                  |  |
| Q3b. If 'other', please specify   |  |
| Q4. Email address in case of query                                      |  |
| Q5. How many CT scanners in your Trust (Eng)/ hospital (Scot, Wal, NI)? |  |

|  | Scanner 1 | Scanner 2 | Scanner 3 | Scanner 4 | Scanner 5 | Scanner 6 |
|--|-----------|-----------|-----------|-----------|-----------|-----------|
| Q6a. Locally allocated name (e.g. A&E CT1)/<br>Reference no.           |           |           |           |           |           |           |
| Q6b. Manufacturer  |           |           |           |           |           |           |
| Q6c. Model   |           |           |           |           |           |           |
| Q6d. No. of slices   |           |           |           |           |           |           |
| Q6e. Age of scanner (years)  |           |           |           |           |           |           |
| Q6f. What year do you anticipate replacing this<br>scanner?            |           |           |           |           |           |           |
| Q6g. How many hours does this machine operate in a<br>typical week?    |           |           |           |           |           |           |
| Q6h. Average daily patient throughput on this<br>machine               |           |           |           |           |           |           |
| Q6i. Is this machine:  |           |           |           |           |           |           |
| Q6j. Is this machine:  |           |           |           |           |           |           |
| Is the scanner used for the following:                                 |           |           |           |           |           |           |
| Q7a. CT colonography   |           |           |           |           |           |           |
| Q7b. Cardiac CT  |           |           |           |           |           |           |
| Q7c. Cancer staging  |           |           |           |           |           |           |
| Q7d. CT angiography  |           |           |           |           |           |           |
| Q7e. Lung nodule monitoring  |           |           |           |           |           |           |
| 7f. Does the scanner have the following dose<br>optimisation features: |           |           |           |           |           |           |



Q8a. Does your trust/ hospital have a regular plan to replace high value capital equipment?

Q8b. If 'yes', does this include replacements for these machines?

Q8c. If 'no' to Q8a, will your radiology department have to build a successful business case to progress replacements?

Q9. Text box for clarification