National Audit Office

Department of Health

Managing high value capital equipment in the NHS in England

Detailed Methodology

MARCH 2011

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1 This appendix outlines the research methods used in the course of our examination.

Study scope

2 Our report examines how efficiently three types (modalities) of high value equipment – Magnetic Resonance Imaging (MRI) scanners, Computerised Tomography (CT) scanners, and Linear Accelerator (linac) machines – are used in the NHS in England. We examined the planning for high value equipment, the delivery of related services to meet demand, and the management of high value equipment. Our fieldwork took place in December 2010 and January 2011.

Methodology

3 The main methods used during the course of this study were:

- review of key policy documents, major reports and academic literature;
- evaluation of existing datasets;
- collection of opening hours through telephone and email enquiry;
- analysis of data to examine costs and efficiency;
- visits to NHS acute trusts;
- qualitative analysis with case examples;
- semi-structured interviews with the Department of Health and key stakeholders; and
- advice from an expert panel assembled by the National Audit Office.

Review of key policy documents, major reports and academic literature

4 We reviewed a range of published and unpublished documents written by the Department, its arm's-length bodies, and other organisations in the fields of radiotherapy and diagnostic imaging, to develop our understanding of the key issues and of the work that has already been carried out in improving how high value equipment is managed.

5 Key documents reviewed included:

- published reports by the Department and its arm's-length bodies including the National Institute for Health and Clinical Excellence;
- published reports by professional bodies and other organisations including the Royal College of Radiologists, the Society and College of Radiographers, NHS Supply Chain, the National Cancer Action Team, industry bodies including the European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry (COCIR) and the Association of Healthcare Technology Providers for Imaging, Radiotherapy and Care (AXrEM);
- published papers from academic journals;
- unpublished documents written by policy teams within the Department; and
- advisory documents written by the NHS Improvement Radiology Service Improvement Team.

Analysis of existing datasets

6 We obtained and evaluated a range of published and unpublished datasets from the Department, its arm's-length bodies, and other organisations in the fields of radiotherapy and diagnostic imaging. Our purpose was to establish our understanding of the provision and use of high value equipment in England and internationally, the projected and actual replacement of machines, the workforce relevant for the three types of equipment, and the demand and supply of related services.

7 Key datasets obtained and evaluated included:

- data on imaging and radiodiagnostics (KH12), published by the Department;
- monthly waiting times and activity data for diagnostics (DM01), published by the Department;
- NHS reference costs 2009-10: organisation-specific reference cost data used for the NHS as the basis for Payment by Results and published by the Department;
- NHS staff numbers published by the NHS Information Centre;
- machine profile data on MRI, CT and linac machines collected and provided by the Health Protection Agency (HPA);
- the Radiotherapy Dataset (RTDS) by the National Cancer Services Analysis Team (NATCANSAT);

- UK National Radiotherapy Equipment Survey (2008) summary data by the National Cancer Services Analysis Team (NATCANSAT);
- UK Census of Radiotherapy Workforce (2008) published by the National Cancer Services Analysis Team (NATCANSAT);
- Clinical Radiology Census 2009, by the Royal College of Radiologists;
- data about the Department's Cancer Equipment Programmes 2000-2007; and
- Health Data (2010), which provides international data on the number of machines per million population in 2008, prepared by the Organisation for Economic Co-operation and Development (OECD).[1]

Collection of opening hours through telephone and email enquiry

8 We contacted 157 individual acute trusts by telephone, email and through site visits to obtain their opening hours for their units operating CT, MRI and where applicable linac machines. We obtained information on routine opening hours, as well as information on emergency and on-call arrangements, for 73 trusts in total. Of these 73 trusts, information was obtained for MRI units in 71 trusts, and for CT units in 66 trusts (some trusts had both MRI and CT units). We obtained opening hours for radiotherapy units with linac machines in 12 trusts.

Analysis of data to examine costs and efficiency

9 We analysed the Royal College of Radiologists' Clinical Radiology Census data to evaluate the vacancy rate and the practice of using overtime, radiographers and the independent sector in the reporting on imaging examinations in the NHS in England.

10 We intended to carry out analysis examining the efficiency of diagnostic scanning. However, the activity data collected by the Department for CT and MRI machines include NHS activity contracted out by trusts, so did not allow measurement of the utilisation of machines within trusts. From our visits we found variations in the average number of scans per CT machine per trust varied from around 7,800 to almost 22,000 in 2009-10. We also contacted the four major industry suppliers for CT and MRI - Philips, Toshiba, Siemens and GE Healthcare – and the Association of Healthcare Technology Providers for Imaging, Radiotherapy and Care (AXrEM) to understand what data might be available to NHS trusts to benchmark their utilisation. We found that although some utilisation data were collected by industry suppliers, they were not collected systematically and these data were rarely requested by the NHS.

1 OECD, Health Data (2010). The Figures we present in Part One of the report reflect the latest data available comparing the UK with other countries, for 2008. OECD data are available for previous years which include comparisons for CT and MRI with countries such as USA, Canada and Italy, but not for radiotherapy machines for USA and Canada. The UK's relative position in these datasets for earlier years is broadly similar to that presented for 2008.

Cost of machines installed and replacement cost

11 We estimated the total spending by the NHS on CT, MRI and linac machines between 2000 and 2007 by extrapolating from the departmental central spending on those modalities managed by the Cancer Equipment Programmes. The extrapolation is based on the proportions of the machines funded centrally out of the total number of machines installed for the same period (estimated from data provided by HPA), and the actual central spending by the Department on those machines including VAT. The actual spending on CT, MRI and linacs managed by the Cancer Equipment Programmes was £407 million. Adjusting for inflation, we estimated that the total NHS spending between 2001 and 2007 on those machines was £564 million in 2009-10 prices, equivalent to £80 million on average annually over the period.[2]

12 For 2008 to 2010, we estimated spending on the three types of machines based on the number of machines installed using data from HPA, and the average price paid for those machines procured through NHS Supply Chain. These prices include installation costs for machines, but not the £1-1.5 million cost of bunkers which would be needed for additional linac machines. We have included VAT at 17.5 per cent in our calculation but have not included the cost of additional bunkers in our calculations. Average spending between 2008 and 2010 on the three types of machines was estimated to be £50 million per year.

13 As above, for the current value of all installed machines, we applied the average price from NHS Supply Chain for 2009 and 2010 to all machines currently installed in the NHS (see Figure 5 in the main report), including VAT at 17.5 per cent. Total current value of these three types of machines in the NHS is £1 billion.

14 Our estimate of replacement cost of all machines currently in service was made on the basis that all machines are to be replaced 10 years after installation; the age profile is based on HPA data and the unit price is based on the average price paid through NHS Supply Chain for 2009 and 2010. We assumed a constant price over the next 10 years, and included VAT at 20 per cent for our replacement cost calculation. Our estimates included installation costs, but not the cost of bunkers for linac machines. We also applied a GDP deflator at 3.5 per cent. Our calculations estimate that replacing all machines currently in service will cost the NHS £1 billion (Net Present Value) over the next ten years, comprising of £295 million (MRI), £283 million (CT) and £388 million (linac).

2 For each calendar year between 2001 and 2007, the cost is proportioned by the number of machines installed in that year and then inflated to 2009-10 prices using GDP deflator published by HM Treasury (updated on 22 December 2010). The costs do not include building costs or the cost of bunkers needed for additional linac machines.

Variations in reference costs

15 We carried out data analysis from NHS reference costs using organisation-specific reference cost submissions (2009-10) to evaluate the variations in reported unit costs submitted by trusts for CT and MRI scans and radiotherapy treatment with linac machines by acute trusts.[3] We found:

- For diagnostic equipment, at 5th and 95th percentiles, the reported average unit cost per scan in 2009-10 for CT ranged from £54 to £268 with a national average of £121. For MRI, the average cost per scan ranged from £84 to £472, with a national average of £184.
- For radiotherapy equipment (linacs), average reported reference costs per treatment session (fraction) in 2009-10 ranged from £73 to £225 (5th and 95th percentiles). The national average was £123 per fraction.

Variations in linac machine throughput (fractions delivered per machine) by centre

16 To probe possible reasons for variations in the number of fractions delivered by linac machines, we examined correlations, and partial correlations between case mix, average number of therapeutic radiographers per machine and average number of fractions delivered per machine using the Department's Radiotherapy Dataset.

17 We found no strong direct correlation between case mix and throughput (number of fractions) per linac machine. However, after controlling for the number of radiographers per linac machine, we found that certain diagnostic groups (proxy for case mix) correlate negatively and significantly with throughput per machine, and for the diagnostic groups of the central nervous system (CNS) and the brain in particular. Controlling for case mix, the number of staff per machine has a significant positive correlation with the number of fractions per machine, with a correlation coefficient of 0.5.

18 We carried out linear regression analysis to explore the extent to which variations in the number of fractions delivered could be explained using available data. We assumed a multiplicative functional form of *average fractions per machine = f (number of staff per machine, case mix)*, and carried out linear regression analysis using SPSS following natural logarithmic transformation. We found that about 40-50 per cent of the variations in throughput across all centres could be explained by case mix and the number of radiographers per machine, depending on the number of diagnostic groups included in the analysis.

19 In the regression analysis, we used the number of whole time equivalent (WTE) therapeutic radiographers as a proxy for the number of staff dedicated to linac machines. This assumption is made based on our analysis of activity data from reference cost data submissions, whereby about 90 per cent of reported activity in the radiotherapy treatment centres is related to delivery of treatment with linac machines. For case mix, we used the proportion of fractions delivered for each diagnostic group.

3 Codes included in the analysis for linac: SC22Z to SC25Z, and SC31Z, for CT: RA08Z to RA14Z, and RA50Z; for MRI: RA01Z to RA07Z. We included all unit cost submissions by acute trusts in our analysis, but excluded all PCT submissions including Isle of Wight PCT.

20 To deliver a fraction of radiotherapy requires the skills of a multi-professional team including inputs from clinical oncologists, medical physicists and other staff. The skill mix of those staff could also impact on the throughput per machine. For case mix, the nature of fractions delivered in terms of radical treatment or palliative treatment, could also affect throughput through the complexity of the fractions delivered. Other factors such as opening hours, and location of linac machines to provide easy access could also affect services demanded and in turn throughput of machines. These factors could potentially explain more of the variations, however, due to the limitations of data, we have not included these in our analysis.

Visits to NHS acute trusts

21 We visited 13 NHS acute trusts during December 2010 and January 2011 to gain an in-depth understanding of how trusts:

- evaluate the need for, and subsequently plan to purchase, contract out or lease high value equipment (CT, MRI and linac machines);
- manage the everyday utilisation of such machines, once they have been purchased or otherwise;
- organise their services to maximise the efficiency with which they use machines;
- manage the relationship between finance and clinical teams; and
- gain information, and what information they use to support their planning and management.

22 The 13 trusts (six of which were Foundation Trusts (FTs) and two of which were specialist hospital trusts) were selected based on our initial data analyses, interviews with stakeholders and experts, and document reviews. We aimed to include, in our programme of visits, trusts that were reasonably representative of the population in terms of size (large or small acute trusts), status (teaching, specialist or district general), activity level, and geographical location within England.

Qualitative analysis with case examples

23 From our own visits to trusts, we identified nine case examples (six FTs and three non-FTs) which demonstrated steps trusts had been taking to improve their management and use of high value equipment. We reviewed these alongside the work of NHS Improvement, and included examples from work it had published. We also reviewed a small amount of data provided by trusts we visited which we used to inform our analyses and preparation of case examples.

24 Interviews taken from our visits were analysed to draw out key themes relating to:

- the planning for purchase of machines or meeting replacement and/or additional capacity requirements through leasing or contracting out;
- key factors in the everyday management of the use of machines;
- the steps taken by trusts to maximise the efficiency with which they use machines; and
- the information they use to support overall planning and management of machines.

Semi-structured interviews with the Department of Health and key stakeholders

25 We held semi-structured interviews with the Department and key stakeholders to gain an in-depth understanding of policies and management issues around these three types of high value equipment, to gain access to and understanding of datasets, and to triangulate with quantitative data evaluation and analysis. The key stakeholders we interviewed included the National Cancer Action Team, the Royal College of Radiologists, NHS Improvement, the Society and College of Radiographers, the Health Protection Agency, Alliance Medical, NHS Supply Chain, NHS trust finance directors, medical directors, radiotherapy and radiology business managers, and various clinical staff.

Expert Panel

26 We assembled a panel of experts who met once to discuss our emerging findings and who were invited to comment on a draft of our provisional audit findings. The panel included members of the Royal College of Radiologists, the Society and College of Radiographers, NHS Improvement, the National Cancer Action Team, NHS Supply Chain, the Health Protection Agency, the Department of Health and Alliance Medical. The members were invited to comment in a personal capacity.

Design and Production by NAO Communications
DP Ref: 009543-002