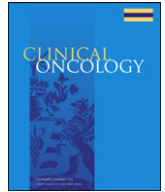




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## Original Article

## Survey of the Availability and Use of Advanced Radiotherapy Technology in the UK

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## Abstract

**Aims:** To determine the availability of intensity-modulated radiotherapy (IMRT) treatment in the UK and to assess the magnitude of the shortfall in terms of patient treatments. In addition, the availability of image-guided radiotherapy (IGRT) was also reviewed.

**Materials and methods:** A survey was carried out between July and September 2008 of the use of advanced technology in radiotherapy.

**Results:** In total, 50 centres responded out of the 58 National Health Service centres canvassed, representing about 89% of patients treated in the UK. Forty-six centres had at least two machines capable of IMRT and 26 centres had at least one machine capable of IGRT. Thirty-two centres were carrying out forward-planned IMRT and 18 centres were carrying out the more complex inverse-planned IMRT. In all, 38 centres (76% of respondents) were offering either forward- or inverse-planned IMRT to some of their patients. All the centres with IGRT capability were using IGRT for at least some of their patients. Respondents were asked to list the total number of radical and palliative patients being treated according to the treatment site. Forty-two per cent of respondents took the option to list the total number of radical and palliative patients only. Based on these data, 10.7% of radical patients are currently being given forward-planned IMRT, mainly for breast cancer (18.6% of such patients) and 2.2% of radical patients are being given inverse-planned IMRT, mainly for prostate (7.5% of such patients) and head and neck cancer (6.7% of such patients). Whereas at present only 18 centres are able to treat with inverse-planned IMRT, 45 centres expected to be able to do so by 2010. Respondents were asked to estimate the percentage of patients who should be given IMRT for each site and this was used to estimate the shortfall in IMRT provision.

**Conclusions:** Based on the consensus of opinion, 32% of radically treated patients should receive inverse-planned IMRT and 22% forward-planned IMRT, making a total of 55%. In fact, 2% receive inverse-planned IMRT and 11% the less complex forward-planned IMRT. Thus, with an estimated 75 948 radical treatments being carried out with megavoltage radiotherapy, the professional opinion is that 41 421 of patients would benefit from treatment with IMRT. In fact, only 9775 were so treated in 2008; a shortfall of 32 497 patients treated instead with conventional radiotherapy.

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**Key words:** Capacity; IGRT; IMRT

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## Introduction

Recent press concern about the lack of availability of intensity-modulated radiotherapy (IMRT) treatments led the Royal College of Radiologists together with the Institute of Physics and Engineering in Medicine, the Society and College of Radiographers, the National Cancer Research Institute and the Academic Clinical Oncology and Radiobiology Research Network to set up a Radiotherapy Development Board. Their analysis of the benefits of IMRT [1] is published elsewhere in this issue. A survey carried out in 2007 [2] showed that under half of the centres in the UK were using IMRT either forward- or inverse-planned. However, the extent of the shortfall of provision of IMRT in terms of patient numbers was not clear from this survey. It was therefore decided to carry out a second survey

12 months later, both to see whether the number of centres offering IMRT had increased and to assess the magnitude of the shortfall in terms of patient treatments. In addition, the availability of image-guided radiotherapy (IGRT) was also reviewed.

## Materials and Methods

A questionnaire was developed, which was sent to all centres in the UK. Forty-five National Health Service (NHS) centres in England, two NHS centres in Scotland, two NHS centres in Wales and the only centre in Northern Ireland responded. Two of the private centres responded, but neither of them gave sufficient details to allow them to be formally included in the analysis. Using data from the National Cancer Services Analysis Team (NATCANSAT) for numbers of courses per centre it was possible to estimate the proportion of patients that were not represented. This showed that the data reflected the treatment of 93% of patients in England and 89% of patients in the UK. In November 2009 a short follow-up survey of English centres was conducted looking only at the number of patients being treated with IMRT and this achieved responses from all centres in England.

IMRT was defined as any treatment where more than one segment is delivered from a single beam direction, but automated wedges using two segments were not considered as IMRT. For example, concomitant boosts carried out

using two beams from one direction were recorded as 'forward-planned IMRT'. Respondents were asked to specify whether forward-planned or inverse-planned IMRT or both was used in their centre. IGRT was defined as any imaging technology (including marker recognition systems) that is used to improve the accuracy of external beam radiotherapy treatment, with the exception of megavoltage portal images, unless used for on-line correction.

The first part of the survey dealt with the availability of equipment for IMRT and IGRT. For each anatomical site, respondents were asked to list the total number of patients and the number treated using IMRT; but in order to secure the maximum response rate they were also allowed to provide total figures. Respondents were asked to indicate which additional sites they would be treating by 2010 and what proportion of their patients they would like to treat with IMRT if there were no resource issues. Ninety per cent of respondents completed this part of the questionnaire. In order to test the reliability of the responses, analyses were carried out considering the number of patients already treated with IMRT in the centre and also whether the centre's oncologists had been involved in the preparation of the response. Respondents were also asked to select and rank the most important reasons for their centre not doing more IMRT from a list of eight options and to indicate the source(s) of funding for their present IMRT service.

**Table 1**

Number of courses of radiotherapy given in the 50 responding centres per annum by site. Percentages shown are percentages of the total number of radical or palliative treatment courses, respectively. The total number of radical and palliative treatments given at the end of the table are the data as returned by the centres. Where some centres did not provide a breakdown or where the breakdown provided did not match the categories suggested, the total numbers have been adjusted in proportion to the detailed data supplied by the other centres. The large number of unclassified palliative cases reflects the less precise classification of palliative treatments in many hospital information systems.

| Site                                    | Radical |            | Palliative |            | Total   |
|---|---------|------------|------------|------------|---------|
|   | Number  | Percentage | Number     | Percentage |         |
| Brain metastases                        | 165     | 0.2        | 4126       | 7.6        | 4291    |
| Primary brain tumours                   | 2286    | 3.0        | 869        | 1.6        | 3156    |
| Non-malignant brain                     | 347     | 0.5        | 12         | 0.0        | 360     |
| Head and neck, thyroid                  | 7219    | 9.5        | 1100       | 2.0        | 8319    |
| Breast                                  | 29 655  | 39.0       | 3959       | 7.3        | 33 613  |
| Lung                                    | 4345    | 5.7        | 11 114     | 20.5       | 15 460  |
| Oesophagus, stomach                     | 1749    | 2.3        | 2196       | 4.1        | 3945    |
| Other thorax                            | 205     | 0.3        | 419        | 0.8        | 624     |
| Liver, gallbladder                      | 21      | 0.0        | 16         | 0.0        | 37      |
| Pancreas                                | 136     | 0.2        | 102        | 0.2        | 238     |
| Other abdomen                           | 795     | 1.0        | 695        | 1.3        | 1490    |
| Bladder                                 | 1463    | 1.9        | 1253       | 2.3        | 2715    |
| Prostate                                | 9971    | 13.1       | 4068       | 7.5        | 14 039  |
| Rectum                                  | 4861    | 6.4        | 1028       | 1.9        | 5889    |
| Cervix                                  | 1471    | 1.9        | 203        | 0.4        | 1674    |
| Endometrium                             | 1291    | 1.7        | 154        | 0.3        | 1445    |
| Other pelvis (e.g. anus, vagina, vulva) | 1948    | 2.6        | 1391       | 2.6        | 3339    |
| Sarcomas                                | 730     | 1.0        | 304        | 0.6        | 1034    |
| Total Body Irradiation                  | 355     | 0.5        | 1          | 0.0        | 356     |
| Other not included above                | 6935    | 9.1        | 21 093     | 39.0       | 28 028  |
| Total                                   | 75 948  |            | 54 103     |            | 130 051 |
|   | 58%     |            | 42%        |            | 100%    |

Similar analyses were carried out for IGRT, but because the use of this technology is in its infancy, the questions related to future uses were omitted. Respondents were asked whether they were collaborating in a national or multicentre clinical trial involving IMRT or IGRT.

## Results

### Equipment

Of 245 linear accelerators recorded in the study, 219 were equipped to carry out IMRT and of these 44 were equipped to carry out IGRT. Seventy-four per cent of centres had linear accelerators from only one manufacturer. Every centre had at least one linear accelerator equipped with the hardware and software to carry out IMRT, although four centres had only one such linear accelerator and might reasonably decide that without a back-up machine it was inappropriate to embark on an IMRT programme. On the other hand, only 26 centres had one or more machines with kilovoltage IGRT facilities. Fifty-nine more linear accelerators were expected to be purchased by 2010, of which 29 were replacements for existing equipment. Of the new linear accelerators to be purchased, 90% would have IGRT facilities. (It was assumed that all would have facilities for IMRT.)

### Patient Treatments

Table 1 shows the total number of courses of treatment from all the listed centres by site. Some centres, representing 42% of the total number, provided only the total of palliative and radical cases. Their numbers have been split between sites using the detailed data from the other centres. The proportions by site thus represent the proportions from the 58% of centres, but the totals reflect all the respondents. It was necessary to make these adjustments in order to be able to estimate the total shortfall of IMRT treatments.

### Current Intensity-modulated Radiotherapy Treatments

Table 2 shows the number of patients receiving IMRT treatments in each category. The percentages of patients being treated are calculated as percentages of the total number of radical treatments as listed in Table 1. The results are shown graphically in Fig. 1, in which the proportion of patients in individual centres is compared with the average proportion recommended by the respondents.

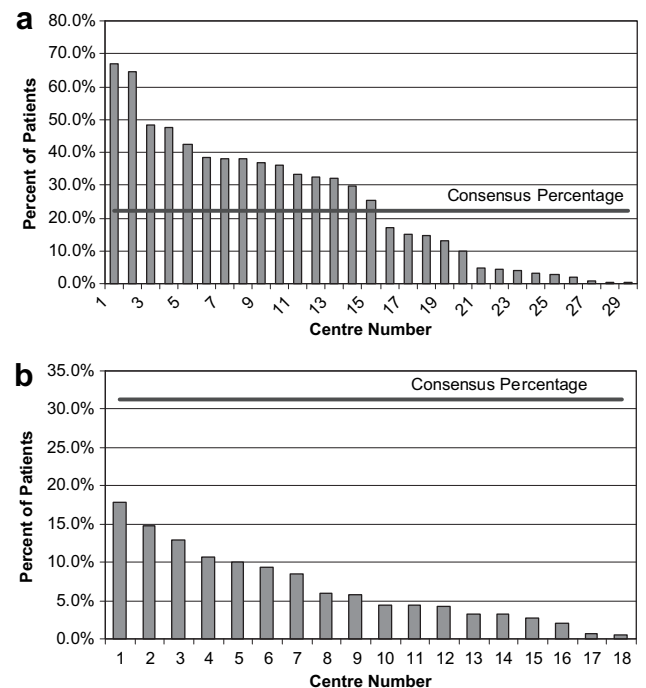
### Future Use of Intensity-modulated Radiotherapy

In order to estimate the potential demand for IMRT, centres were asked to indicate whether they intended to use IMRT in the future for particular sites and also to indicate the proportion of patients for which they would expect IMRT to be of benefit. Seventy per cent of centres were offering either forward- or inverse-planned IMRT at the

**Table 2**

Courses of radiotherapy per annum being carried out for each treatment site in the responding centres. Percentages are shown of the total number of radical patients shown in Table 1.

| Site                                    | Forward planned |             | Inverse planned |            |
|---|-----------------|-------------|-----------------|------------|
|   | Number          | Percentage  | Number          | Percentage |
| Brain metastases                        | 10              | 6.1         | 0               | 0.0        |
| Primary brain tumours                   | 152             | 6.6         | 65              | 2.8        |
| Non-malignant brain                     | 0               | 0.0         | 52              | 15.0       |
| Head and neck, thyroid                  | 754             | 10.4        | 483             | 6.7        |
| Breast                                  | 5517            | 18.6        | 56              | 0.2        |
| Lung                                    | 170             | 3.9         | 70              | 1.6        |
| Oesophagus, stomach                     | 117             | 6.7         | 0               | 0.0        |
| Other thorax                            | 0               | 0.0         | 61              | 29.8       |
| Liver, gallbladder                      | 0               | 0.0         | 0               | 0.0        |
| Pancreas                                | 0               | 0.0         | 24              | 17.6       |
| Other abdomen                           | 34              | 4.3         | 2               | 0.3        |
| Bladder                                 | 64              | 4.4         | 8               | 0.5        |
| Prostate                                | 607             | 6.1         | 743             | 7.5        |
| Rectum                                  | 122             | 2.5         | 0               | 0.0        |
| Cervix                                  | 24              | 1.6         | 20              | 1.4        |
| Endometrium                             | 12              | 0.9         | 1               | 0.1        |
| Other pelvis (e.g. anus, vagina, vulva) | 12              | 0.6         | 7               | 0.4        |
| Sarcomas                                | 200             | 27.4        | 63              | 8.6        |
| Total Body Irradiation                  | 52              | 14.7        | 0               | 0.0        |
| Other not included above                | 269             | 3.9         | 3               | 0.0        |
| <b>Total</b>                            | <b>8117</b>     | <b>10.7</b> | <b>1658</b>     | <b>2.2</b> |



**Fig. 1.** Proportion of radical patients in individual centres receiving (a) forward- and (b) inverse-planned intensity-modulated radiotherapy. The lines indicate the target number based on the views of the respondents derived from Table 3.

**Table 3**

Future use of intensity-modulated radiotherapy (IMRT). Columns 1 and 2 indicate the proportion of centres that expect to offer IMRT to that site with either inverse or forward planning, respectively. The remaining columns show the percentage of patients for whom respondents considered that IMRT would be beneficial.

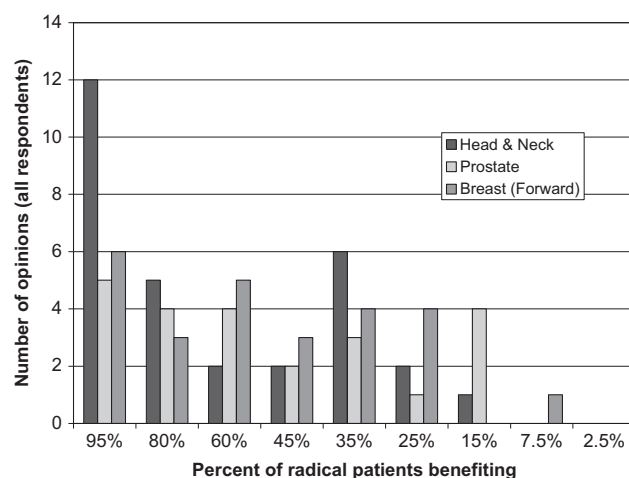
| Site                                       | Centres who plan to offer IMRT for treatment of this site |                 | Average of all replies weighted according to patient numbers |                 | Average of those with oncologist input |                 |
|--|---|-----------------|--|-----------------|--|-----------------|
|  | Forward planned   | Inverse planned | Forward planned  | Inverse planned | Forward planned                        | Inverse planned |
| Brain metastases                           | 2%  | 7%              | 1.0%   | 0.3%            | 2.6%                                   | 0.7%            |
| Primary brain tumours                      | 9%  | 30%             | 5.2%   | 11.0%           | 6.7%                                   | 11.3%           |
| Non-malignant brain                        | 0%  | 9%              | 0.0%   | 27.0%           | 0.0%                                   | 35.4%           |
| Head and neck, thyroid                     | 14%   | 84%             | 6.2%   | 61.5%           | 3.0%                                   | 54.0%           |
| Breast                                     | 66%   | 11%             | 40.8%  | 9.7%            | 41.6%                                  | 14.2%           |
| Lung                                       | 11%   | 32%             | 3.7%   | 17.7%           | 4.0%                                   | 18.4%           |
| Oesophagus, stomach                        | 11%   | 23%             | 0.8%   | 15.4%           | 0.0%                                   | 15.4%           |
| Other thorax                               | 2%  | 7%              | 0.0%   | 11.8%           | 0.0%                                   | 18.6%           |
| Liver, gallbladder                         | 0%  | 9%              | 0.0%   | 9.1%            | 0.0%                                   | 11.0%           |
| Pancreas                                   | 0%  | 5%              | 0.0%   | 10.5%           | 0.0%                                   | 16.1%           |
| Other abdomen                              | 2%  | 7%              | 0.0%   | 34.4%           | 0.0%                                   | 43.9%           |
| Bladder                                    | 11%   | 2%              | 7.8%   | 9.2%            | 5.5%                                   | 7.8%            |
| Prostate                                   | 20%   | 75%             | 9.3%   | 48.5%           | 6.7%                                   | 43.0%           |
| Rectum                                     | 9%  | 16%             | 7.4%   | 12.5%           | 3.6%                                   | 14.7%           |
| Cervix                                     | 9%  | 18%             | 7.2%   | 21.5%           | 1.4%                                   | 20.7%           |
| Endometrium                                | 11%   | 14%             | 7.9%   | 15.7%           | 3.3%                                   | 20.5%           |
| Other pelvis<br>(e.g. anus, vagina, vulva) | 2%  | 11%             | 0.5%   | 25.4%           | 0.8%                                   | 37.1%           |
| Sarcomas                                   | 5%  | 25%             | 7.3%   | 29.8%           | 2.8%                                   | 38.0%           |
| Total Body Irradiation                     | 5%  | 7%              | 18.5%  | 0.0%            | 6.8%                                   | 0.0%            |
| Other not included above                   | 5%  | 7%              | 2.2%   | 2.7%            | 1.1%                                   | 3.8%            |
| Total                                      | 86%   | 90%             | 23.7%  | 30.4%           | 22.3%                                  | 32.2%           |

time of the survey. However, only 36% were offering inverse-planned IMRT to their patients, although by 2010 90% of centres said that they expect to be doing so. The short survey carried out in 2009 showed that the numbers had in fact only risen to 44%, so it seems unlikely that this aspirational figure will be achieved. (Although the question relating to the proportion of patients that would benefit from IMRT implied that this was a total of all patients in that category it seems likely from the responses that this was interpreted as the proportion of radical patients. It is possible, therefore, that the percentages stated for the number of radical patients should be higher.)

Table 3 shows an analysis of the views of respondents towards a consensus about the proportion of patients who should be treated with IMRT. There was considerable variation in the views of the respondents on the exact proportions of patients who would benefit from IMRT and this is illustrated in Fig. 2. This shows the numbers of respondents considering that a particular proportion of patients would benefit from IMRT for three of the main tumour sites. The strongest consensus was in relation to the use of IMRT for head and neck cancer. It should be noted that there were very few respondents who did not accept the need for IMRT as a treatment method.

Table 4 shows the difference in the numbers of patients currently being treated with IMRT and the number of treatments that would be required if all those patients who might benefit from IMRT were so treated. With an

estimated 75 948 radical treatments being carried out with megavoltage radiotherapy, the consensus view is that 41 421 patients would benefit from treatment with IMRT. In fact, only 9775 were so treated in 2008; a shortfall of 32 497 patients who were instead treated with conventional radiotherapy.



**Fig. 2.** Histogram showing the proportion of all centres who considered a particular level of patients should be treated with intensity-modulated radiotherapy. (a) Forward breast planning, (b) prostate planning, both forward and inverse, (c) head and neck inverse planning.

**Table 4**

Numbers of patients who would benefit from intensity-modulated radiotherapy (IMRT) treatment compared with numbers being treated. Note that in some instances the calculated shortfall for forward-planned IMRT was negative — in these cases the value has been set to zero. The first two columns are repeated from the last two columns of Table 3. The numbers of patients for each site are taken from Table 1.

| Site                                    | Percentage requiring treatment |                 | Number requiring treatment |                 | Number receiving treatment |                 | Shortfall       |                 |
|---|--------------------------------|-----------------|----------------------------|-----------------|----------------------------|-----------------|-----------------|-----------------|
|   | Forward planned                | Inverse planned | Forward planned            | Inverse planned | Forward planned            | Inverse planned | Forward planned | Inverse planned |
| Brain metastases                        | 2.6%                           | 0.7%            | 110                        | 29              | 10                         | 0               | 100             | 29              |
| Primary brain tumours                   | 6.7%                           | 11.3%           | 213                        | 357             | 152                        | 65              | 61              | 292             |
| Non-malignant brain                     | 0.0%                           | 35.4%           | 0                          | 127             | 0                          | 52              | 0               | 75              |
| Head and neck, thyroid                  | 3.0%                           | 54.0%           | 253                        | 4496            | 754                        | 483             | 0               | 4013            |
| Breast                                  | 41.6%                          | 14.2%           | 13981                      | 4765            | 5517                       | 56              | 8464            | 4709            |
| Lung                                    | 4.0%                           | 18.4%           | 625                        | 2842            | 170                        | 70              | 455             | 2772            |
| Oesophagus, stomach                     | 0.0%                           | 15.4%           | 0                          | 608             | 117                        | 0               | 0               | 608             |
| Other thorax                            | 0.0%                           | 18.6%           | 0                          | 116             | 0                          | 61              | 0               | 55              |
| Liver, gallbladder                      | 0.0%                           | 11.0%           | 0                          | 4               | 0                          | 0               | 0               | 4               |
| Pancreas                                | 0.0%                           | 16.1%           | 0                          | 38              | 0                          | 24              | 0               | 14              |
| Other abdomen                           | 0.0%                           | 43.9%           | 0                          | 655             | 34                         | 2               | 0               | 653             |
| Bladder                                 | 5.5%                           | 7.8%            | 149                        | 211             | 64                         | 8               | 85              | 203             |
| Prostate                                | 6.7%                           | 43.0%           | 937                        | 6037            | 607                        | 743             | 330             | 5294            |
| Rectum                                  | 3.6%                           | 14.7%           | 214                        | 867             | 122                        | 0               | 92              | 867             |
| Cervix                                  | 1.4%                           | 20.7%           | 23                         | 347             | 24                         | 20              | 0               | 327             |
| Endometrium                             | 3.3%                           | 20.5%           | 47                         | 296             | 12                         | 1               | 35              | 295             |
| Other pelvis (e.g. anus, vagina, vulva) | 0.8%                           | 37.1%           | 26                         | 1238            | 12                         | 7               | 14              | 1231            |
| Sarcomas                                | 2.8%                           | 38.0%           | 29                         | 393             | 200                        | 63              | 0               | 330             |
| Total Body Irradiation                  | 6.8%                           | 0.0%            | 24                         | 0               | 52                         | 0               | 0               | 0               |
| Other not included above                | 1.1%                           | 3.8%            | 299                        | 1064            | 269                        | 3               | 30              | 1061            |
| Total                                   |                                |                 | 16 931                     | 24 490          | 8117                       | 1658            | 9665            | 22 832          |

#### *Reasons for Lack of Progress in Intensity-modulated Radiotherapy*

There were 48 responses to the questions about the reasons for not using IMRT, but only 35 respondents assigned an order of importance. The results are given in Table 5.

#### *Sources of Funding for Intensity-modulated Radiotherapy*

Funding arrangements in the UK are very different from those in the USA and IMRT is often carried out for the same remuneration as conventional treatment, despite the increased staff time involved. Fifty-eight per cent of respondents indicated that this was the case. Respondents were asked to indicate how their IMRT programme was funded. The results are shown in Table 6. Funding could come from more than one source, as is apparent from the table.

#### *Use of Image-guided Radiotherapy*

The availability of IGRT facilities was less widespread than for IMRT, with only 26 of the 50 centres having even one machine with kilovoltage imaging, although this is expected to increase to 43 centres by 2010. This was clearly the major reason for the lack of its use. Respondents were

able to choose from a drop down list of alternative methods of IGRT. The uses that were being made of IGRT are shown in Table 7. One of the options offered was off-line kilovoltage imaging, but not surprisingly, all centres that were using kilovoltage imaging were making on-line corrections. A number of centres who did not have kilovoltage imaging facilities were using megavoltage imaging to make on-line corrections. Of the 26 centres with kilovoltage imaging facilities, 23 were using them, which is in stark contrast to the IMRT situation.

**Table 5**

Reasons for lack of progress in offering intensity-modulated radiotherapy to a larger group of patients. The numbers represent the number of respondents. The reasons are listed in order of the number of centres indicating that the reason was relevant to them.

|                                       | An issue | Main reason | In top three |
|---------------------------------------|----------|-------------|--------------|
| Physicist availability                | 43       | 15          | 33           |
| Lack of funding                       | 26       | 8           | 15           |
| Lack of equipment                     | 23       | 7           | 13           |
| Clinical oncologist availability      | 27       | 4           | 15           |
| Dosimetrist availability              | 27       | 1           | 14           |
| Treatment radiographer availability   | 10       | 1           | 2            |
| Time for training                     | 13       | 0           | 6            |
| Number of respondents for this column | 48       | 35          | 35           |



**Table 6**  
Sources of funding for the additional work involved in intensity-modulated radiotherapy treatment.

| Source of funding                              | Number of centres |
|--|-------------------|
| National Health Service funded                 | 3                 |
| Funded by research funds                       | 0                 |
| No extra funding                               | 21                |
| Partial National Health Service funding        | 12                |
| Partially funded by research funds             | 9                 |
| Part National Health Service and part research | 8                 |
| Number of responses                            | 36                |

*Reasons for Lack of Progress in Image-guided Radiotherapy*

Not surprisingly, the lack of equipment was the principle reason for not carrying out IGRT. The results of this part of the survey are shown in [Table 8](#).

*Governance issues*

It is recommended that IMRT should be developed within the context of a clinical trial. Of the 35 centres carrying out some form of IMRT, 25 were taking part in national or multicentre studies and a further two were carrying out a study in-house. It is also recommended [3] that there should be an IMRT team to oversee the

**Table 7**  
Uses of image-guided radiotherapy (IGRT) and the methods used.

|   | On-line MV | On-line kV | On-line cone beam | Cone beam off-line | Using any form of IGRT |
|---|------------|------------|-------------------|--------------------|------------------------|
| Brain metastases                        | 2          | 3          | 1                 | 0                  | 5                      |
| Primary brain tumours                   | 4          | 3          | 3                 | 1                  | 9                      |
| Non-malignant brain                     | 1          | 2          | 1                 | 1                  | 4                      |
| Head and neck, thyroid                  | 7          | 6          | 2                 | 2                  | 12                     |
| Breast                                  | 5          | 2          | 0                 | 0                  | 6                      |
| Lung                                    | 7          | 4          | 6                 | 3                  | 17                     |
| Oesophagus, stomach                     | 7          | 3          | 6                 | 2                  | 14                     |
| Other thorax                            | 4          | 4          | 3                 | 1                  | 10                     |
| Liver, gallbladder                      | 3          | 2          | 0                 | 1                  | 6                      |
| Pancreas                                | 5          | 3          | 2                 | 2                  | 9                      |
| Other abdomen                           | 4          | 3          | 3                 | 1                  | 10                     |
| Bladder                                 | 6          | 1          | 6                 | 3                  | 15                     |
| Prostate                                | 12         | 8          | 5                 | 5                  | 24                     |
| Rectum                                  | 8          | 4          | 3                 | 0                  | 13                     |
| Cervix                                  | 9          | 3          | 2                 | 0                  | 14                     |
| Endometrium                             | 8          | 3          | 0                 | 0                  | 10                     |
| Other pelvis (e.g. anus, vagina, vulva) | 6          | 1          | 2                 | 0                  | 8                      |
| Sarcomas                                | 5          | 2          | 1                 | 1                  | 6                      |
| TBI                                     | 2          | 0          | 1                 | 0                  | 3                      |
| Other not included above                | 1          | 1          | 0                 | 0                  | 2                      |

**Table 8**  
Reasons for lack of progress with image-guided radiotherapy. The reasons are listed in order of the number of centres indicating that the reason was relevant to them.

|                                       | An issue | Main reason | In top three |
|---------------------------------------|----------|-------------|--------------|
| Lack of equipment capability          | 40       | 30          | 33           |
| Lack of machine time                  | 23       | 2           | 16           |
| Radiographer availability             | 17       | 0           | 14           |
| Lack of funding                       | 17       | 3           | 11           |
| Physicist availability                | 14       | 3           | 10           |
| Time for training                     | 8        | 0           | 4            |
| Clinical oncologist availability      | 7        | 2           | 4            |
| Dosimetrist availability              | 7        | 0           | 3            |
| Concerns about dose                   | 1        | 0           | 0            |
| Number of respondents for this column | 47       | 40          | 40           |

development of the techniques. Twenty-two of the centres had such a team.

For IGRT, the development of research studies is less advanced, with only six centres currently involved in multicentre studies, although there were 30 centres who expressed an interest in joining national studies. On the other hand, 21 of the 31 centres carrying out some form of IGRT were conducting in-house studies. One of the issues with IGRT is whether radiographers can make on-line corrections. Twenty-four respondents said that their radiographers did do so.

**Discussion**

This survey represents the state of development of IMRT and IGRT facilities in the UK in September 2008. [Figure 1b](#) shows that the amount of inverse-planned IMRT being offered to patients falls significantly short of what clinicians feel should be offered. The fact that the number of centres offering the less labour intensive forward-planned approach is greater, indicates that this is not due to a lack of desire on the part of the staff involved, but as indicated in [Table 6](#), is largely due to the lack of specific funding, as well as the shortage of physics staff. Until there is financial recognition of the extra planning effort required, it is unlikely that the desired level of inverse-planned IMRT use will be achieved. A funding system that gives enhanced payment per fraction for techniques that take longer to deliver would penalise the use of IMRT (which can often reduce the time taken to treat complex cases and also allows reduced fractionation schedules) unless there is a compensating significant increase in payment for treatment preparation. A similar study a year earlier by Jefferies *et al.* [2] found that 22/48 centres were using IMRT and 10 centres were intending to use it before 2009. This compares with the 35/50 now using some form of IMRT. Jefferies *et al.* [2] did not state the number of centres using inverse-planned IMRT. In the present survey, only 18 said they were carrying out inverse-planned IMRT.

Some centres have shown that IGRT can be carried out with relatively little additional cost and this perhaps explains the high uptake of this technique in centres that have the necessary equipment. The need for accurate radiotherapy is self-evident and when this technology becomes available there is great enthusiasm for its use.

In order to accelerate the uptake of inverse-planned IMRT, the National Radiotherapy Implementation Group has commissioned a mentoring system in which centres already experienced in the delivery of IMRT will assist centres who want to introduce it [4]. Consideration is also being given to an appropriate tariff to encourage the introduction of IMRT.

## References

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