Journal of Radiotherapy in Practice

Journal of Radiotherapy in Practice 2003
3, 181–184

Original Article

Provision of IMRT in the UK. Part 2: Current levels, planned expansion and obstacles to implementation

C. R. Baker*, V. Hardy†

**Radiotherapy Division, School of Health Sciences, University of Liverpool; †Radiotherapy Department, Suffolk Oncology Centre, Ipswich Hospital NHS Trust, UK*

Abstract

UK Radiotherapy Departments have been surveyed to establish the current level of provision of intensity-modulated radiotherapy (IMRT) and its expected growth in the next 2 to 5 years. At the time of writing, nine UK Departments have implemented IMRT, providing a national capacity of approximately 20 new patients per month. By 2005, a further nine Departments expect to have implemented IMRT. As confidence and experience of IMRT grows, streamlining of quality control (QC) and the development of class solutions for inverse treatment planning are expected to significantly reduce the preparation time required for each patient and so increase patient capacity in all Departments.

Staff training requirements, extra workloads in treatment planning and QC, identification of inverse planning parameters and current limitations of inverse treatment planning systems were identified as the key learning points for Departments that have been through the implementation process. Obstacles identified as preventing early implementation include equipment availability, staff shortages and heavy clinical workloads limiting the amount of time available for implementation.

Keywords

Implementation of IMRT; quality control

INTRODUCTION

With the latest wave of linear accelerators being installed in UK Radiotherapy Departments, the hardware and software required for IMRT is becoming increasingly available. IMRT, however, represents a significant change in practice for all staff groups involved in the preparation and delivery of radiotherapy. Commissioning, QC and staff training are major issues to be dealt with for any Radiotherapy Department wishing to implement this treatment modality. The impact upon workloads is yet to be realised.

This paper details the current provision of IMRT in the UK, the expected rate at which this is expected to rise over the next 2 to 5 years and some of the lessons that have been learned by those Departments that have successfully implemented IMRT. A general review of the significant issues for implementing IMRT and of developments that complement or offer alternatives to linear accelerator-based IMRT is presented in a separate paper.[1]

Correspondence to: Dr. Colin Baker, Radiotherapy Division, School of Health Sciences, University of Liverpool, Thompson Yates Building, Brownlow Hill, Liverpool L69 3GB, UK. Tel: 0151 794 5754; E-mail: colin.baker@liverpool.ac.uk

IMRT CAPACITY SURVEY

Questionnaires were distributed to 66 UK Radiotherapy Departments. These were designed to establish the following:

- The number of Departments having already implemented IMRT.
- Expected date of implementation for those Departments planning to introduce IMRT.
- How the current provision (anatomical sites and patient capacity) is expected to develop in the future.
- Obstacles that impede the implementation of IMRT.
- Lessons that have been learned to date for those Departments that have implemented IMRT.

From 66 UK Radiotherapy Departments contacted, 55 replied to questionnaires. At the time of asking, nine Centres had implemented IMRT, with another nine expecting to have implemented IMRT by 2005. Prostate (plus nodes) and head and neck tumours were equally popular sites for IMRT techniques, implemented in six and five Departments, respectively. Additionally, IMRT techniques have been applied to breast, pancreas, lung and brain treatments as shown qualitatively in Figure 1.

Shortages of equipment (IMRT-capable linear accelerators (17%), inverse planning systems (5%), or both (14%)) and staff shortages (24%), or both equipment and staff shortages (40%) were the main reasons for not having implemented IMRT. These responses are shown proportionally in Figure 2. Half of the Departments planning to implement IMRT also identified current workload as a limiting issue. Additional obstacles reported were time for implementation (which also relates to capacity issues and staff shortage), staff training requirements and evidence of the necessity for IMRT techniques.

The lessons learned from Departments that have implemented IMRT will be of particular interest for those planning to implement in the future. Main issues raised were:

- Staff training requirements, their organisation and delivery.
- Appreciation of the increased workload for all staff groups in the treatment planning (outlining and inverse-planning), QC and delivery stages.
- Identification of dose and weight constraints for inverse-planning algorithms.
- Limitations of existing inverse-planning systems, development of work-arounds to achieve acceptable treatment plans, avoiding hotspots.
- Instances of poor communication between manufacturers.

The average time taken for inverse treatment planning was reported to be 3 h (ranging from 1 to 8 h). Time allocated for QC measurements averaged 4 h (ranging from 1.5 to 8 h). The average treatment slot was reported as 20 min (ranging from 15 to 60 min). Clark et al.[2] provide a detailed comparison of timings for each stage of treatment planning and delivery for conformal and IMRT prostate treatment, concluding that overall IMRT prostate requires double the total time of conformal treatments (23 h against 12.5).

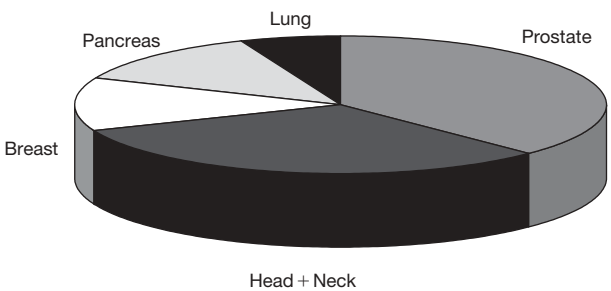

Figure 1. Sites currently treated in the nine UK Departments where IMRT is implemented (percentages have been omitted due to the low statistics involved).

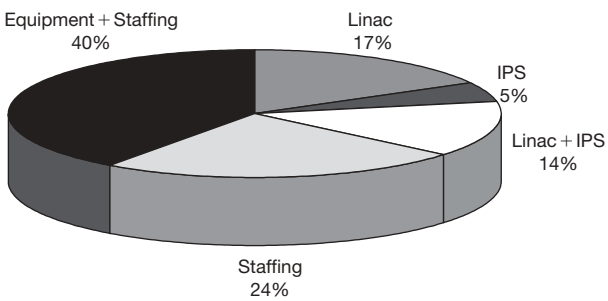

Figure 2. Reported obstacles impeding IMRT implementation, shown as a proportion of 42 Departments giving specific reasons. Equipment shortages are shown as IMRT-capable linear accelerator (Linac), inverse treatment planning system (IPS), or both.

https://doi.org/10.1017/S1460396903000530 Published online by Cambridge University Press

DISCUSSION

Advances in treatment technology allow these complex treatments to be delivered safely and effectively in routine clinical application, rather than being restricted to a research setting. In the current climate of protracted waiting lists, efficiency of linear accelerator use must be a prime consideration. Anecdotal evidence would indicate those UK Departments currently operating IMRT programmes limit this work-flow either through clinical trials or advanced referral patterns such as prostate patients who can receive hormonal treatment prior to radiotherapy. The increase in the number of beam directions (typically 5 to 7 as opposed to 3 to 4 for conventional treatment) increases the daily delivery times. Traditional treatment scheduling based on treating six patients/h on a linear accelerator has been reviewed. Typically, an IMRT treatment will take 15–20 min[3–5] of which approximately only 5 min would be the time from first beam on to last beam off, although anecdotal evidence would indicate this is now reducing. Clearly, this will be a restriction in Departments implementing this technology until adequate facilities are available to accommodate existing workloads. If dose escalation becomes common as a result of better dose conformity to the target, additional demands on resources may be made if this is delivered by increasing fraction number rather than fraction dose.

The traditional radiographer role of calculating and checking all treatment parameters has long been adapted following the widespread introduction of record and verify systems (R&V) designed to check the complex settings of multi leaf collimators and dynamic wedges. The advent of IMRT has added another dimension to the radiographer role in that treatment complexity is further increased making the manual input of data impractical and inefficient.[6] Data networks between treatment planning and delivery systems become vital with the complexities of IMRT to minimise the risk of error. Thus, the emphasis changes from inputting data to checking the details of that sent between systems. Automatic sequencing of treatment fields for these complex treatments ensures safe and efficient treatment delivery within a clinically acceptable timeframe rather than selecting each beam from file and risking error in the selection process.[6] Thus, the traditional role of the radiographer in positioning the machine and setting treatment parameters has also changed to one of checking the settings once executed automatically.

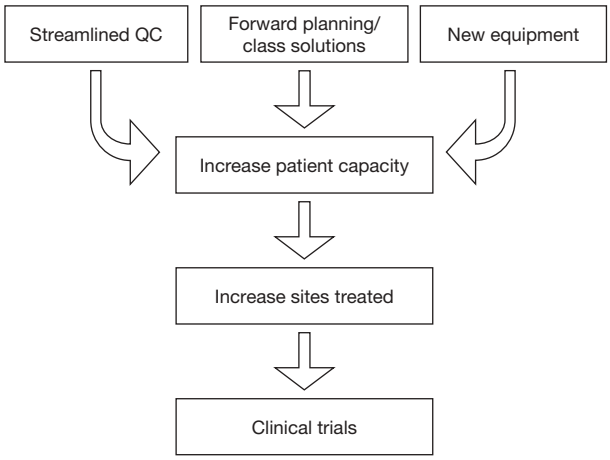

Figure 3. Expected development of patient capacity for IMRT.

Implementation of any new technique, such as IMRT, presents an initially steep learning curve. With greater familiarity and experience, QC time, in particular is likely to be reduced as more efficient methods are developed for in vitro dose verification. This reduction in QC time in the verification stage will increase potential patient capacity for IMRT. In addition, the development of standard beam arrangements and inverse-planning parameters will provide class solutions that will reduce the time currently needed in the treatment planning stage. Combined with the greater availability of hardware and software capable of delivering IMRT, this will rapidly increase patient capacity, assuming there is adequate accelerator time, allowing the application of IMRT to more anatomical sites. This expected development in IMRT provision is illustrated in Figure 3.

CONCLUSION

IMRT provision in the UK is currently at an early stage with nine of the 66 UK Radiotherapy Departments offering this technique routinely, representing a national capacity of approximately 20 new patients per month. The number of Departments offering IMRT is expected to double

https://doi.org/10.1017/S1460396903000530 Published online by Cambridge University Press

by 2005. In addition, patient capacity for IMRT will increase as inverse treatment planning and QC procedures become more streamlined and class solutions are developed, but this will need to be complemented by an appropriate increase in treatment capacity in general. This will allow more sites to be investigated and further clinical trials to assess the improvements in outcome.

Acknowledgements

The authors would like to express their thanks to all staff in the UK Radiotherapy Departments that responded to the questionnaires. Dose data for the DVHs in Figure 1 were provided by Clatterbridge Centre for Oncology, Wirral, UK.

References

1. Baker CR, Hardy V. Provision of IMRT in the UK. Part 1: A review of planning, delivery and related technologies. Journal of Radiotherapy in Practice 2003; 3(4): 9–13.
2. Clark CH, Mubata CD, Meehan CA, et al. IMRT clinical implementation: Prostate and pelvic node irradiation using Helios and a 120-leaf multileaf collimator. J Appl Clin Med Phys 2002; 3(4): 273–284.
3. Eisbruch A, Marsh LH, Martel MK, et al. Comprehensive irradiation of head and neck cancer using conformal multisegmental fields: Assessment of target coverage and noninvolved tissue sparing. Int J Radiat Oncol Biol Phys 1998; 41(3): 559–568.
4. Verhey LJ. Comparison of three dimensional conformal radiation therapy and intensity modulated radiation therapy systems. Sem in Radiat Oncol 1999; 9(1): 78–98.
5. Hunt MA, Zelefsky MJ, Wolden S, et al. Treatment planning and delivery of intensity-modulated radiation therapy for primary nasopharynx cancer. Int J Radiat Oncol Biol Phys 2001; 49(3): 623–632.
6. Klein EE, Drzymala RE, Williams R, Westfall LA, Purdy JA. A change in treatment process with a modern record and verify system. Int J Radiat Oncol Biol Phys 1998; 42(5): 1163–1168.