Clinical Oncology 31 (2019) 706–710

Contents lists available at ScienceDirect

Clinical Oncology

journal homepage: www.clinicaloncologyonline.net

Editorial

Implementing the Royal College of Radiologists' Radiotherapy Target Volume Definition and Peer Review Guidelines: More Still To Do?

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Received 4 April 2019; accepted 29 July 2019

Accurate definition of the gross target volume (GTV) and organs at risk (OARs) is one of the most important steps in high-precision radiotherapy. Ironically, this process has also been described as the 'weakest link' in the radiotherapy treatment chain [1,2]. Numerous studies have shown that this process is prone to interobserver variation and human errors, particularly for lung cancer [3–7]. Contouring errors can be minor, caused by the unavoidable difficulty of distinguishing tumour boundaries from adjacent structures, leading to an increased dose to an OARs, or major, caused by a geographical tumour miss, leading to a possible tumour recurrence [8]. Training [9,10] and well-defined protocols [11,12] have been found to reduce the interobserver variation, but they do not eliminate the risk of misinterpreting tumour spread in the images, leading to a gross error in target definition. Numerous studies have shown that quality assurance checks by a second expert or multidisciplinary team (MDT; peer review) can identify gross errors in 17–30% of target volume definitions [8,13–15].

In view of these findings, the Royal College of Radiologists followed the lead of other professional bodies [16–18] and issued guidelines in 2017 to establish minimum standards for peer review as part of radiotherapy quality assurance processes in the UK [1]. No studies have been published evaluating peer review practices across centres in the UK and therefore we conducted a survey of practice with the aim to establish practice and derive recommendations based on the results.

Survey

The survey was submitted by the Royal College of Radiologists electronically to all radiotherapy centres in the UK ($n = 62$) (see Supplementary material). The questionnaire was divided into four sections. The first section was aimed at evaluating the lung cancer workload and expertise available within each centre. The second section evaluated the peer review practices for the delineation of the lung GTV and OAR across centres in the UK. The third section evaluated factors that may act as barriers for the routine implementation of peer review using a rating score of 1–5. The final section evaluated the training provided for target volume and OAR delineation.

Twenty-four of 62 centres (39%) replied to the questionnaire. The case loads of each centre and the number of clinical and radiation oncologists employed by each centre for the treatment of lung cancer, together with their speciality, are summarised in Table 1.

GTV outlines were always reviewed in 33% of centres, sometimes reviewed in 62% of centres and never reviewed in one centre. Case selection for review varied, with the GTV being reviewed for all radical cases (61%), for new GTV protocols (79%) and for patients in clinical trials (79%). Palliative cases were not reviewed in 71% of centres. A radiologist was involved in the peer review at the oncologist's request in only 8% of centres. In one of the smaller centres that only employed one clinical oncologist specialising in lung cancer, a radiologist was involved for some cases and the peer review was carried out via web conference.

The responsibility for outlining OARs varied between the different departments. In most departments the oncologist

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https://doi.org/10.1016/j.clon.2019.07.021

outlined the more complex OARs, such as the brachial plexus (88% of centres) and oesophagus (55% of centres), whereas the delineation of more simple OARs, such as the lung, spinal cord and heart, was delegated to either radiographers or dosimetrist in 88, 83 and 67% of the centres, respectively. An oncologist reviewed the OAR outlines in 58% of centres, whereas in 25% of centres the OAR outlines were reviewed by a physicist or dosimetrist for completeness and in one centre by a MDT.

Peer review of GTV outlines was always carried out before treatment planning in most centres (45%), whereas it was always carried out after plan generation but before treatment started in 17% of centres. One centre never carried out a peer review, whereas two centres did not specify. In the remaining centres, peer review varied depending on staff availability, with 13% of centres carrying out a peer review before or after plan generation but before treatment started, whereas in 13% of centres peer review was carried out at some point during treatment. A similar survey of practice carried out in Ontario, Canada [19] revealed that only 43% of centres reviewed at least 50% of curative cases, whereas less than 20% of cases treated with palliative intent were reviewed in most centres. Only 36% of Canadian centres reported carrying out a peer review before treatment initiation, suggesting that peer review is a more widely established practice across UK centres.

Seventeen centres provided a short description of the peer review workflow. This varied widely among centres. Ten centres highlighted that their aim was to review the outlines before treatment planning within a specific timeframe during a MDT meeting. However, the number of cases reviewed varied depending on time availability and the complexity of cases. Three centres did not have a fixed workflow, two of which were developing a formal process. For all other centres, the outlines were either reviewed by a second oncologist or discussed within a MDT meeting.

The main barrier to peer review identified by the centres was allocated time, with a mean score of 3.87, followed by a shortage of oncologists, the availability of radiology services, delays to the start of treatment, information technology infrastructure and the availability of workstations, with mean scores of 3.49, 3.09, 2.81, 2.20 and 1.84, respectively.

We found that 46, 58 and 63% of centres used an in-house developed training system to provide training to oncologists, radiographers and physicists/dosimetrists, respectively. Conversely, no formal system was used in 8, 21 and 17% to provide training to oncologists, radiographers and physicists/dosimetrists, respectively. Thirteen per cent of centres relied on international courses, such as ESTRO, to provide training to oncologists. In most (54%) centres, no formal system was used to assess competencies for oncologists, whereas in 38% of centres the competency framework was established by the clinical mentor. The competencies for radiographers were certified by the clinical mentor in most centres. Less than 10% of the centres relied on an automated software to assess competencies.

Peer Review: Cases Reviewed and Workflow

Peer review practices varied widely across UK centres. Although MDT discussion can be a tool to identify discrepancies, the more experienced oncologists may make most of the decisions. Furthermore, the display of contours may bias the observers to 'believe' them and may not be as effective as independent contouring to detect contouring issues. This bias can be reduced by having two oncologists individually delineate the contours. However, the latter is even more time consuming. On the other hand, time constraints during MDT meetings may lead to cases being omitted from thorough discussion. Eventually some centres explained that they only reviewed random cases, whereas others reviewed only difficult cases during these meetings. Only one centre stated that the GTV is individually outlined by two oncologists for Stereotactic ablative radiotherapy (SABR) cases. Although interobserver variation for SABR cases has been

Table 1
Responding centres' case loads and workforce

Case load	No. centres	No. radical patients	No. palliative patients	No. oncologist (range)	Distribution of oncologists	Radiotherapy techniques offered
Low	13	50–100	50–500	1–5	1/13 = 1 oncologist 6/13 = 2 oncologists 5/13 = 3 oncologists 1/13 = 5 oncologists	5/13 = 3DCRT + SABR 8/13 = 3DCRT only 1/13 = brachytherapy*
Medium	6	100–200	50–300	3–8	2/6 = 3 oncologists 3/6 = 4 oncologists 1/6 = 8 oncologists	5/6 = 3DCRT + SABR 1/6 = 3DCRT only
High	5	More than 200	200–500	4–14	2/5 = 9 oncologists 1/5 = 5 oncologists 1/5 = 4 oncologists 1/5 = 14 oncologists	5/5 = 3DCRT + SABR

3DCRT: Three Dimensional Conformal Radiation Therapy.
SABR: Stereotactic ablative radiotherapy.
* The only centre that treated more than 200 palliative patients annually.

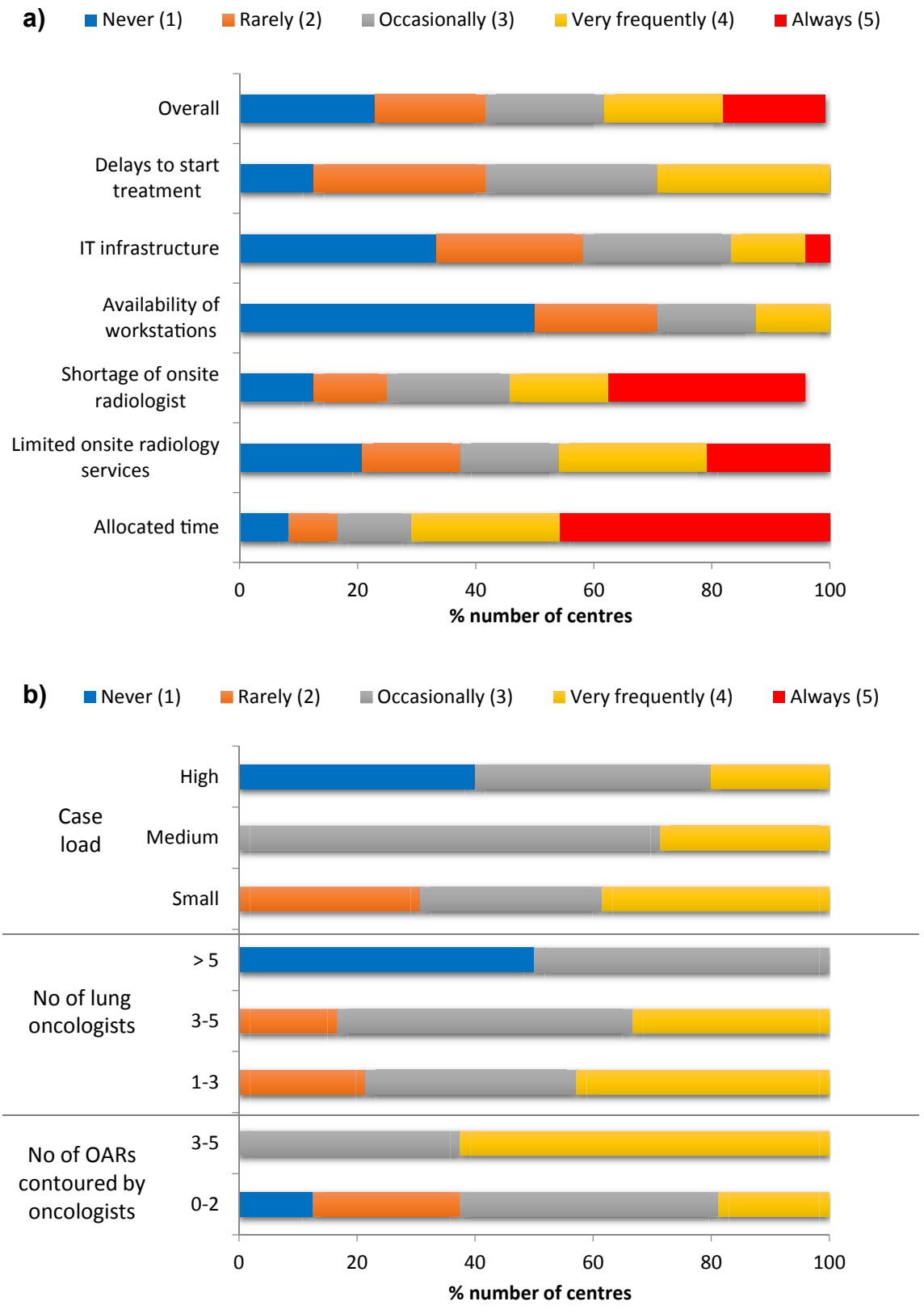

Fig 1. (a) Impact of various factors on the performance of peer review using a score of 1 (never a barrier) to 5 (always a barrier); (b) barrier score encountered by the different centres stratified according to the lung cancer case load, number of oncologists employed and number of organs at risk (OARs) contoured by the oncologist.

reported to be small (standard deviation 1.2–1.8 mm) when compared with more advanced cases [5,20], small errors on SABR plans can have a major impact due to the delivery of a higher more conformal dose. More research is required to identify an optimal workflow for peer review and this may include comparing the outcomes of peer review carried out individually or within a MDT. The impact of peer review on treatment outcomes also needs to be audited to justify its costs.

Barriers to Peer Review

Centres with a higher lung cancer case load used more specialist lung oncologists and reported fewer barriers to carrying out peer review (Table 1, Figure 1). One of the small centres pointed out that peer review was frequently compromised by annual leave and sick leave. A shortage of staff is one of the key barriers to peer review, as also indicated by the Canadian survey [19]. The development of workflows to facilitate collaboration with other institutes can be a solution. A good practice example of this was provided by one centre that employed only one lung oncology specialist; the only way to carry out peer reviews was by collaborating with another hospital. Centres where the oncologist was responsible for carrying out all or most of the OAR contours also reported more barriers to carrying out peer review (Figure 1). The contouring workload on the oncologist could be reduced by delegating this task to radiographers or by increasing the use of auto-segmentation tools [21]. An alternative approach to peer review is to partially automate the process. Altman *et al.* [22] proposed a framework to quantitatively assess head and neck contour integrity by evaluating the size, shape, position and other cofactors derived from historical data. Through this workflow, 95% (40/42) of the errors were identified, but nine false positives were also detected. This approach could potentially reduce quality assurance time and facilitate the process, particularly for small centres. However, the automated process should not replace human judgement.

Training on Target Volume and Organ at Risk Outlines

Training is also an important aspect that needs to be integrated as part of the quality assurance in target volume and OAR outlining. According to Konert *et al.* [10], multiple training interventions are often required in order to change clinical practice in target volume outlining and peer review. Apart from reducing the risk of errors, this introduction of peer review could be used to facilitate continuous professional development for oncologists and may help to support the iterative process of improving. As a result, accurate documentation of the peer review process is important to guide improvements. However, unfortunately, such documentation was only reported in three centres. Software and workflows need to be improved in order to provide a better link between quality assurance and continuous professional development.

Conclusion

Although peer review of radiotherapy lung cancer target volumes is being carried out by most centres (95%), workflows and the number and types of cases selected varied widely, highlighting the need to provide more human resources and improvements in the workflow and training to facilitate this process and to maximise safe target volume delineation. Software also needs to be developed to automate and facilitate current quality assurance workflows.

Conflict of Interest

The authors declare no conflicts of interest.

Acknowledgements

Thanks to the Royal College of Radiologists United Kingdom for distributing the questionnaire. Professor Marcel van Herk is supported by NIHR Manchester Biomedical Research Centre United Kingdom.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clon.2019.07.021.

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