Radiography 22 (2016) 206–216

Contents lists available at ScienceDirect

Radiography

journal homepage: www.elsevier.com/locate/radi

Process evaluation of treatment times in a large radiotherapy department

R. Beech [a, *], K. Burgess [b], J. Stratford [c]

[a] The Christie NHS Foundation Trust, UK
[b] Directorate of Medical Imaging and Radiotherapy, University of Liverpool, UK
[c] The Wade Centre for Radiotherapy Research, The Christie NHS Foundation Trust, UK

ARTICLE INFO

Article history:
Received 6 November 2015
Received in revised form
7 March 2016
Accepted 9 March 2016
Available online 26 March 2016

Keywords:
Scheduling
Room-occupancy
Appointment
Time
Throughput
Provision

ABSTRACT

Purpose/objective: The Department of Health (DH) recognises access to appropriate and timely radiotherapy (RT) services as crucial in improving cancer patient outcomes, especially when facing a predicted increase in cancer diagnosis. There is a lack of 'real-time' data regarding daily demand of a linear accelerator, the impact of increasingly complex techniques on treatment times, and whether current scheduling reflects time needed for RT delivery, which would be valuable in highlighting current RT provision.

Material/methods: A systematic quantitative process evaluation was undertaken in a large regional cancer centre, including a satellite centre, between January and April 2014. Data collected included treatment room-occupancy time, RT site, RT and verification technique and patient mobility status. Data was analysed descriptively; average room-occupancy times were calculated for RT techniques and compared to historical standardised treatment times within the department.

Results: Room-occupancy was recorded for over 1300 fractions, over 50% of which overran their allotted treatment time. In a focused sample of 16 common techniques, 10 overran their allocated timeslots. Verification increased room-occupancy by six minutes (50%) over non-imaging. Treatments for patients requiring mobility assistance took four minutes (29%) longer.

Conclusion: The majority of treatments overran their standardised timeslots. Although technique advancement has reduced RT delivery time, room-occupancy has not necessarily decreased. Verification increases room-occupancy and needs to be considered when moving towards adaptive techniques. Mobility affects room-occupancy and will become increasingly significant in an ageing population. This evaluation assesses validity of current treatment times in this department, and can be modified and repeated as necessary.

Introduction

Radiotherapy (RT) plays a crucial role in successful treatment of 50% of UK cancer patients.[1] Patients require access to appropriate modern RT techniques promptly to maximise benefits and improve outcomes.[2] However, resources may soon be inadequate due to an ageing population, higher cancer prevalence, improved detection and earlier diagnosis, requiring greater investment in RT provision.[3–6] The National Radiotherapy Advisory Group (NRAG) in 2007 highlighted the necessity of commissioning more radiotherapy fractions to meet this demand,[5] supported by the National Audit Office (NAO), which recommended that fractions (attendances) per year per linear accelerator reach at least 8700 by 2016, placing significant pressures on throughput.[7] Since these publications, RT complexity and dose/fractionation regimes have evolved considerably; however, these reports emphasise the need for service evaluation.

The National Radiotherapy Implementation Group (NRIG) reinforced the requirement for NHS resource optimisation whilst enhancing current treatment and verification techniques, for example, wider implementation of Intensity-Modulated Radiotherapy (IRMT) and Image-Guided Radiotherapy (IGRT) with a view to delivering 4D Adaptive Radiotherapy (4D-ART) as standard.[8] This has been partly achieved due to the Radiotherapy Innovation Fund

* Corresponding author. Radiotherapy, The Christie NHS Foundation Trust, Wilmslow Road, Manchester M20 4BX, UK
E-mail address: rosie.beech@christie.nhs.uk (R. Beech).

http://dx.doi.org/10.1016/j.radi.2016.03.001
1078-8174/

and the Commissioning for Quality and Innovation (CQUIN) payment framework.[9,10] Increased focus is on the introduction of new techniques and tools such as R-Port for modelling future changes and capacity, the Radiotherapy Data Set, the support of advanced RT by the NHS England Radiotherapy Clinical Reference Group (CRG), and introduction of a National Radiotherapy Tariff to standardise UK commissioning.[8,11]

Radiotherapy provision is also under scrutiny internationally. The European Society for Radiotherapy and Oncology (ESTRO) commissioned a Quantification of Radiation Therapy Infrastructure and Staffing Needs (QUARTS) study in 2005 to examine needs of the European RT service against current resources.[12–14] Great variation in provision and need was seen across Europe; additionally, resources in England were found to be only 50% of estimated level of need based on cancer incidence and machine capacity in 2005.[12]

Radiotherapy commissioners are recognising the importance of analysing factors affecting workload and departmental efficiency. The Basic Treatment Equivalent (BTE) tool to model linear accelerator throughput was originally developed in 1996 in Australia to predict and compute waiting times during treatment, accounting for treatment complexity and patient performance status, which were not historically considered when scheduling.[15,16] The BTE has since been updated to incorporate elements recognised to affect fraction duration, such as patient mobility, treatment intent and imaging, but has not yet been widely adopted across the UK.[17,18]

Literature review

Published literature addressing workload and capacity in RT is limited, with few references to fraction durations and adopting a variety of approaches. For example, to assess throughput, the ESTRO-QUARTS studies used the benchmark of 'completed treatment courses per year'.[14]

A relatively small Belgian time-and-motion study examined the impact of IMRT, quality assurance (QA) and verification using electronic portal imaging devices (EPIDs) on length of RT fractions.[19] The mean fraction length measured over various techniques (11.6 min) reflected their standard 12 min treatment slot. IMRT increased this by 2.8 min over conventional techniques, and verification by 5.7 min. A poorer patient performance status increased treatment duration by 3.6 min on average.

A smaller UK study examined treatment delivery time for head and neck IMRT and conventional 3D-RT and prostate IMRT patients.[20] Overall median 'on-couch to off-couch' time was 12 min overall; head and neck IMRT decreased treatment time over conventional phased treatments. Another UK study reinforced the speed of IMRT delivery (in this case TomoTherapy) over conformal RT, particularly in the case of head and neck treatments.[21]

The German Society of Radiation Oncology (DEGRO) recognised a lack of real-time measurements in this field, seeking to measure manpower and room-occupancy of core procedures to substantiate resource recommendations. DEGRO undertook separate prospective multicentre evaluations of workload for various RT and stereotactic RT/radiosurgery treatment sites, for different points on the treatment pathway.[22–27] These large complex evaluations found an increase in room-occupancy with IMRT over 3D-CRT for routine irradiation, and with portal imaging.

Repeated in a larger study of IMRT in four departments, DEGRO recorded mean room-occupancy of 18.3 min with routine 2D or 3D image-guidance and 10.6 min without for various oncological groups.[28] This evaluation did not consider the full range of tasks that radiographers carry out daily, which may increase impact on service delivery.

Cancer treatment is increasing in complexity. Since publication of these studies, there has been wider implementation of IMRT arc therapy such as VMAT (Volumetric-Modulated Arc Therapy) and improved IGRT, such as 3D Cone-Beam Computed Tomography (CBCT) for online and offline verification. Arc therapy substantially reduces 'beam-on' times for treatments such as prostate cancer[29]; however, impact on room-occupancy is unknown. Frequent online verification may also affect room-occupancy. NRIG recognises that increasing treatment complexity and imaging, while improving treatment quality, can slow delivery and machine throughput.[8]

There are no current published standards for RT durations. At the department studied, allocated treatment slots are historical and not formally evidence-based. In an NHS culture where evidence-based practice is encouraged and expected,[30] it is surprising that this has not been addressed.

Justifications for the study

The National Radiotherapy Patient Experience Survey was commissioned as patient experience and quality of care received are crucial to informing fundamental changes to departmental organisation.[8,31] A large majority (94%) of patients surveyed would be happy or very happy to return to the same RT department for further treatment,[31] however only 67%, confirmed that their treatment began on time or within 20 min of their appointment.[9] Poor experiences such as this could exacerbate the anxiety and depression experienced by some cancer patients while undergoing treatments.[32]

Other local and national justifications include workforce and equipment. Student attrition rates are currently higher than other healthcare professions, with practice placement dissatisfaction factored highly.[33] Time pressures in the department may be detrimental to student education, but NRIG highlights the need for an increase in workforce by 2016.[8] Additionally, unrealistic expectations in the working environment may hamper staff retention. Improving throughput is imperative for streamlined efficient service delivery and could be significant in maintaining a satisfied workforce. Linear accelerators should be replaced every 10 years, in a rolling replacement programme which can result in shift-working to maximise resources.[5] Fatigue and stress caused by a pressured working environment can also contribute to treatment errors - as emphasised in 'Towards Safer Radiotherapy' — which are of major concern.[34]

Economics of current and future RT services need to be highlighted to combat the predicted rising cancer burden; ESTRO have commissioned the HERO project (Health Economics in Radiation Oncology) to assess need, availability and cost of the RT service across Europe to provide data for governments to maximise benefits and improve cancer care.[35]

Study aims

Intentions to increase throughput and efficiency rely on accurate and realistic timings of daily RT activity. The NRIG report argues that benchmarking throughput would not support quality service delivery[8]; however, historical timings do not reflect the dynamic and developing field of radiotherapy.

This process evaluation was undertaken in a large diverse radiotherapy department to provide an informed set of room-occupancy timings, producing real-time information with an evidence base to refine current schedules, assist management decision-making, and act as a tool to be modified continuously or as required.

Method

Linear accelerators were evaluated at a central RT department of a large regional cancer centre and one of its satellite centres. All were CBCT-enabled for treatment verification; the sample