

Measuring and improving radiotherapy delivery efficiency with SGRT implementation

University Hospital
Southampton

Amy Shaw
Technical Lead Radiographer
Lauren Peares
Senior Radiographer
Gary Lau
Clinical Specialist

NHS

University Hospital Southampton
NHS Foundation Trust

What We Have



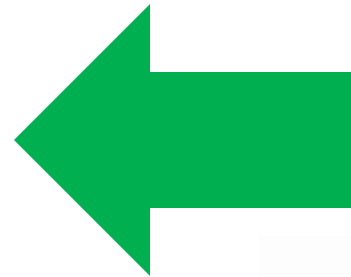
- 6 Versa HD Linacs at main site
- 1 Synergy Agility at satellite site

All linacs now **SGRT** enabled:

- 3 Linacs with ExacTrac Dynamic and Hexapod 6DoF couch
- 4 Linacs with AlignRT
- 2 x SimRT for CT Sim

The need for SGRT

- Tattoo-less treatments
- Open faced masks
- Reduction in manual handling
- Improved treatment accuracy
- Improved patient experience
- Reduction in treatment times



Base Line Efficiency Study

Journal of Radiotherapy in Practice

cambridge.org/jrp

Original Article

Cite this article: Cooke A and Holborn C. (2022) Measuring and improving radiotherapy delivery efficiency. *Journal of Radiotherapy in Practice* page 1 of 6. doi: [10.1017/S146039692200005X](https://doi.org/10.1017/S146039692200005X)

Received: 7 September 2021

Revised: 11 November 2021

Accepted: 19 November 2021


Key words:

radiotherapy workflow; efficiency; throughput; room occupancy

Author for correspondence:

Amy Cooke, Radiotherapy, University Hospital Southampton NHS Foundation Trust, Tremona Road, Southampton, Hampshire SO16 6YD, UK
E-mail: amy.shaw@uhs.nhs.uk

Measuring and improving radiotherapy delivery efficiency

Amy Cooke¹  and Catherine Holborn²

¹University Hospital Southampton NHS Foundation Trust, Southampton, UK and ²Sheffield Hallam University, Sheffield, UK

Abstract

Introduction: The researcher's centre was in a unique position of merging with another established radiotherapy centre to create a Satellite Site. It was noted that the Satellite Site delivered more fractions per linac within the same working day profile as the Main Site. Subtle differences in the workflows allowed for an appraisal of the processes within a fraction of radiotherapy and how this can be refined to improve efficiency.

Methods: Retrospective fraction timings were collected using the Oncology Information System for 98 breast and prostate treatments at both sites. A literature review was also conducted to further explore factors that impact fraction timings in other departments internationally.

Results: Breast and prostate treatments took 2.1 and 2.93 minutes, respectively, longer to deliver at the Main Site. Set-up to the isocentre and verification image assessment took significantly longer in all cases at the Main Site. Literature surrounding efficiency is scarce but suggests methods used for online management of verification imaging significantly impacts appointment times.

Conclusion: Implementation of a paperless workflow and process improvements for image assessment such as introducing a traffic light protocol may reduce the time to deliver a fraction of radiotherapy and maximise service efficiency.



University Hospital Southampton
NHS Foundation Trust

How can local external beam radiotherapy delivery times be improved to meet the national service specification?

**At point of merge with single linac centre:
2019 RTDS: Satellite Site delivered 7550# and 5940# at the Main Site**

Aims:

1. Review overall approach to radiotherapy delivery
2. Identify areas within the treatment delivery workflow requiring improvement
3. Develop a strategy to achieve 9000 attendances per year per linac

Objectives:

- Define the key stages that constitute fraction time
- Measure the time taken for each of the key stages to be achieved at the Main Site and at the Satellite Site
- Identify which time points have the most influence on fraction time through observation locally
- Conduct a literature review to develop a detailed a plan for improving local fraction time

Lack of literature on efficiency within a fraction of radiotherapy

Methods

Electronic Entry in OIS	Time point in clinical workflow	Key Stage
Site Set Up Widget	Patient on bed	Set Up
1 st Couch Move Assistant	Move to isocentre	In room checks
1 st Verified Treatment	CBCT image acquisition	Image assessment
2 nd Couch Move Assistant	CBCT image assessment	
2 nd Verified Treatment	Treatment delivery	Treatment Delivery
Code Capture	Feet of bed	

Base	Prostate	FB Breast	FB Breast with imaging	DIBH Breast	DIBH Breast with imaging	Total
Satellite	18	12	6	3	9	48
Main	21	10	6	3	8	48

Data collected between March to April 2020

Literature Review:

Criteria	Comments
2015-2020	When addressing fractional delivery efficiency, it was important to include studies from recent times to ensure that the equipment used for delivery had similar technical capability
Peer Reviewed	To ensure the articles' quality only studies published in peer reviewed journals were included
Time and motion primary studies	Fractional timing data was sought therefore articles relating to other aspects of radiotherapy efficiency were excluded

Results 1

Total Treatment Times:

Base	Site	Average/ Minutes (2dp)	SD
Satellite	Prostate	10.24	2.17
Main	Prostate	13.17	3.17
Satellite	Breast FB	9.71	2.65
Main	Breast FB	11.81	4.05
Satellite	Breast DIBH	23.20	9.58
Main	Breast DIBH	20.36	4.44

- Total treatment time was 2.93 minutes faster for prostates and 2.1 minutes faster for FB breasts at the Satellite Site
- DIBH appears to take longer at the Satellite Site by 2.84 minutes. Low patient numbers

- Set Up and Image assessment are key areas of the workflow where timings differ
- Prostate and FB breast take longer to set up at the main site, unlike DIBH breast
- Image assessment takes longer and a larger proportion of the workflow at the Main Site in every case

Set Up:


Base	Site	Average/ Minutes (2dp)	Percentage difference of average Satellite time compared to Main time/ %
Satellite	Prostate	2.86	-23.94
Main	Prostate	3.76	
Satellite	Breast FB	3.78	-13.70
Main	Breast FB	4.38	
Satellite	Breast DIBH	9.85	+32.04
Main	Breast DIBH	7.46	

Image Assessment:

Base	Site	Average/ Minutes (2dp)	Percentage difference of average Satellite time compared to Main time/ %
Satellite	Prostate	2.73	-43.24
Main	Prostate	4.81	
Satellite	Breast FB	1.57	-73.10
Main	Breast FB	5.83	
Satellite	Breast DIBH	5.19	-9.74
Main	Breast DIBH	5.75	

Time Line

January 2022: first system installed



February 2022: last system installed



February 2022: first system commissioned



June 2022: last system commissioned



July 2022: Go Live at satellite-breast and prostate

Time Line

August 2022: Go live at Main Site- breast and prostate



September 2022: Colorectal Tx



October 2022: tattooless for Align RT sites



October 2022: reduced appointment times



November 2022: DIBH, Limbs

Jan 2023: Thorax, Abdomen and H&N

February 2023: Gynae, Limbs and Palliative

Data collection after SGRT implemented

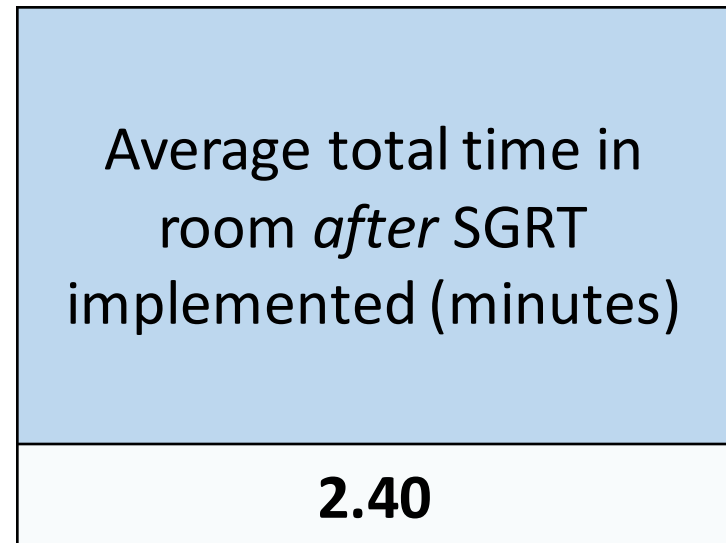
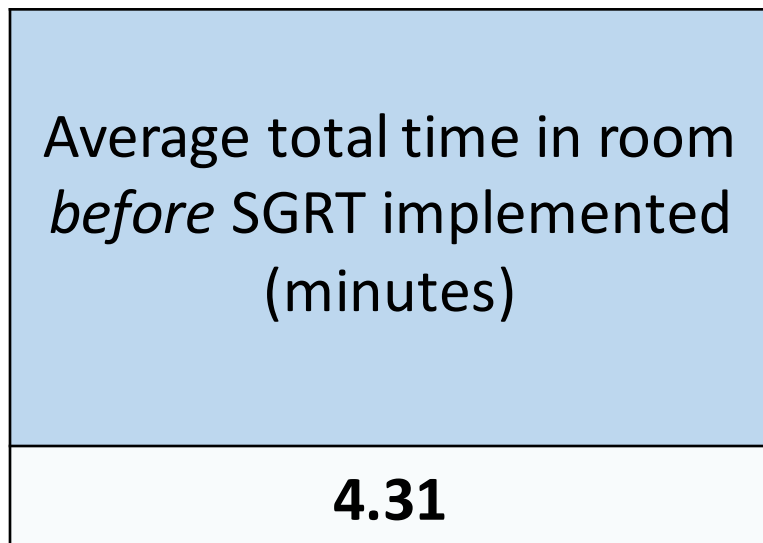
- We repeated the data collection in August 2022 once SGRT was established at both the Main and Satellite Sites
- The same method was used as in baseline study, but we combined the set up and in room checks as there are now no moves to isocentre

Electronic Entry in OIS	Time point in clinical workflow	Category
Site Set Up Widget	Patient on bed	Set Up
1 st Couch Move Assistant	Move to isocentre	In room checks
1 st Verified Treatment	CBCT image acquisition	Image assessment
2 nd Couch Move Assistant	CBCT image assessment	
2 nd Verified Treatment	Treatment delivery	Treatment Delivery
Code Capture	Feet of bed	

 **Start of patient setup**

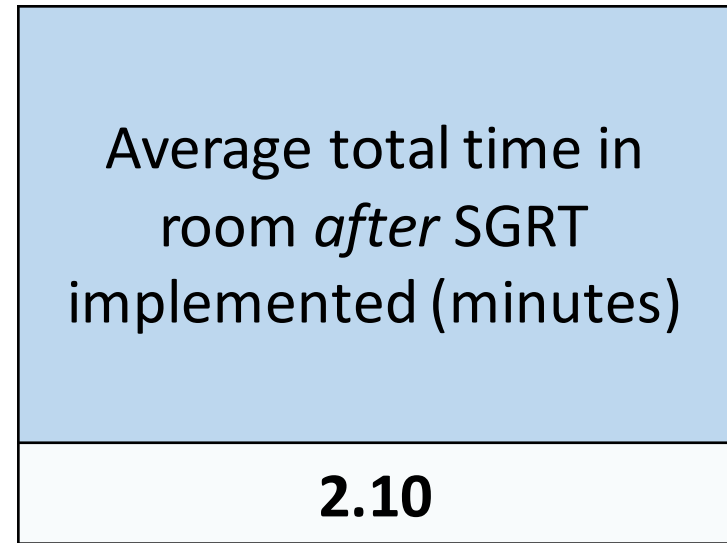
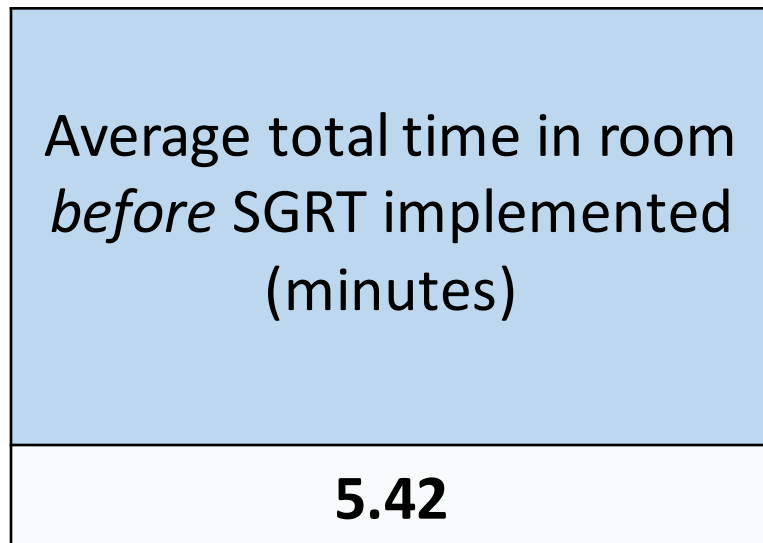
 **End of patient setup**

Comparing data from before SGRT was implemented at **Satellite Site** to data after SGRT was implemented (*Prostate Patients*)



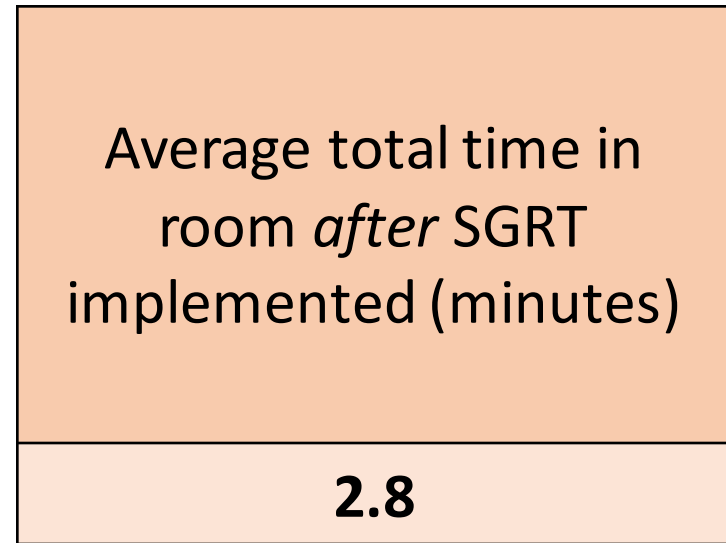
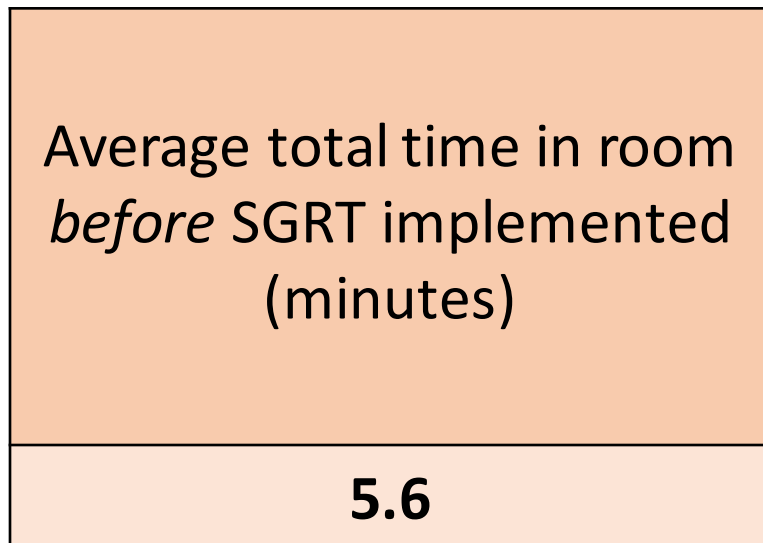
= Time saving of **44.3%**

Comparing data from before SGRT was implemented at **Main Site** to data after SGRT was implemented (*Prostate Patients*)



= Time saving of **61.3%**

Comparing data from before SGRT was implemented at **Satellite Site** to data after SGRT was implemented (*Free-Breathing Breast Patients*)



= Time saving of **50%**

Comparing data from before SGRT was implemented at **Main Site** to data after SGRT was implemented (*Free-Breathing Breast Patients*)

Average total time in room
before SGRT implemented
(minutes)

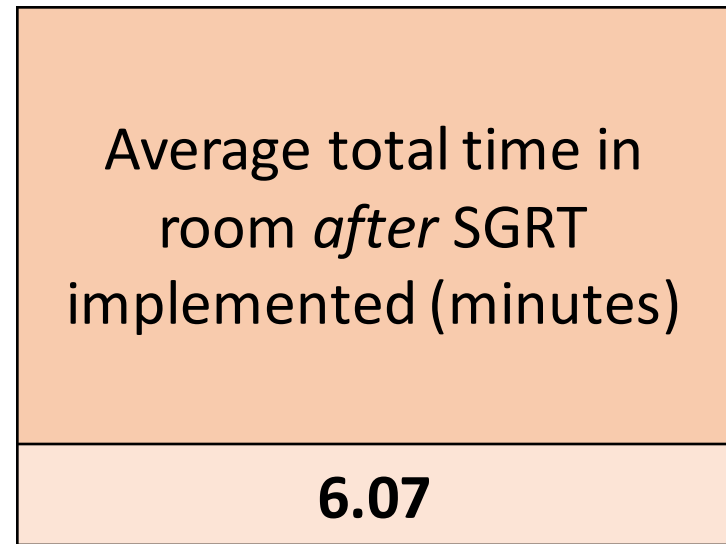
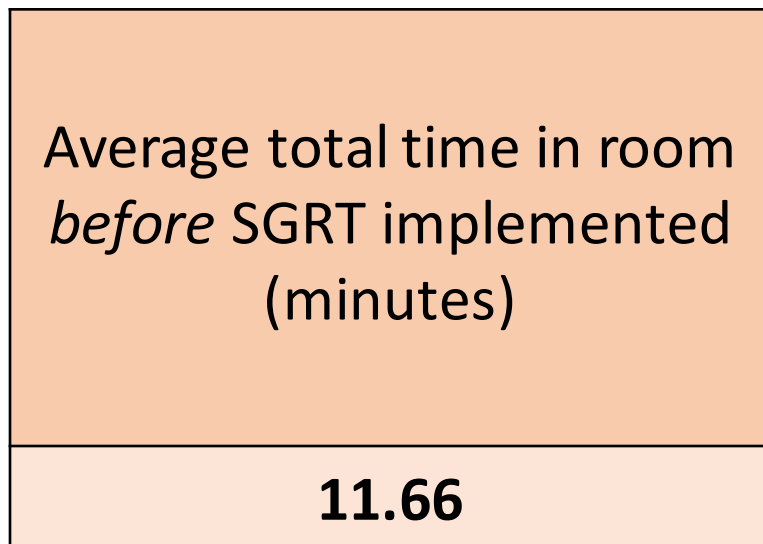
6.05

Average total time in
room *after* SGRT
implemented (minutes)

4.3

= Time saving of **28.9%**

Comparing data from before SGRT was implemented at **Satellite Site** to data after SGRT was implemented (*DIBH Breast Patients*)



= Time saving of **52%**

Comparing data from before SGRT was implemented at **Main Site** to data after SGRT was implemented (*DIBH Breast Patients*)

Average total time in room
before SGRT implemented
(minutes)

8.96

Average total time in
room *after* SGRT
implemented (minutes)

5.30

= Time saving of **59%**

What is the outcome?

Site	Appointment time before ART	Appointment time now
Prostate	18	15
Free-breathing Breast	18	15
Colorectal	18	15
DIBH Breast	24	18

In a year this will result in an additional 32 800 minutes of linac time or **2190 appointments** or 150 patients

Analysis of imaging data

- Breast patients slight reduction in repeat CBCTs after SGRT
- Average number of daily CBCTs per patient for prostate has increased from 1.2 to 1.3 at the main site, and increased from 1.1 to 1.3 at the satellite site
- Audit revealed differences in ROI placement for pelvic cases
- Once troubleshooting becomes more natural to staff, audit to be repeated and further data collected
- DIBH audit to be undertaken

Future Indications

Current clinical use:

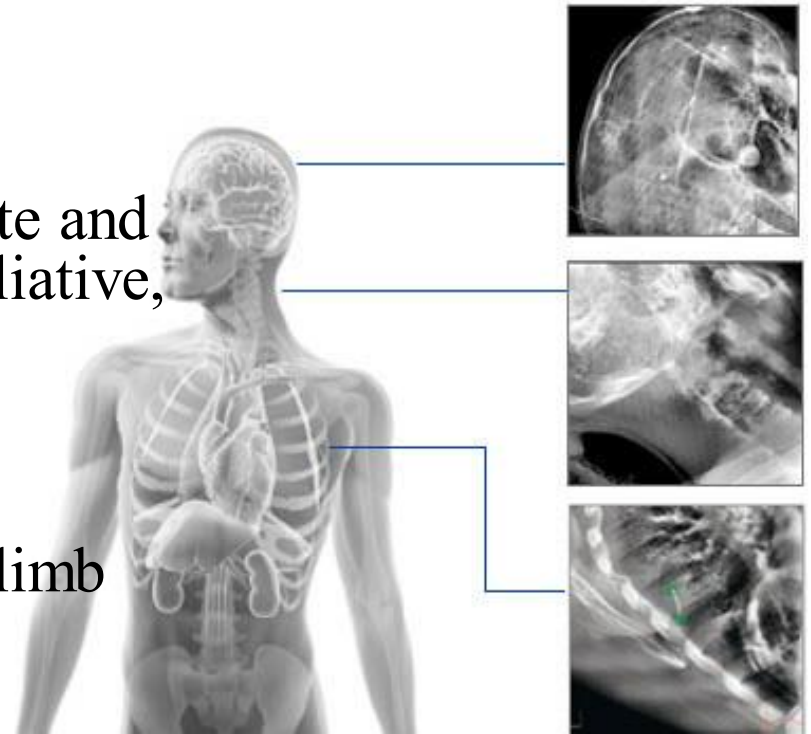
- Breast FB, Breast DIBH, Prostate and Colorectal, Gynaecological, Palliative, Limbs, Thorax and Abdomen

Future clinical use:

- Tattooless for thorax, abdomen limb and palliative

Future functions:

- Sim RT for DIBH
- Sim RT for 4DCT



Example 1



Gross set up error is obvious and can be corrected prior a cone beam scan

Example 2



Therefore less likely to repeat setup, repeat scans, and therefore lower concomitant dose

Example 3



Going straight to iso-centre using couch move assist

Example 4



Real time tracking of the patient

Thank you! Any Questions?

Please contact
amy.shaw@uhs.nhs.uk or
lauren.peares@uhs.nhs.uk or
Gary.lau@uhs.nhs.uk