Singapore Healthcare Management 2019

Achieving Highly Reliable Outcomes in the delivery of Radiation Treatments requiring Deep Inspiration Breath Hold technique for Left Sided Breast Cancers

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breath-hold zone.

INTRODUCTION

Adjuvant Radiation Therapy (RT) plays a vital role in the treatment of breast cancer because it improves both local control and overall survival [1]. However, long term follow up has shown that patients receiving breast RT also have an increased risk of cardiac disease [2,3]. Minimizing radiation induced cardiac toxicity is thus an important aspect of breast cancer survivorship.

Deep Inspiration Breath Hold (DIBH) is an RT technique that seeks to decrease radiation dose delivered to the heart by delivering radiation only when the patient has achieved and is holding a specific depth of inspiration. (Fig 1-3).





Figure 2: A green light illuminates to

indicate that the patient has reached

the appropriate level of inspiration.



Figure 3: Radiation Therapy is initiated

when the patient has reached the

Figure 1: The device used for DIBH.

In an environment where workload is high, time pressure may cause staff to begin treatment before the patient has reached the required depth of inspiration thus increasing unintended radiation dose to the heart.

PROJECT AIM

This project aims to put into place sustainable process changes and effective interventions to consistently reduce such DIBH incidents.

METHODOLOGY

A multidisciplinary team was formed consisting of Radiation Oncologists, Radiation Therapists, the Department manager, Physicists, Health informaticians and representative from the Quality Management Department. The team met regularly to analyze collected baseline and subsequent data, identify the causes of the radiation incidents and plan preventive measures. The team retrospectively reviewed the 5 DIBH related incidents which occurred in the one year period September 2017 to August 2018. Outcomes (HRO) Trajectories Tool and Model-based Risk Management [4] approach was used to analyze the system in question and human behaviors associated with these events. They examined the chain of events that led to an incident and considered the actions of those involved. The Defences (D1-3) in place at that time were analyzed using the Hazards & Threats Assessment of the HRO Trajectories tool to assess the likelihood of human compliance in each of them.

The DIBH incidents were found to be due to:

• No fixed role assignment for Radiation Therapists (RTT) in the team for performing the tasks of DIBH coaching, monitoring & treatment delivery.

• Technical system design challenges - The radiation treatment delivery system was not integrated with the DIBH system. These two systems are each manually controlled by a different RTT (1 & 2) whose actions need to be coordinated.

• Failure in communication – RTT2 did not wait for the breath hold confirmation from RTT1 before proceeding to deliver the dose treatment.

Risk Mitigation Strategies

PDSA 1



Defences D1-3 were implemented following the first DIBH incident in Aug 2017

• D1 - Fixed role assignments for radiation therapists (RTTs) in the team for giving instructions to the patient to inhale, hold breath and exhale, and for treatment delivery.

• **D2** - Doing a Time-Out prior to DIBH RT was made mandatory

• D3 - A " Do not Disturb. DIBH treatment in progress" sign was put on the Treatment Console whenever a DIBH treatment was being carried out.



PDSA

PDSA 2

Two new defences D4 & D5 were designed and instituted :

D4 – RTT1 (who monitors the breathing and gives the command) will watch RTT2 (who turns on the beam) to ensure that he does not anticipate the command and start the treatment prematurely.

D5 – RTT2 will repeat RTT1's command for "Beam On" before executing it. The Hazards & Threats Assessment for likelihood of compliance for these 2 actions were assessed as "high" (Fig 5) and they were implemented.

Using the Hazards and Threats assessment tool. D1, D2 and D3 were rated as having a Medium likelihood of compliance (Fig 4), which means that they are not very reliable as defence mechanisms. This was borne out in practice as similar incidents continued to occur after their implementation.

Likelihood of Compliance as assessed using the Scoring tool	D1 Score	D2 Score	D3 Score
Total Score Greater Than or Equal to 10 = High likelihood of compliance	3	6	6
Total Score Between 9 and -9 = Medium likelihood of compliance Total Score Less Than or Equal to -10 = Low likelihood of compliance	Medium	Medium	Medium

Figure 4

Likelihood of Compliance as assessed using the Scoring tool	D4 Score	D5 Score
Total Score Greater Than or Equal to 10 = High likelihood of compliance	31	31
Total Score Between 9 and -9 = Medium likelihood of compliance		
Total Score Less Than or Equal to -10 = Low likelihood of compliance	High	High

Figure 5

PDSA 3

To have the Three Effective Defences recommended by the model, the team implemented the 3rd Defence **D6**. This made use of an auto-gating module to automatically prohibit the delivery of radiation whenever the patient is not in the desired inspiration zone.



CONCLUSION

Outcome Engenuity's Highly Reliable Outcomes (HRO) Trajectories Tool and Model-based Risk Management approach (Fig 6) is an effective method for designing and evaluating the reliability of the interventions for the prevention of patient harm. The three defences that were put in place have proven to be very effective in producing a highly reliable outcome as Zero DIBH radiation incidents have been reported since their implementation.

References:

1.Rutqvist LE, Lax I, Fornander T, Johansson H. Cardiovascular mortality in a randomized trial of adjuvant radiation therapy versus surgery alone in primary breast cancer. Int J Radiat Oncol Biol Phys. 1992;22(5):887-96.

2. Darby SC, Ewertz M, McGale P, et al. Risk of ischemic heart disease in women after radiotherapy for breast cancer. N Engl J Med. 2013;368(11):987–98.

3. Marks LB, Yu X, Prosnitz RG, et al. The incidence and functional consequences of RT-associated cardiac perfusion defects. Int J Radiat Oncol Biol Phys. 2005;63(1):214-23.

4. Outcome Engenuity_Highly Reliable Outcomes: Hazards and Threats Assessment Tool 2017



Figure 6: We made our system more reliable and safe by having 3 layers of defence between the error and the harm.