

# Spirometry-monitored deep inspiration breath-hold radiotherapy for breast cancer: Cancer Partners UK's approach to improving outcomes in left-sided breast cancer radiotherapy - an evidence - based review

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296 cohort patient study

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Spirometry-monitored deep breathing technique to increase the accuracy of radiotherapy treatment

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## Overview

More than 37,000 patients with breast cancer received radiotherapy in the UK in 2012<sup>[1]</sup>. With the support of increasingly sophisticated techniques, breast cancer survival rates are improving.

But as more people live with or beyond the disease, doctors are also encountering more instances of individual's presenting with longer term healthcare issues as a direct consequence of the treatment that was designed to help save their lives.

One such consequence is damage to the heart from radiation, if the organ is caught in the field of radiation during radiotherapy treatment. This can often be the case with individuals being treated for left-sided breast cancer, resulting in these patients having a greater risk of experiencing cardiovascular side effects in the years following their treatment<sup>[2-5]</sup>.

In fact, a recent analysis of more than 30,000 women<sup>[8]</sup> treated with radiotherapy for left-sided breast cancer demonstrated a 3% increase in the risk of death for every 1Gy – the basic measure of radiation dose – received by the heart. The analysis also showed that this risk begins within five years of treatment and that up to 88% of patients with left-sided breast cancer treated with radiotherapy are likely to have screen detected deformities of the cardiac muscle within the first five years after their treatment<sup>[3,7]</sup>.

Furthermore, this risk is not just a short-term risk, but also continues into the third decade after treatment<sup>[3,4]</sup>. Additionally, the risk is even greater in women with pre-existing cardiac risk factors e.g. smoking and obesity, and is further exacerbated if the woman is having other therapies that also have negative effects on the heart e.g. Anthracyclines<sup>[3]</sup>.

A particular radiotherapy technique, spirometry-monitored deep inspiration breath-hold (DIBH) has been specifically designed to alleviate these risks. By adopting this spirometry-monitored type of DIBH technique during radiotherapy treatment, which can move the heart away from the radiation fields, the risk of a patient experiencing the side effects or even dying as a result of their treatment can be reduced<sup>[7]</sup>.

This whitepaper outlines a study that Cancer Partners UK has conducted, which was peer-reviewed at ESTRO 2015<sup>[5]</sup>. The study involved looking at treatment planning data from 296 left-sided breast cancer patients treated with spirometry-monitored DIBH in its centres during 2013/14 and the resulting effects on cardiac dose and cardiac risk.

The study found that the risk of serious cardiovascular side effects and death is higher in patients who do not receive spirometry-monitored DIBH.

[Click here to view a SlideShare of the study](#)

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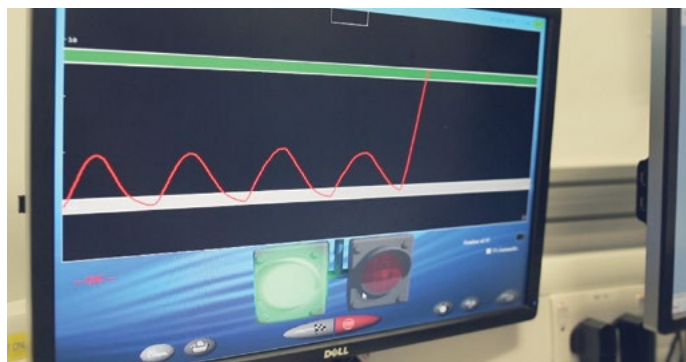
## How does spirometry-monitored deep inspiration breath-hold work?

Spirometry-monitored deep inspiration breath-hold (DIBH) involves a patient learning to hold their breath for a short time (just a matter of seconds) whilst their radiation dose is administered.

This simple action lifts the chest cavity away from the heart and the expanded lungs move the heart deeper into the body. This then allows the beam to treat the breast tissue whilst avoiding or reducing the dose to vital organs such as the heart.

Differing to more commonly used 'free-breathing' techniques, spirometry-monitored DIBH ensures the patient's 'deep breath' and heart position is consistent throughout their treatment. A mouthpiece is used and goggles are worn, which displays a simple green and red light system, to help guide the patient when to take the breath, how much breath to take in and when to release it. If at any time the patient loses control of their breath, the system automatically cuts out and the treatment stops.

Image 1: Image of display showing the green and red light system



Every patient is trained before receiving the treatment, with as many preparation visits as is required to make them feel comfortable and fully prepared for their role in the procedure.

Click on the link below to watch the video which provides an introduction to spirometry-monitored DIBH.



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## The study and its key findings

Cancer Partners UK undertook one of the largest studies of its kind comparing spirometry-monitored DIBH plans with conventional free-breathing plans in 296 patients receiving radiotherapy for left-sided breast cancer between February 2013 and September 2014.

During the planning process two CT scans were taken – one while the patient was free-breathing (FB) and one while the patient was performing a deep breath. Using these images radiation delivery plans were designed against both the free-breathing and the deep-breath scans.

This enabled a comparison of heart dose between DIBH and a FB technique, to ensure the patient benefited from the right technique for them.

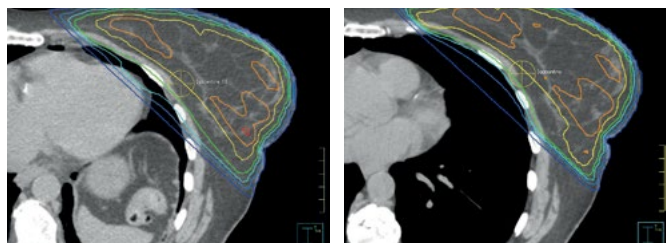


Image 2: Free-breathing, heart is in high dose region

Image 3: Full inspiration breath-hold, heart is pushed out of high dose region

Figures 1-3 summarise the results for whole heart mean, LAD coronary artery near maximum(2%) and mean doses.

Figure 1: Comparison of whole heart mean dose - DIBH vs. FB

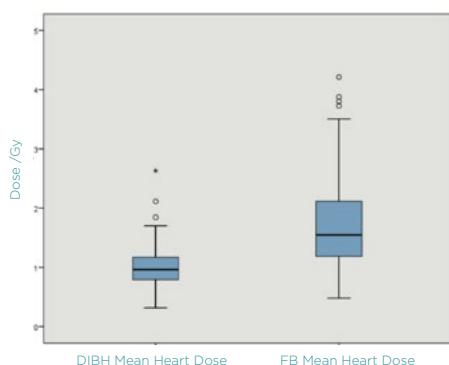


Figure 2: Comparison of LAD coronary artery near maximum(2%) dose - DIBH vs. FB

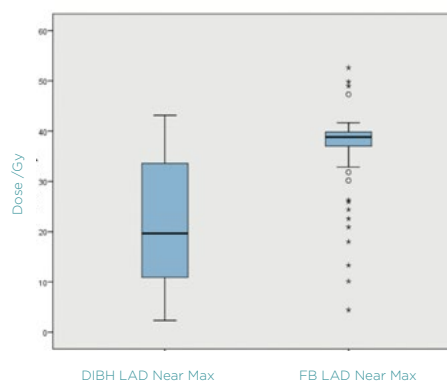
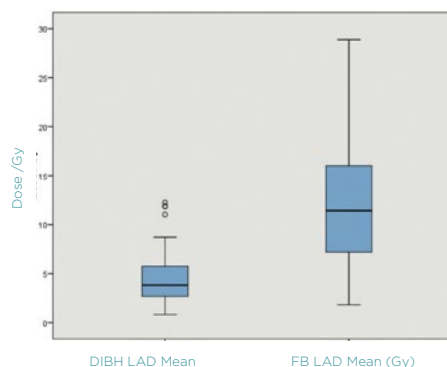


Figure 3: Comparison of LAD coronary artery mean dose - DIBH vs. FB



A statistically significant reduction in whole heart mean dose and LAD coronary artery near maximum(2%) and mean dose was demonstrated when using DIBH, see Table 1.

Table 1. Comparison of cardiac doses - DIBH vs. FB

Parameter	DIBH median (IGR)	FB median (IGR)	Median of differences (95% CI)*	Wilcoxon signed-rank test significance
Whole heart mean Dose/Gy	0.96 (0.76-1.16)	1.55 (1.10-2.00)	0.62 (0.56-0.69)	p <0.001
LAD mean dose/Gy	3.83 (2.28 - 5.38)	11.44 (6.99 - 15.89)	7.28 (5.98-8.66)	p <0.001
LAD near Max/Gy	19.66 (8.26 - 31.06)	38.81 (37.36 - 40.26)	15.11 (12.32-17.70)	p <0.001

\* Hodges-Lehmann estimate

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## Conclusion

The results of the study showed that spirometry-monitored DIBH has a significant effect in reducing the risk of cardiac damage in patients receiving left-sided breast radiotherapy<sup>[5]</sup>. DIBH should therefore be utilised for all left-sided breast treatments.

In 2012, there were 37,132<sup>[8]</sup> breast cancer patients in the UK; potentially, around half of these could have been eligible for DIBH (approximately 18,500). Based on these numbers, spirometry-monitored DIBH might have prevented as many as 11 deaths and 24 major coronary events. The benefits for DIBH are even greater in individuals who have at least one cardiac disease risk factor when treated (e.g. high blood pressure or smoking), making spirometry-monitored DIBH treatment, an even safer choice for them.

## Additional considerations when assessing patient eligibility

Some literature has raised concerns about a potential risk associated with raised blood pressure and oxygen levels observed in some small breath-hold studies. Although there is no evidence of clinical harm as a result – and the proven benefits of reducing radiation-induced heart damage strongly outweigh the theoretical risk here – patients should still be assessed to make sure they are suitable for DIBH.

Cancer Partners UK is developing protocols to ensure all patients treated with DIBH for left-sided breast cancer undergo a pre-participation cardiac assessment and have their blood pressure, heart rate and blood oxygen saturation (SpO<sub>2</sub>) levels monitored before, during and after treatment.

In all cases, the patient's personal history and physiological risk factors should also be considered when assessing a patient's eligibility for DIBH.

[www.cancerpartnersuk.org](http://www.cancerpartnersuk.org)

## DIBH adoption in the future

Spirometry-monitored DIBH is not yet widely available on the NHS. The small increase in time and expense to adopt and train for the technique may be one explanation.

All eight Cancer Partners UK centres across the UK offer DIBH to patients. After assessing for eligibility and capability, 90% of all of Cancer Partners UK's left-sided breast cancer patients have been treated with this technique.

To find out more about this study or spirometry-monitored DIBH, please contact [enquiries@cancerpartnersuk.org](mailto:enquiries@cancerpartnersuk.org) or visit [www.cancerpartnersuk.org](http://www.cancerpartnersuk.org)

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