

## The application of deep inspiration breath hold in left-sided breast radiotherapy: a balance between side effects and costs

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**Purpose:** Deep inspiration breath hold (DIBH) is an effective technique for cardiac sparing during radiotherapy for left-sided breast cancer. Cost investments and its' effect on work processes are, however, barriers to its widespread application. The aim of this study is to compare the effects of DIBH and free breathing (FB) on dosimetric and clinical results in patients, in addition to assessing the implications for the operational and financial outcomes of radiotherapy departments.

**Methods:** DIBH and FB treatment plans were created for 100 patients treated for left-sided breast cancer in a Belgian academic hospital and the average mean heart dose (MHD) was computed for both techniques.

The 10-year cardiovascular disease and cardiovascular mortality risk was calculated with the SCORE2 and SCORE2-OP risk prediction algorithms. Costs, consumed resources and work times were calculated using time-driven activity-based costing (TD-ABC). The impact of DIBH versus FB on throughput was assessed in a discrete event simulation model of the radiotherapy workflow.

**Results:** There was a significant difference between the MHD in DIBH versus FB treatment plans ( $p < 0.001$ ). On average, the MHD was 2.55 Gy lower in DIBH compared to FB (95% CI [2.25 - 2.85]). Furthermore, both the predicted 10-year cardiovascular disease as mortality risk were significantly lower in DIBH ( $p < 0.001$ ), 0.92% (95% CI [0.73% - 1.10%]) and 0.31% (95% CI [0.25% - 0.37%]) respectively.

DIBH led to a 10% (95% CI [10% - 11%]) increase in the average work time per left-sided breast cancer patient due to a longer duration of the simulation and treatment phase. As a consequence, the maximum achievable throughput decreased with 12% (95% CI [12% - 13%]). Additionally, the mean cost per left-sided breast cancer patient rose with 21% (95% CI [20% - 21%]) as a result of the required capital investment and the higher utilisation of radiotherapy treatment technicians.

**Conclusions:** Treating left-sided breast cancer patients with DIBH significantly reduces MHD, predicted 10-year cardiovascular disease risk and cardiovascular mortality risk. Although DIBH requires some costs and time investments its growing application may have important implications for the long-term cardiovascular health of breast cancer survivors.

**Keywords:** Breast cancer, Radiotherapy, Deep inspiration breath hold, Time-driven activity-based costing, Cardiovascular disease, Cardiovascular mortality?