The Active Breathing Coordinator (ABC™) for mDIBH Treatment of the Left Breast

Daria C. Comsa, PhD, MCCPM
Stronach Regional Cancer Centre, Newmarket, Canada
Radiation Oncology Department, University of Toronto

Outline
- Description of the ABC system
- ABC technique implementation at SRCC
- Clinical flow for ABC treatments
- QA and CQI program

The ABC System
- Designed and first prototype tested at William Beaumont Hospital
- An Elekta product, manufactured by Aktina Medical (ABC™ R3.0)
- Can be used with Elekta’s gating control system (Response™)
The ABC System
Main components:
- Trolley – keeps system together
- ABC Control module
- Patient respiratory system
- Patient control switch
- Laptop (control software)
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Working principle:
- The patient breaths through a snorkel;
- A spirometer measures the resulting air flow (displayed on a monitor);
- The breath hold is automatically achieved when the volume of air inhaled exceeds a preset threshold by inflating a balloon valve that stops the air flow.
Resources at the Stronach Regional Cancer Centre

- 3 Elekta Infinity linacs (Agility™ MLC);
- 1 CT simulator (Philips Brilliance Big Bore)
- Pinnacle v9.8, MosaiQ v2.62
- 33 Radiation Therapists (6 Dosimetrists)
- 4.5 FTE Medical Physicists
- ~1200 patients / year; ~50% IMRT and VMAT

Resources at the Stronach Regional Cancer Centre

Breast patients in 2015:
- ~ 500 breast and CW
- 210 left side
- 173 (76%) ABC treatments

ABC technique - clinical implementation

Interprofessional team formed to carry out the implementation tasks:
- Site visit to a centre that already used the technique
- Establish clinical work flow, QC tests, write procedures
- In-service sessions with all staff
- Dedicated linac and staff – speed up learning
- REB approved for collecting patient data and use for continuous quality improvement (CQI)
ABC technique - clinical implementation

September 2011 - September 2013

- Left breast patients simulated first in free-breathing;
- Eligible for ABC if max dose to 10 cc of heart > 50% Rx.
- All left breast patients are considered for ABC
- ~10% not eligible (age, anxiety); technique not attempted.
- ~15% do not tolerate ABC.

ABC clinical flow:

ABC Education session

ABC CT-simulation & planning YES

Breath hold for >25s NO

FB CT-simulation & planning

ABC treatment SUCCESS

NO

FB treatment

YES

Continue ABC

ABC Patient Education session

- Takes place in a dedicated room, with an ABC system available – 30 minutes
  - Explain the rationale behind using the ABC device. Ensure patient is aware that if the ABC teaching is not successful, there are other mechanisms available to treat the patient successfully.
  - Demonstrate and practice correct snorkle positioning, use of green button, practice breathhold in treatment position.
ABC Patient Education session

- Goals of education session:
  i. Ensure patient is comfortable with the process
  ii. Capture ABC values required for CT Simulation and treatment, record in R&V system.
    - Maximum Inhale Volume
    - Threshold (80% of Maximum Inhale Volume)
    - Max Breath Hold Duration
    - Max Breath Hold for Tx (2 sec less than max bh)

CT-simulation with ABC technique

- The CT-sim scan is done under breath hold.
- Free breathing TTH and Breath Hold TTH (measured from the CT scan) are documented along with standard measurements.
- Document volume of air held (VAH) (l) in the MosaiQ plan setup note.

Planning with ABC technique

- Similar to the free-breathing planning;
- At least 80% of treatment delivered through the open tangents, limit the number of small segments.
IGRT and Treatment

- 2D MV portal imaging for the 2F, 3F, 4F techniques
  - each image requires a single short breath hold.
- 3D kV CBCT for boost treatments
  - CBCT preset – 200°, 1 min acquisition, low dose
  - minimum 2 breath holds for the CBCT acquisition.

Comsa et al. 2014
Treatment time and breath-hold requirements using the ABC treatment technique:

<table>
<thead>
<tr>
<th></th>
<th>Average time required [min]</th>
<th>Average # of breath holds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setup</td>
<td>Imaging</td>
<td>Treatment</td>
</tr>
<tr>
<td>2F</td>
<td>11 ±3</td>
<td>3±1</td>
</tr>
<tr>
<td>4F</td>
<td>11±3</td>
<td>5±4</td>
</tr>
</tbody>
</table>

Treatment scheduling

<table>
<thead>
<tr>
<th></th>
<th>ABC</th>
<th>Non-ABC</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC Patient Education</td>
<td>30 min</td>
<td>--</td>
</tr>
<tr>
<td>CT-sim</td>
<td>30 min</td>
<td>30 min</td>
</tr>
</tbody>
</table>

2F
- Tx Day 1 | 30 min | 30 min |
- Day 2 + | 20 min | 15 min |

4F
- Tx Day 1 | 40 min | 30 min |
- Day 2 + | 25 min | 20 min |
QA tests for ABC

- Check system connectivity and function
- ABC Daily tests (performed by RT)
- Tests are repeated if the system is disconnected
- When used with the gating system, additional daily, monthly tests (TG 142).

QA tests for ABC

- Daily tests
  - System connectivity – system check result on ABC laptop
  - Functionality of patient control switch button
  - System calibration
    - VAH 3.0+/− 0.2L
    - Inhalation response (+ve sloped)

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[Diagram or image related to QA tests for ABC]
Continuous Quality Improvement

- ABC assists breath hold, but there is no monitoring system
- Need to ensure reproducibility of lung volume and heart position in field with breath hold

Continuous Quality Improvement

- Use CBCT data to assess inter-fraction variation of heart position in field
- Largest average change per patient was 6.2 mm.

Continuous Quality Improvement

- Even in the presence of a systematic heart shift of 6mm, the ABC technique showed superior dose reduction to the heart compared to the free-breathing plan.
Breathing traces (>10,000) were quantitatively analyzed in MATLAB to derive the excess of volume of air inhaled at treatment compared to that at planning (ΔVAH).

Most patients showed excess breath-hold (ΔVAH). As flow rate increases, excess breath hold increases.

Conclusions - ‘Tips/Hints’

- Volume of air held (VAH) at treatment vs. threshold
- Rate of inspiration influences volume of air in lung held
  - Slow = value closer to threshold
  - Fast = value larger than threshold
- Patient education has an important role in the success of the ABC technique
Acknowledgements

- Physics and therapy groups at SRCC
- Our friends at the Princess Margaret Hospital, Toronto

Thank you!
<table>
<thead>
<tr>
<th>Patient no.</th>
<th>VAIH (L)</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CT-sim</td>
<td>Treatment</td>
</tr>
<tr>
<td>Patient 1</td>
<td>1.41</td>
<td>1.5 ± 0.11</td>
</tr>
<tr>
<td>Patient 2</td>
<td>1.33</td>
<td>1.29 ± 0.07</td>
</tr>
<tr>
<td>Patient 3</td>
<td>1.86</td>
<td>1.87 ± 0.05</td>
</tr>
<tr>
<td>Patient 4</td>
<td>1.64</td>
<td>1.95 ± 0.03</td>
</tr>
<tr>
<td>Patient 5</td>
<td>1.70</td>
<td>1.67 ± 0.04</td>
</tr>
</tbody>
</table>

Standard deviations are included for treatment VAIH values.