

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

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## Outline

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



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## 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™)



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### 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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## The ABC System

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.




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### 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




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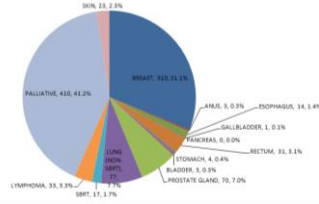
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### Resources at the Stronach Regional Cancer Centre

Care Plans Applied from April to December 2015  
(n = 996)



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




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### 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)




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### 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.



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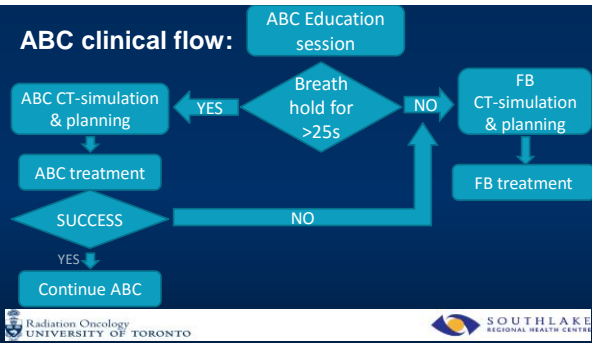
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### ABC clinical flow:



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### 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.



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## 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)

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## 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.

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## 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.

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## 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<sup>0</sup>, 1 min acquisition, low dose
  - minimum 2 breath holds for the CBCT acquisition.

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## IGRT and Treatment

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

|    | Average time required [min] |         |           |       | Average #of breath holds |
|----|-----------------------------|---------|-----------|-------|--------------------------|
|    | Setup                       | Imaging | Treatment | total |                          |
| 2F | 11 ±3                       | 3±1     | 4±2       | 18±3  | 8±3                      |
| 4F | 11±3                        | 5±4     | 5±2       | 21±5  | 11±2                     |

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## Treatment scheduling

|    |                       | ABC      | Non-ABC |
|----|-----------------------|----------|---------|
|    | ABC Patient Education | 30 min   | --      |
|    | CT-sim                | 30 min   | 30 min  |
| 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  |

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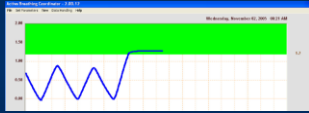
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## Continuous Quality Improvement

- 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

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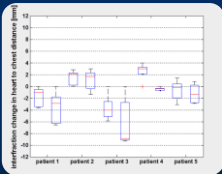
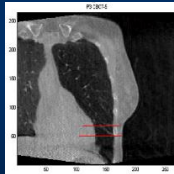
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## Continuous Quality Improvement

- Use CBCT data to assess inter-fraction variation of heart position in field



- largest average change per patient was 6.2 mm.

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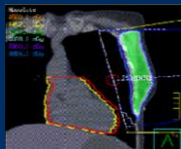
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## Continuous Quality Improvement



| Patient 3         | ABC plan | Heart shift | FB plan |
|-------------------|----------|-------------|---------|
| Max: to1cc (cGy)  | 1470     | 2858        | 4888    |
| Max: to10cc (cGy) | 360      | 1010        | 3786    |
| Mean              | 87       | 142         | 309     |
| VS                | 1%       | 4%          | 9%      |

- 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.

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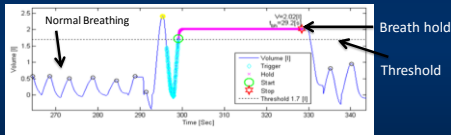
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## Continuous Quality Improvement

- 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 ( $\Delta VAH$ ).



courtesy of Dr. Douglas Moseley

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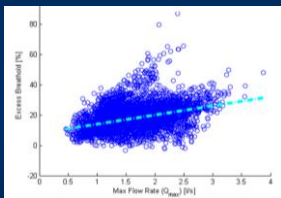
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## Continuous Quality Improvement



- Most patients showed excess breath-hold ( $\Delta VAH$ ).
- As flow rate increases, excess breath hold increases

courtesy of Dr. Douglas Moseley

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## 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

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## Acknowledgements

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

Thank you!

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**Table 3** Volume of air held (VAH) during computed tomographic simulation (CT-sim) and average VAH of all Active Breathing Coordinator treatment fractions

| Patient no. | VAH (L) |             |
|-------------|---------|-------------|
|             | CT-sim  | Treatment   |
| Patient 1   | 1.41    | 1.3 ± 0.1   |
| Patient 2   | 1.33    | 1.29 ± 0.07 |
| Patient 3   | 1.86    | 1.87 ± 0.05 |
| Patient 4   | 1.64    | 1.55 ± 0.03 |
| Patient 5   | 1.70    | 1.67 ± 0.04 |

Standard deviations are included for treatment VAH values.

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