

Pitching

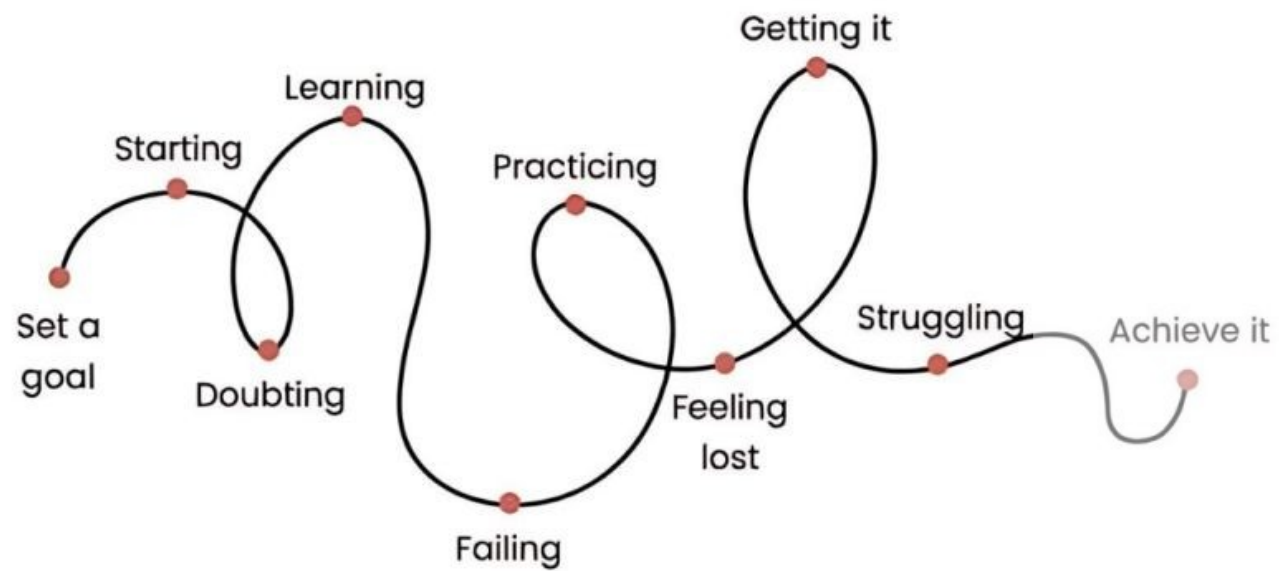
Breathing Management

Experiences & Devices

Nick West

Clinical Scientist | Northern Centre for Cancer Care | Newcastle upon Tyne Hospitals NHS Foundation Trust

International Symposium Birmingham 2026
Breathing Control for Motion Management
in Radiotherapy and Imaging



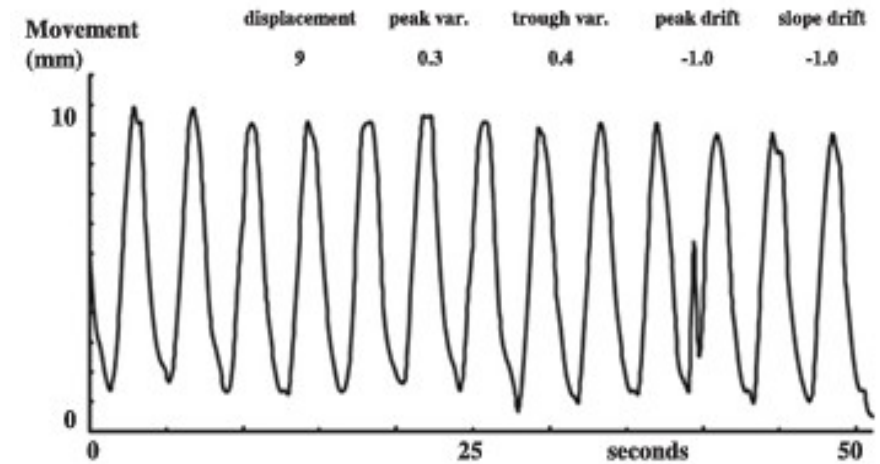
Respiratory motion is a challenge and can be a barrier to thoracic and abdominal SABR

Backstory



Reducing the within-patient variability of breathing for radiotherapy delivery in conscious, unседated cancer patients using a mechanical ventilator

^{1,2}MICHAEL J PARKES, MA, DPhil, FHEA, ³STUART GREEN, BSc, PhD, ⁴ANDREA M STEVENS, FRCR, ³SOPHIA PARVEEN, BSc, ³REBECCA STEPHENS, BSc and ^{1,5}THOMAS H CLUTTON-BROCK, MB BChB, MRCP, FRCA

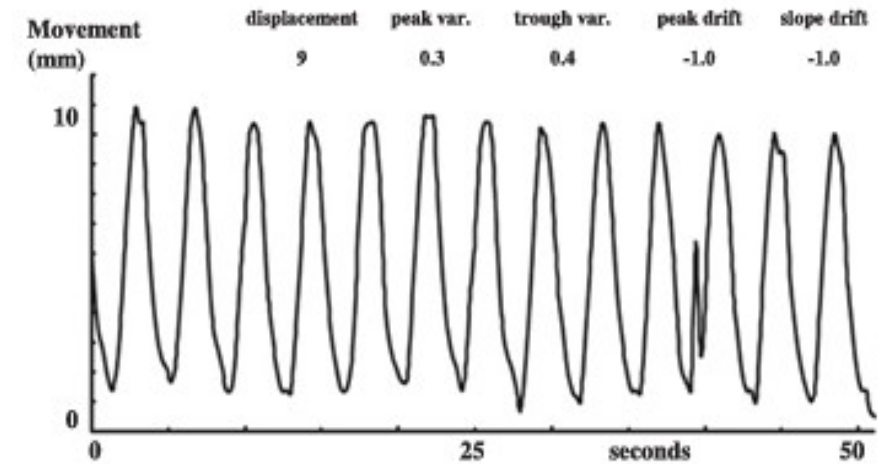


Backstory

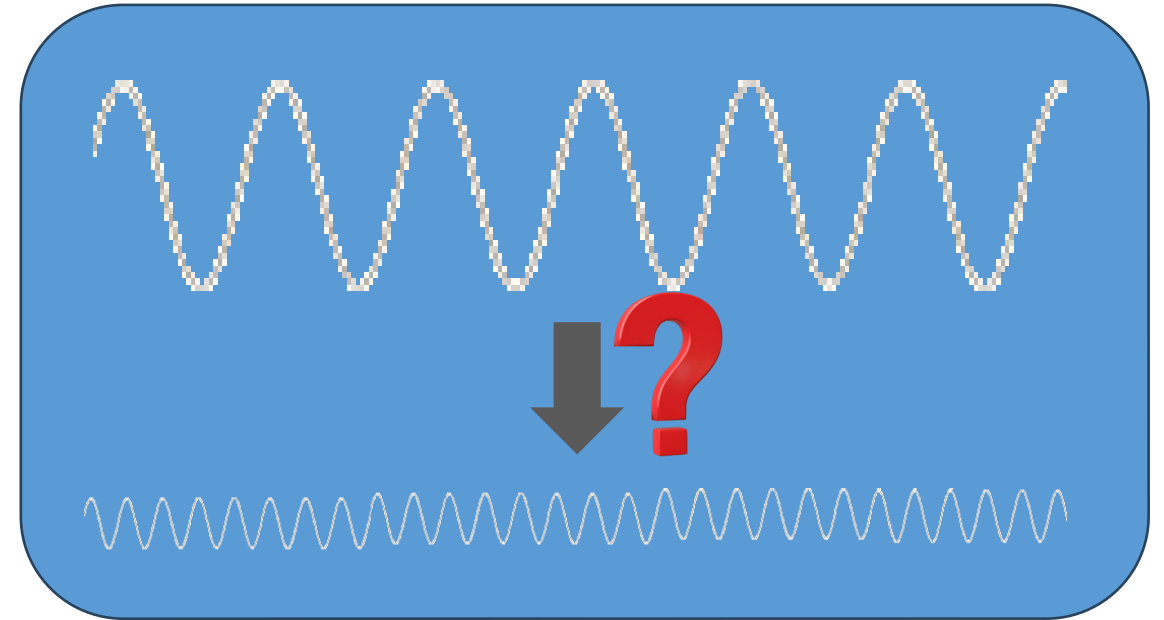


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Backstory



Ventilator requirements

Yes

- Make breathing shallow
- Make breathing regular
- Reduce thoracic and diaphragm motion
- Do repeatably for imaging & treatment

Not

- Maximise oxygenation
- Recruit collapsed lung
- Treat lung disease

Ventilator options



The Newcastle upon Tyne Hospitals
NHS Foundation Trust



HAMILTON MEDICAL

C1



T1



MR1



T1-M



Use	Road?	Air?	MRI conditional	Battery life	Hot-swap battery?	Rugged casing	Military standard	Extreme temp / altitude	Water / dust
ICU / ED / ward	✗	✗	✗	✓	✗	✗	✗	✗	✗
Civilian transport	✓	✓	✗	✓ (~9h)	✓	✓	✗	☐ Moderate	☐ Splash
MRI	✓	✗	✓ (<50mT)	✓ (>9h)	✓	✓	✗	☐ Controlled	✗
Military	✓	✓	✗	✓ (>9h)	✓	✓ (Heavy duty)	✓ MIL-STD-8	✓ -15-50 °C / 25,000 ft	✓ IP54

HAMILTON MEDICAL

C1



T1



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T1-M



Use	Road?	Air?	MRI conditional	Battery life	Hot-swap battery?	Rugged casing	Military standard	Extreme temp / altitude	Water / dust
ICU / ED / ward	✗	✗	✗	✓	✗	✗	✗	✗	✗
Civilian transport	✓	✓	✗	✓ (~9h)	✓	✓	✗	☐ Moderate	☐ Splash
MRI	If the ventilator... Stays by the bedside Rides in helicopters						You want... C1 T1		
Military	Goes into MRI Goes into combat conditions						MR1 T1 Military		
								25,000 ft	✓ IP54

All work the same (turbine compressed air) & suitable for ICU, bedside, ... for adults, paediatrics and neonates.
Differences are only in certification in engineering.

Which ventilator?

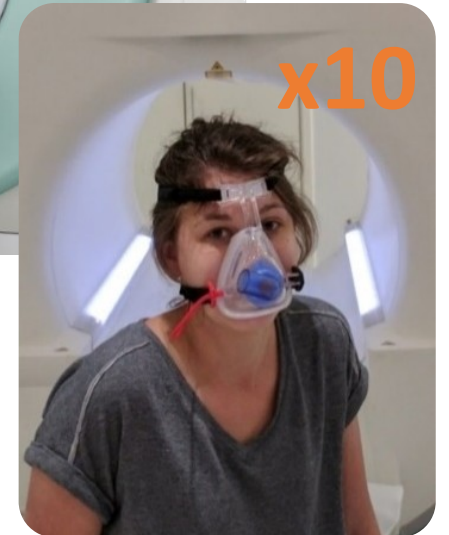
HAMILTON
MEDICAL



C1

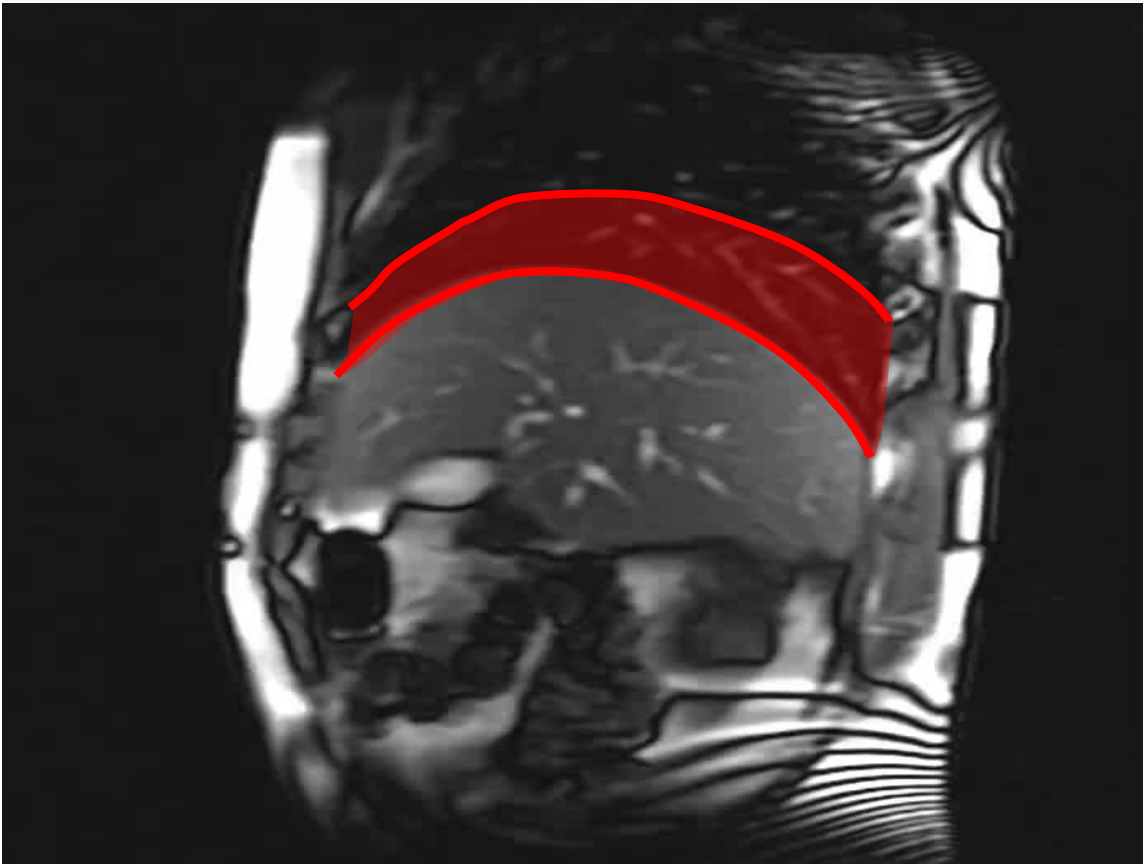


HAMILTON MEDICAL

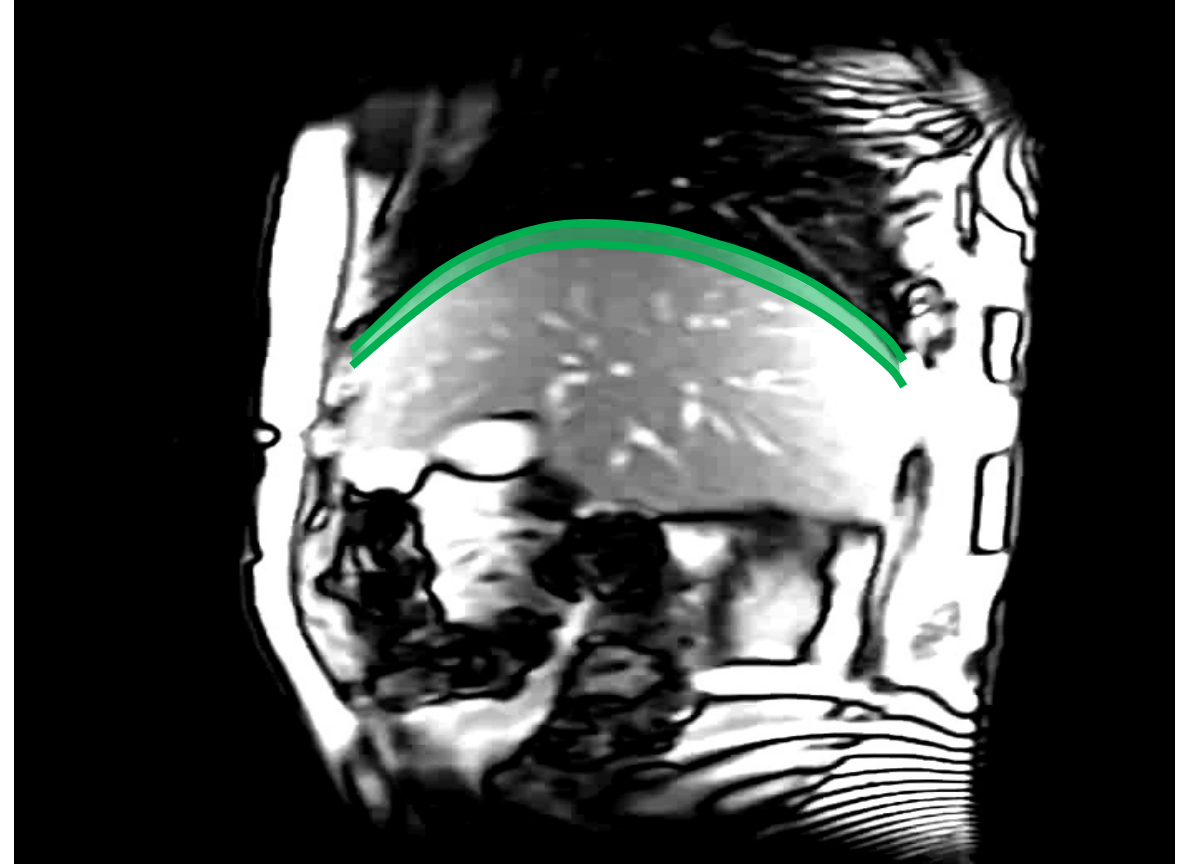


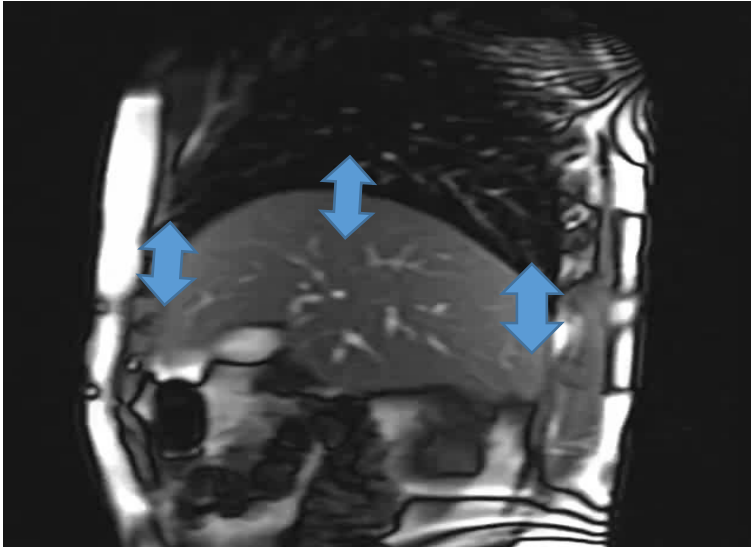
E.g. Sagittal 2D MR Cine

Normal Breathing



Ventilated @ 20 brpm

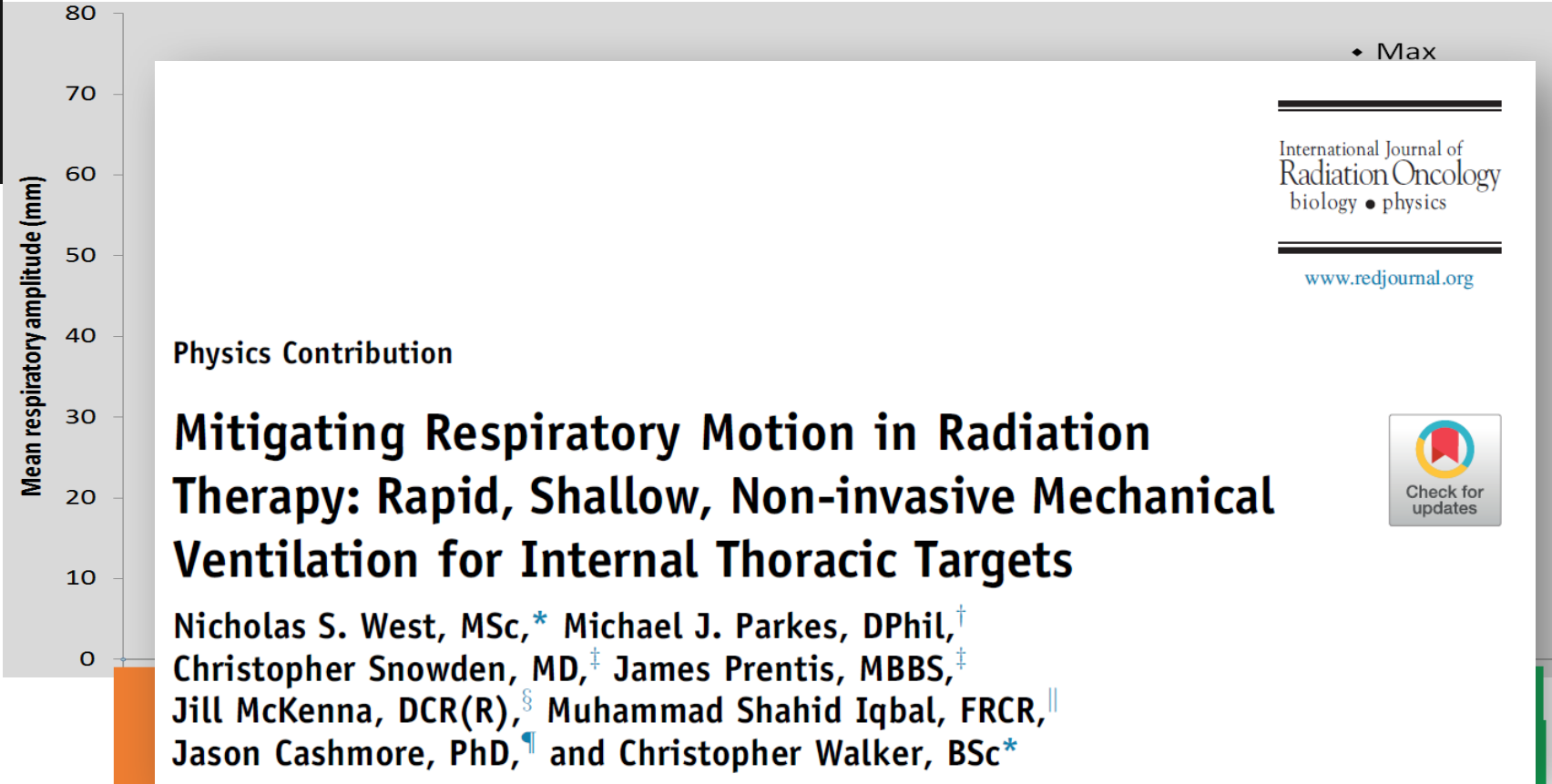




Reproducibility: average sagittal motion

Session #1

Session #2



Hamilton C1 T1 MR1 T1-M

Pros

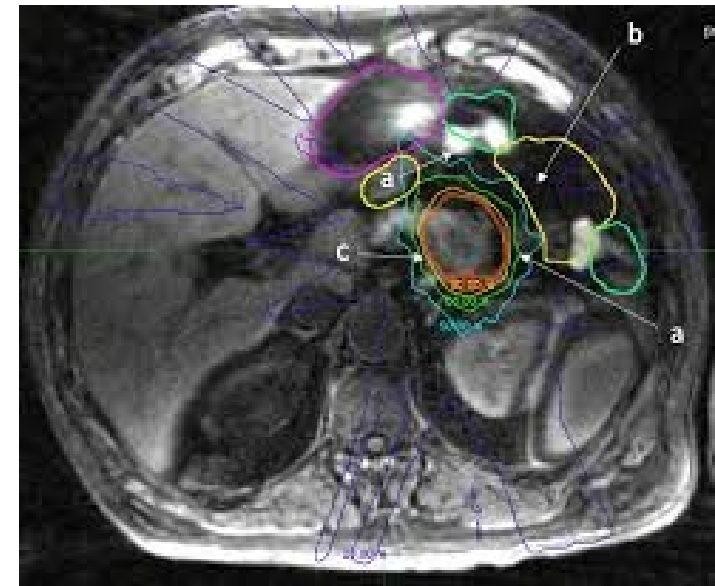
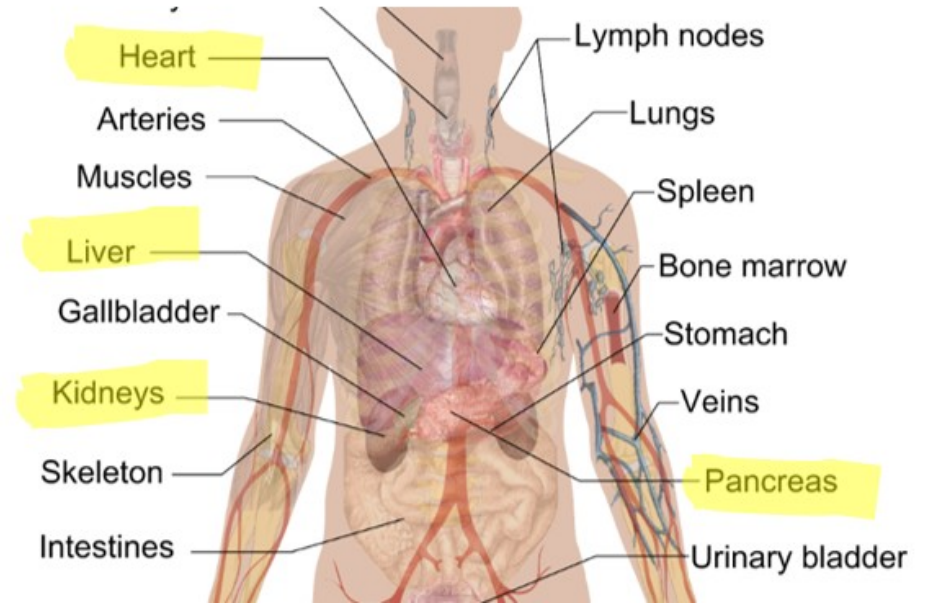
- Intuitive
- Very versatile
 - Wide range of frequencies
 - Wide range of inflation volumes
 - Gas mixing
- Traces
 - Inflation pressure
 - Volume
 - pCO₂
 - SpO₂
- MR1 is MR conditional

Cons

- Too complex for our needs?
- Too versatile?
- Expensive
- Simple modes not programmable
- Limited vendor engagement
- Terminology differs between countries

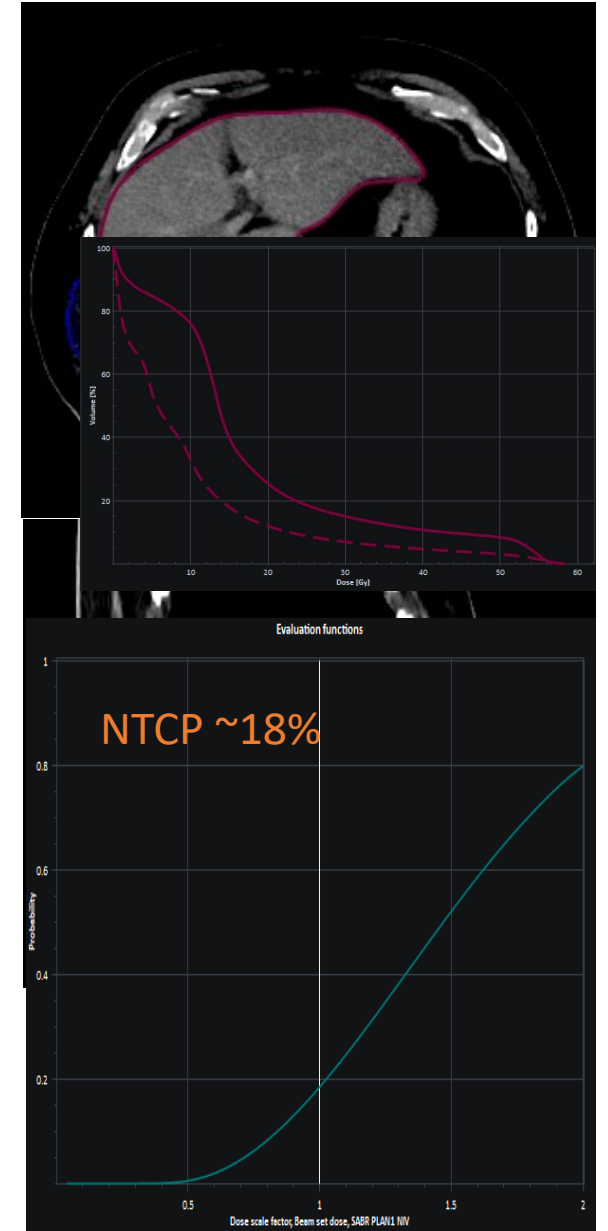
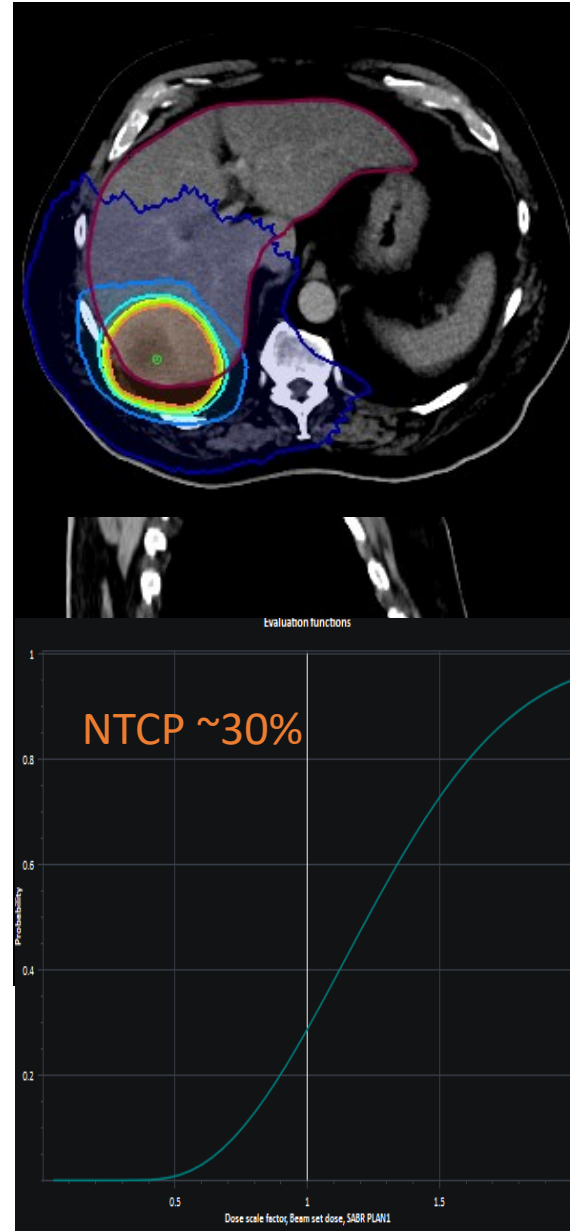
What's next?

- We struggle with upper abdominal targets



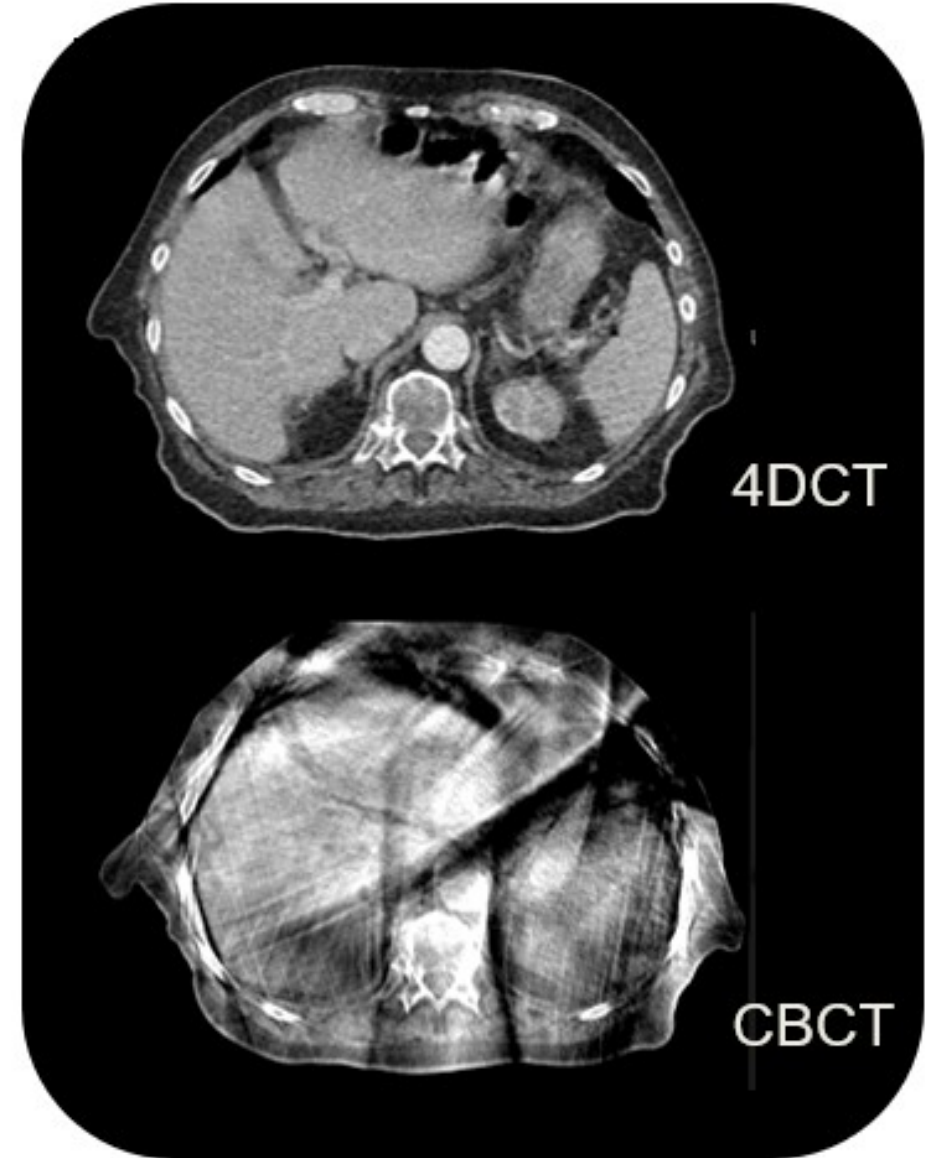
What's next?

- We struggle with upper abdominal targets
- Reducing respiratory motion will increase access to SABR



What's next?

- We struggle with upper abdominal targets
- Reducing respiratory motion will increase access to SABR
- Increase the ability to treat



Respiratory motion is a challenge and can be a barrier to thoracic and abdominal SABR

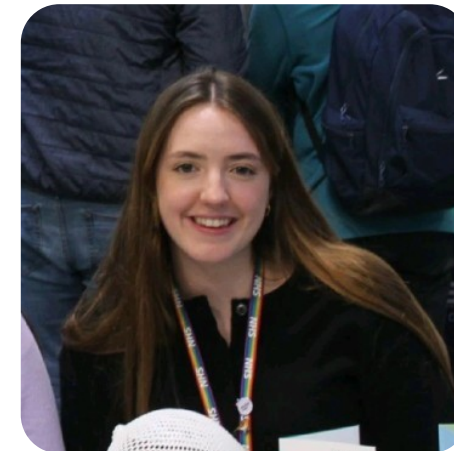
Are we using it routinely for all patients?

Overcoming barriers

ICU equipment

Only anaesthetists

Overseen & assessed by
physicians



Overcoming barriers

ICU equipment

Only anaesthetists

Overseen & assessed by physicians

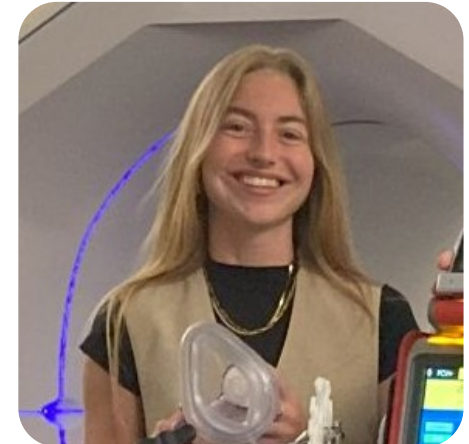
Oxygen is a drug!

Safety /
governance
issues?

Ambient air is feasible

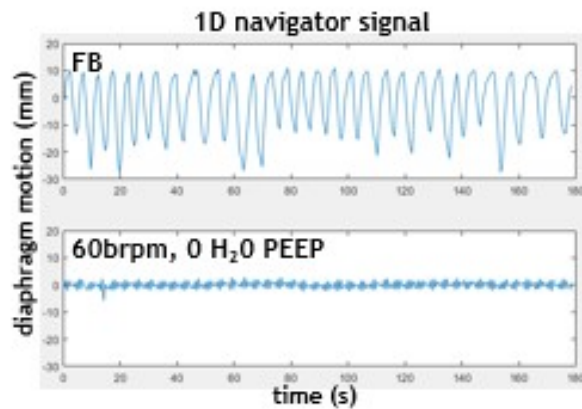
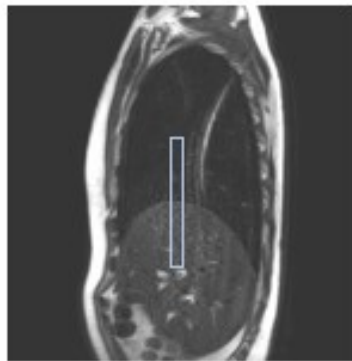
Oxygen & linacs!

Increased arc risk

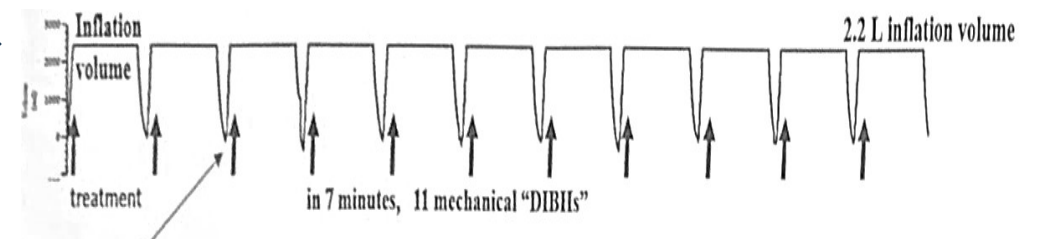


Future aspiration => NIV for problematic patients

Tuning the settings (frequency, amplitude, PEEP, ...) to the needs of the treatment (and increasingly imaging)



Slow deep mechanical ventilation at ~2 brpm



Future aspiration => NIMV for problematic patients

Tuning the settings (frequency, amplitude, PEEP, ...) to the needs of the treatment (and increasingly imaging)

Future aspiration => NIMV for problematic patients

Tuning the settings (frequency, amplitude, PEEP, ...) to the needs of the treatment (and increasingly imaging)



