

Non-invasive mechanical ventilation: overview

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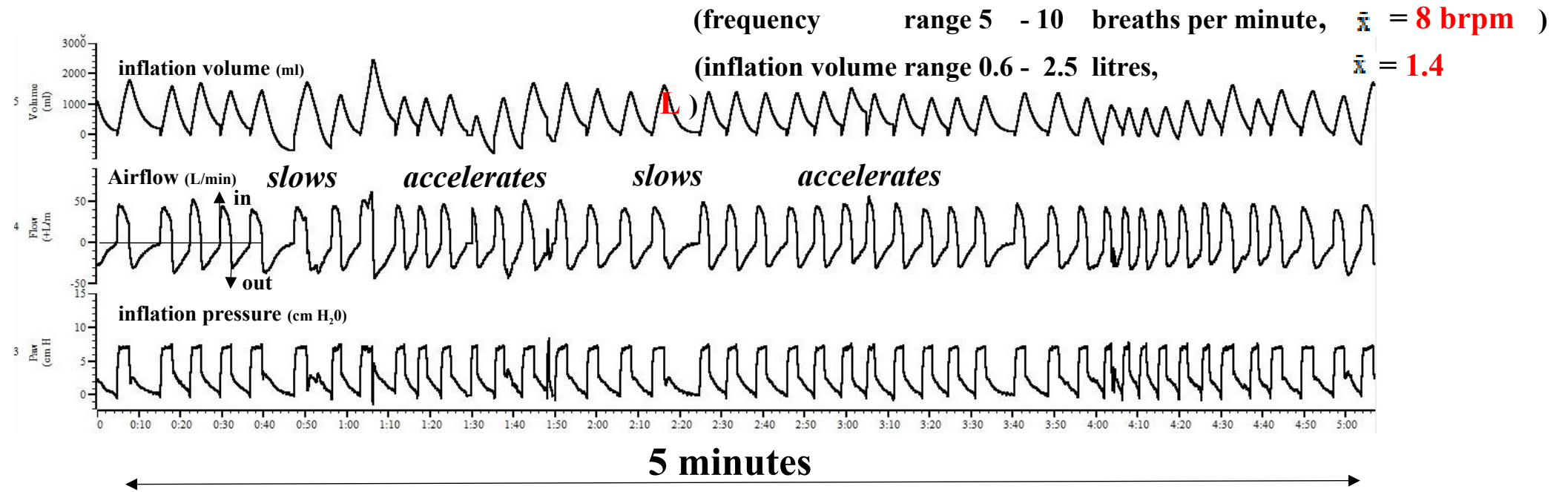


Birmingham 16-17 April 2026

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

The big problem in radiotherapy- spontaneous breathing is always irregular

5 minutes of normal, spontaneous breathing in a seated resting subject

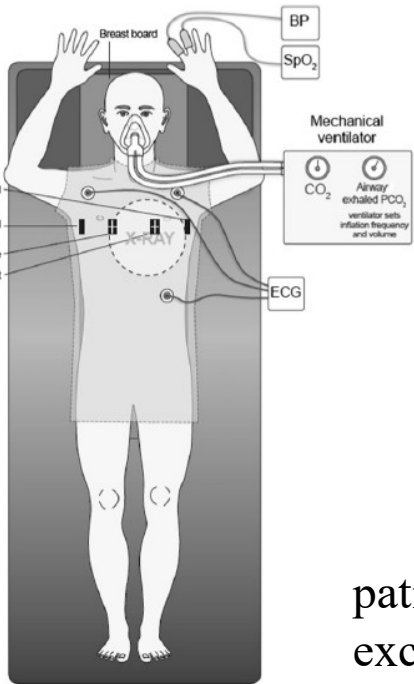


Everyone breathes like this!

Mechanical ventilation in conscious, unmedicated patients delivers completely regular ventilation.

Using a non-invasive mechanical ventilator for patients.

Patient connected to a ventilator via facemask & filter,
Patient initially in complete control of the ventilator =still breathing **spontaneously**.



Switch ventilator to **positive pressure** ventilation
at same frequency and volume.

Ventilator now completely takes over (within ~3 breaths)
(patients no longer use their diaphragm).

Non-invasively monitor continuously
inflation pressure, PCO_2 , SpO_2

(no longer necessary to monitor ECG or BP).
patient does nothing
except listening to music



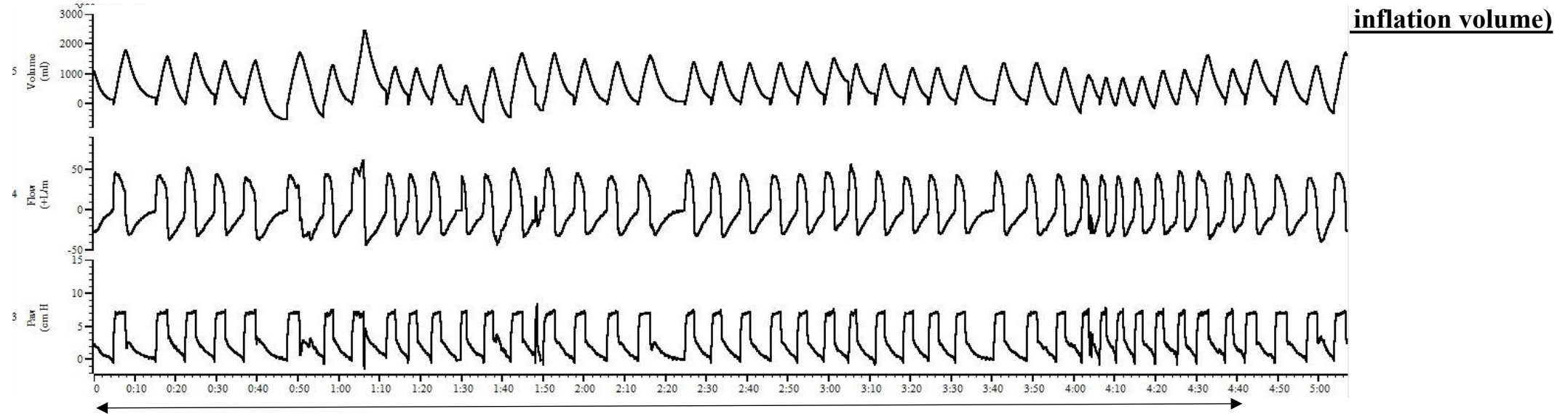
**Can mechanically ventilate anywhere between
slow deep (< 2 brpm @ 1 L) to**

rapid shallow (60 brpm @ ~ 0.3 L)

Mechanical ventilation at the patient's own frequency for up to 1 hour.

5 minutes of normal, spontaneous breathing in a seated resting subject

Regulariz



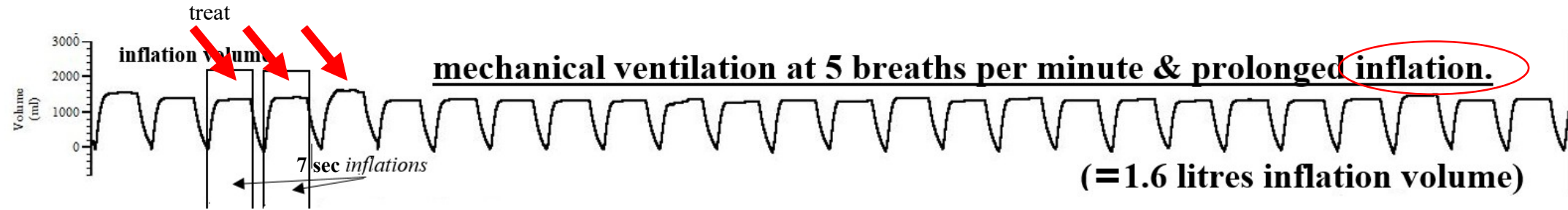
minimal settings adjustment required

Mechanical ventilation is now a well published technique in Radiotherapy

patient does nothing
except listening to music

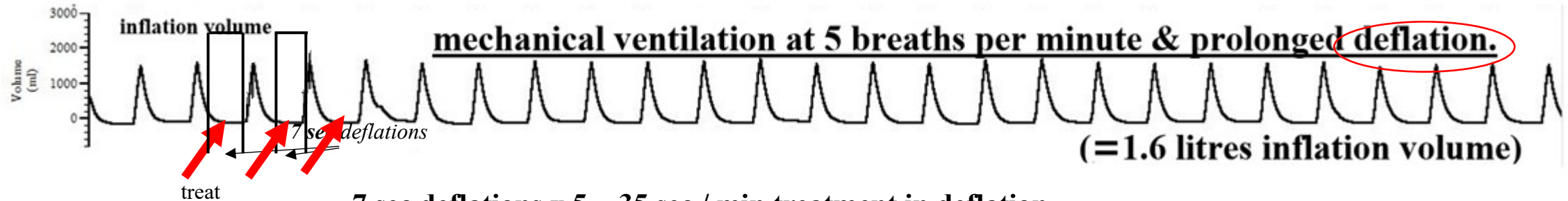
- Parkes (2014) [doi: 10.1259/bjr.20140454](https://doi.org/10.1259/bjr.20140454)
Parkes2016b <http://dx.doi.org/10.1259/bjr.20150741>
West & Parkes.... 2019 <https://doi.org/10.1016/j.ijrobp.2018.11.040>
Van Ooteghem 2019a. <https://doi.org/10.1016/j.radonc.2018.12.026>
Van Van Ooteghem 2019b <https://doi.org/10.1016/j.radonc.2019.09.021>
Parkes 2019a <https://doi.org/10.1016/j.radonc.2019.06.014>
Parkes 2021 [10.1259/bjr.20210079](https://doi.org/10.1259/bjr.20210079)
Vander Veken, Van Ooteghem2023. [183.10.1016/j.radonc.2023.109598](https://doi.org/10.1016/j.radonc.2023.109598)
van Kesteren Parkes...2022 <https://doi.org/10.1186/s13014-022-02068-5>
Veldman Parkes...2023 DOI:10.1002/mp.16403
Veldman, Parkes2023 <https://doi.org/10.1016/j.jcadva.2024.100059>
Veldman.... Parkes 2025 <https://doi.org/10.1016/j.adro.2024.101679>

Can immediately switch to slow mechanical ventilation at 5 brpm to optimize gating



7 sec x 5 brpm = 35 sec /min of treatment time in inflation every minute, for many minutes.

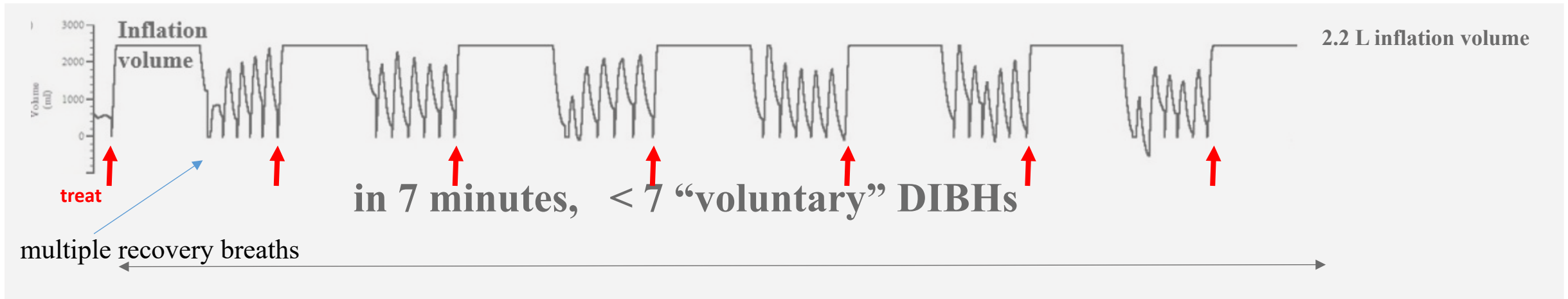
Or



7 sec deflations x 5 = 35 sec / min treatment in deflation....

Treatment planners can now create ...a personalized ventilation treatment plan.

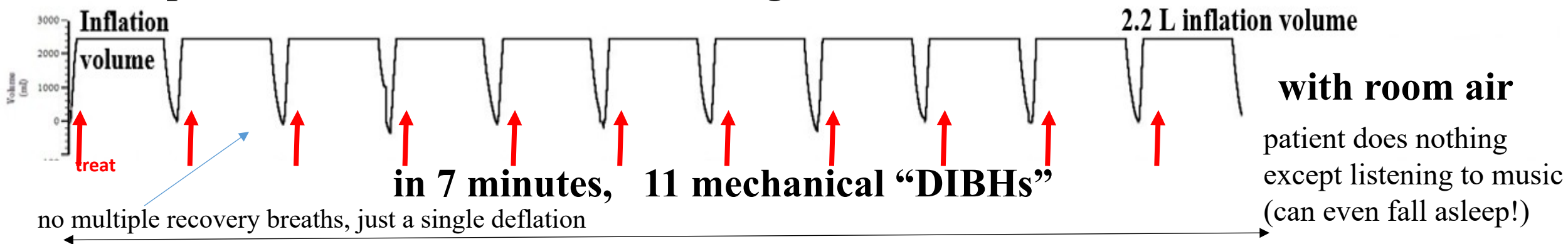
Current clinical practice is “voluntary” DIBHs ~2 brpm, each with multiple recovery breaths.



A mechanical ventilator delivers slow deep mechanical ventilation at < 2 brpm

Vander Veken L, Van Ooteghem (2023) [183.10.1016/j.radonc.2023.109598](https://doi.org/10.1016/j.radonc.2023.109598)

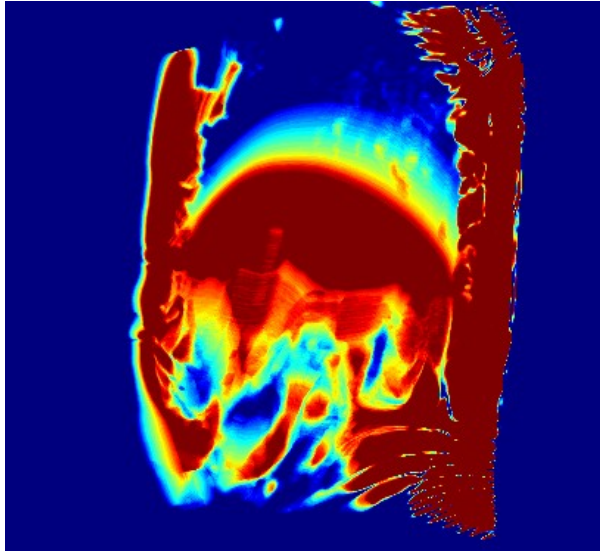
= multiple mechanical “DIBHs” with a single deflation after each inflation.



Time to replace the DIBH technique with mechanical ventilation at < 2 brpm.

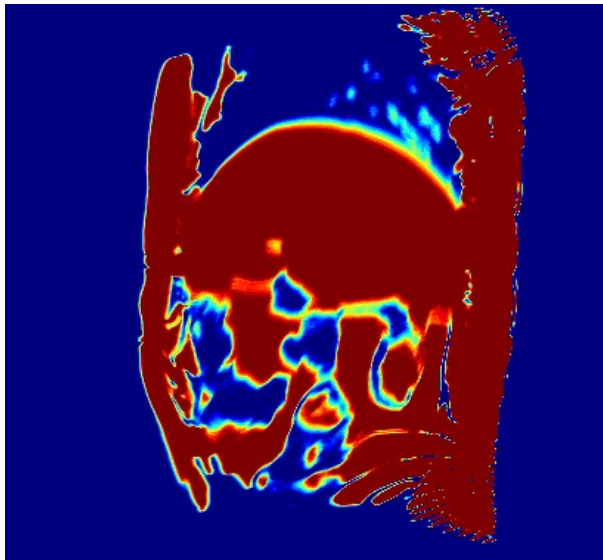
Rapid shallow (20-25 brpm) mechanical ventilation to reduce rhythmic inflation during radiotherapy

West, Parkes *et al.*, 2018 Red Journal. doi.org/10.1016/j.ijrobp.2018.11.040



25 brpm

50 brpm



60 brpm

(400 brpm)

Veldman et al., (2024)

Rapid non-invasive mechanical ventilation appears superior to non-invasive high-frequency jet ventilation in reducing respiratory motion for radiotherapy

<https://doi.org/10.1016/j.jcadva.2024.100059>

Final requirements for mechanical ventilation

A friendly anaesthetist to smooth over the medical politics.

RTTs willing to be trained to deliver all this mechanical ventilation

We are always happy to offer a Teams talk or to visit you

(AUMC now has an RTT certification and training programme).

For the future, we need:-

- ambitious younger oncologists to lead it**
- More involvement of treatment planners to optimize the particular patient's & their tumour's mechanical ventilation regime**

