

Is Supplementary Oxygen Required for Non-invasive Ventilation for Radiotherapy Applications?

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NHS Foundation Trust



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University



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Why is this study important?

From the literature...

Mitigating Respiratory Motion in Radiation Therapy: Rapid, Shallow, Non-invasive Mechanical Ventilation for Internal Thoracic Targets

Nicholas S. West, MSc,^{*} Michael J. Parkes, DPhil,[†] Christopher Snowden, MD,[‡] James Prentis, MBBS,[‡] Jill McKenna, DCR(R),[§] Muhammad Shahid Iqbal, FRCR,^{||} Jason Cashmore, PhD,[¶] and Christopher Walker, BSc^{*}

<
40%
O₂

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

21%
O₂

Johannes K. Veldman MS^{a b}  , Michael J. Parkes PhD^{a b}  , Markus F. Stevens MD, PhD^c  , Kaylee M.L. van Duren MS^{a b}, Zdenko van Kesteren PhD^{a b}  , Joost G. van den Aardweg MD, PhD^d  , Joost van Schuppen MD^e  , Geertjan van Tienhoven MD, PhD^{a b}  , Arjan Bel PhD^{a b}  , Irma W.E.M. van Dijk PhD^{a b}  

Mechanically assisted non-invasive ventilation for liver SABR: Improve CBCT, treat more accurately

Julien Pierrard  ^{a,b} · Nicolas Audag^{c,d} · Christel Abdel Massih^b · ... · Aniko Wale Etume^b · Lamyae Zouheir^b · Geneviève Van Ooteghem^{a,b} ... Show more

60%
O₂

Article | [Open access](#) | Published: 30 December 2022

Non-invasive high frequency oscillatory ventilation inhibiting respiratory motion in healthy volunteers

Yanshan Zhang, Xiaojun Li, Yihe Zhang , Yancheng Ye , Yee-Min Jen, Xin Pan, Xiaowei Li, Tianyan Qin, Pengqing Li, Caixia Lv, Ying Qi, Xin Wang, Yuling Yang & Tong Ma

100%
O₂

Pros & Cons of Supplementary Oxygen

Supplementary oxygen

Advantages

- ✔ Maintains high blood oxygen saturation
- ✔ Extends breath-hold duration

Disadvantages

- ✘ Classified as a drug
- ✘ Formal prescription needed
- ✘ Access to oxygen supply
- ✘ More complex ventilator
- ✘ Contraindications in certain patient groups:
 - Severe COPD
 - A history of Bleomycin
 - A history of Amiodarone

Ambient air

Advantages

- ✔ No supplementary oxygen required
- ✔ No contraindications
- ✔ No formal prescription required
- ✔ Facilitates use of simpler, cheaper ventilator

Disadvantages

- ✘ No formal research completed to prove that ambient air is as safe as 60% O₂ at these ventilation frequencies

Therefore our aim...

**Is Supplementary Oxygen
Required for Non-invasive
Ventilation for Radiotherapy
Applications?**



Multi-centre collaboration



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Locatie AMC, Amsterdam,
Netherlands



Newcastle University

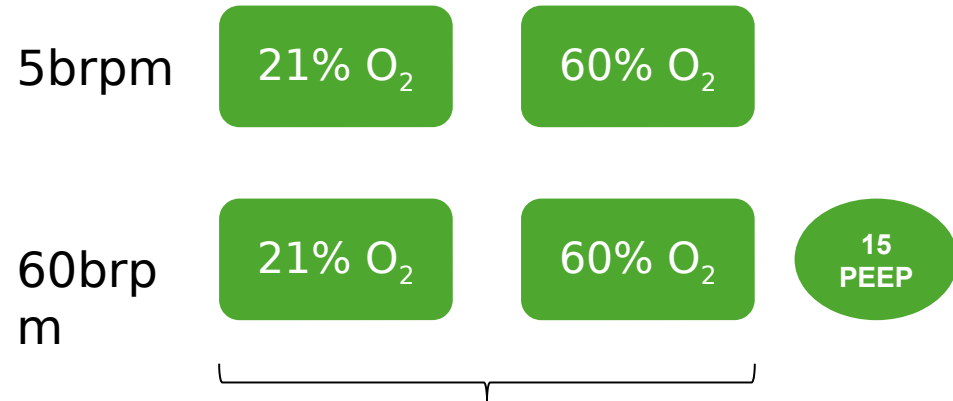
Newcastle upon Tyne,
United Kingdom



Multi-centre collaboration

Amsterdam UMC

10 healthy volunteers



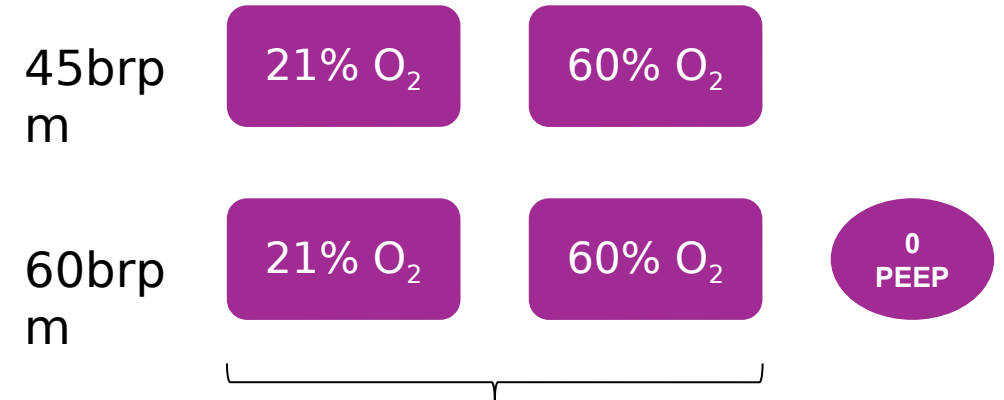
Session 1: 15 minutes at each setting

Session 2: 10 minutes

Order of O₂ within a session randomly determined

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8 healthy volunteers



Session 1: 10 minutes at each setting

Order of O₂ within a session randomly determined

Methods

Measurements

Sentec sensor & monitor

Transcutaneous
 CO_2

Pulse oximeter

Heart rate
(HR)

Partial
pressure of
oxygen (SpO_2)



Capnography

End tidal CO_2^*

**inaccurate for breathing rates > ~20brpm*

Volunteer Questionnaire

Participant Name:

1. I was comfortable whilst being ventilated

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

2. I felt a desire to breathe over the ventilator

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

3. My mouth felt dry during ventilation

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

4. I felt as though I was receiving enough oxygen during ventilation

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

Any comments?

03

Results

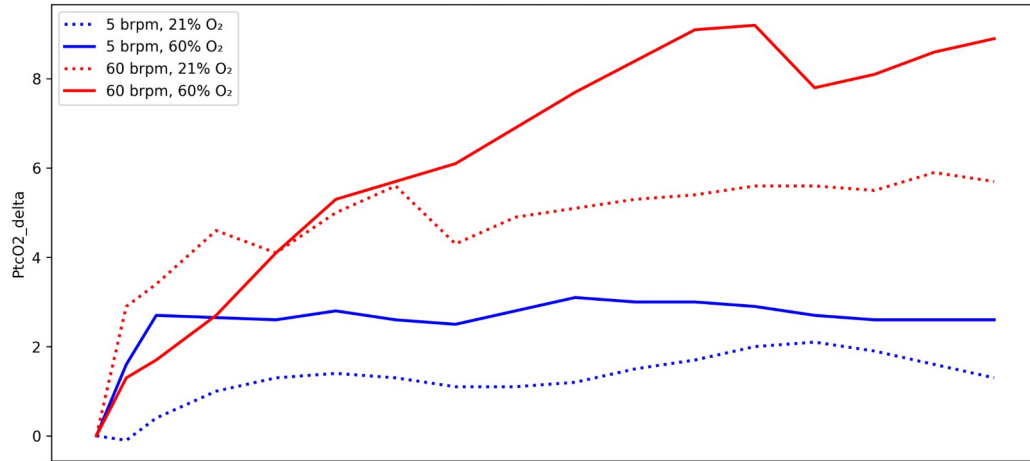


Results

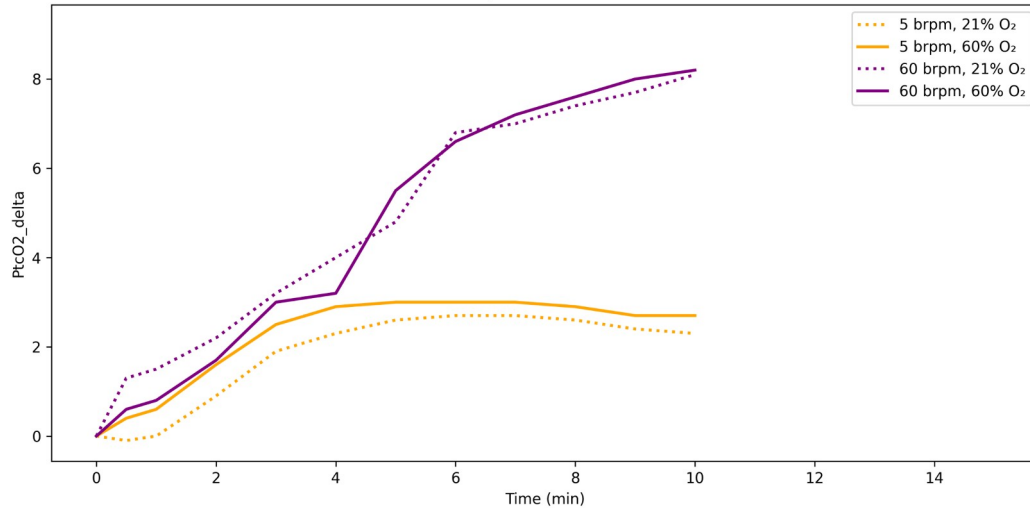
Changes from Baseline

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Participant 3 — Session 1

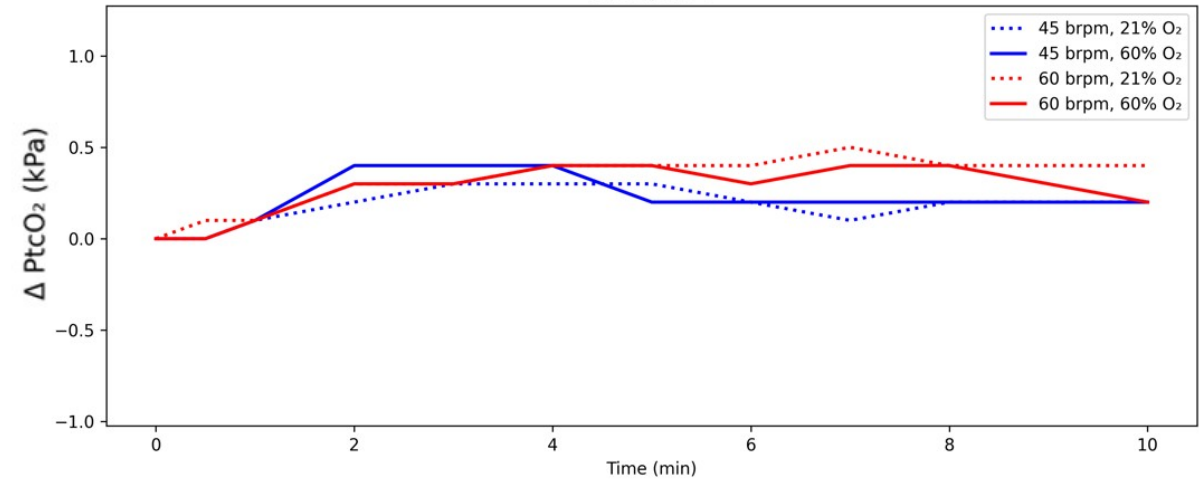


Participant 3 — Session 2



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Participant 8



e.g. Change in PtcCO₂ during session

Significance of Results

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Significant if $p < 0.05$

Parameter	p value			
	Session 1		Session 2	
	5brpm	60brpm	5brpm	60brpm
HR mean	0.3	0.05	0.2	0.4
HR range	0.3	0.9	0.08	0.7
SpO2 mean	0.02	0.002	0.02	0.01
SpO2 range	0.3	0.2	1	0.04
PtcCO2 mean	1	0.8	0.2	0.06
PtcCO2 range	0.6	0.3	1	0.1

Parameter	p value	
	45brpm	60brpm
HR mean	0.1	0.02
HR range	0.6	1
SpO2 mean	0.02	0.03
SpO2 range	1	0.6
PtcCO2 mean	0.8	0.1
PtcCO2 range	0.2	0.5

Significant differences:

- SpO2 mean (for both frequencies)
- HR mean (for 60brpm)
- SpO2 range (60 brpm in 1 session)

Significant differences:

- SpO2 mean (for both frequencies)
- HR mean (for 60brpm)

Participant Comfort

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Overall comfort:

- 60brpm 21% O₂ - 3.5
 - 60brpm 60% O₂ - 3.3
- Session 1
- 5brpm 21% O₂ - 4.6
 - 5brpm 60% O₂ - 4.5

Overall comfort:

- 60brpm 21% O₂ - 4.1
 - 60brpm 60% O₂ - 3.8
- Session 2
- 5brpm 21% O₂ - 4.8
 - 5brpm 60% O₂ - 4.6

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Mean time tolerated:

- 45brpm 21% O₂ - 10 min
- 45brpm 60% O₂ - 10 min

- 60brpm 21% O₂ - 9 min
- 60brpm 60% O₂ - 8.7 min

1/8 participants could not synchronise sufficiently with ventilation for data acquisition

Results

SpO₂ mean/range

Median value for 21% across all breathing rates=99%
Median value for 60% across all breathing rates=100%

Only 2 measurements across all sessions & patients went below 94% saturation (93% and 91%).

PtcCO₂ mean/range

There was no significant differences between mean/range PtcCO₂ at any breathing frequencies.

Discussion

Mean HR

In both centres mean HR was significantly higher at 21% O₂ than 60% O₂.

Over both studies the min HR was 41 and the max HR was 101.

Results outline

SpO₂ mean significantly different (for all breathing frequencies)
HR mean significantly different (for 60brpm)
SpO₂ range significantly different (60brpm in 1 session)

The data indicates that with both ambient air and supplemental oxygen, for up to 15 minutes, the healthy volunteer is being adequately ventilated.

Therefore, supplementary oxygen is not required for non-invasive ventilation for radiotherapy purposes*

*Supplementary oxygen has been shown to be useful to extend the lengths of NIV-assisted breath holds. This was outside the scope of this study.

Results outline

SpO₂ mean significantly different (for all breathing frequencies)

HR mean significantly different (for 60brpm)

SpO₂ range significantly different (60brpm in 1 session)

Acknowledgements

Tabi Cox^{1,2}, Sara Chapman¹, Pete E. Thelwall², Benjamin Pippard^{1,2}, Irma W.E.M. van Dijk^{3,4}, Myrthe Bosse^{3,4}, Michael J. Parkes^{3,4}, Thomas Weststrate^{3,4}, Arjan Bel^{3,4}, Nick S. West^{1,2}

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