Speaking valves in mechanically ventilated ICU patients – improved lung recruitment and improved patient success with communication.

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Research team

- Prof John Fraser
- Dr Petrea Cornwell
- Mr Lawrence Caruana
- Mr Kimble Dunster
- Dr Chris Anstey
Conflict of interest / Declarations

• Research support from:
  - NHMRC
  - TPCH Foundation
  - MN AH research collaborative

• Travel support from Passy Muir Inc to attend conferences in 2015
Background

• Mechanically ventilated patients often voiceless

• Less sedatives, more awake hours

• Patients like to have a say

• Communication difficulties one of the main frustrations for patients - withdrawal, depression, lack of motivation, poor sleep, increased anxiety and stress (Carroll 2007; Casbolt 2002; Hafsteindottir 1996; Leder 1990; Heffner 2005)

• Verbal communication is rated as the only means of highly successful communication (Lohmeier 2003)
What is a SV?

One-way valve that can be used on a TT to redirect expiratory airflow through the glottis
Recruitment Manoeuvres

British Journal of Anaesthesia 1993; 71: 788-795

Effect of a protective-ventilation strategy on respiratory distress syndrome.

The New England Journal of Medicine

Prevention of Endotracheal Suctioning-induced Alveolar Derecruitment in Acute Lung Injury

Salvatore M. Maggiore, François Lellouche, Jérôme Pigeot, Solenne Taille, Nicolas Deye, Xavier Durrmeyer, Jean-Christophe Richard, Jordi Mancebo, Françoise Lemaire, and Laurent Brochard


Dynamics of re-expansion of atelectasis during general anaesthesia.


A randomised controlled trial of an open lung strategy with staircase recruitment, titrated PEEP and targeted low airway pressures in patients with acute respiratory distress syndrome

Carol L Hodgson1,2,5, David V Tuxen1, Andrew R Davies1,2, Michael J Bailey1,2, Alisa M Higgins2, Anne E Holland3,5, Jenny L Keating4, David V Pilcher1, Andrew J Westbrook2, David J Cooper1,2 and Alistair D Nicholl1,2

Effects of alveolar recruitment maneuvers on clinical outcomes in patients with acute respiratory distress syndrome: a systematic review and meta-analysis

Pietro Caironi, Mauro Panigada, Chiara Gamberoni, Mauro Panigada, Chiara Gamberoni

Critical Care Research Group
Electrical Impedance Tomography - EIT

Current injections at each of 16 positions

208 Potentials / Image
(16 x 13 Potentials)
CT and EIT
Aims

To investigate the effect of SV on:

- EELI
- ventilation distribution
- Abdo:chest ratio on breathing as an indicator of diaphragm activity
- clinical bedside respiratory markers
- patient success with communication
Equipment - EIT
Respiratory Inductance Plethysmography - RIP
Procedure

Baseline ventilation
15min

SV
30min
(PEEP ↓ by 5)

Baseline ventilation
15min
Participant data

20 participants, 50% female

Mean age $60.4 \pm 14.9$

Admission for: cardiac Sx (13), resp. failure (5), GI Sx (1)

85% percutaneous traches

4.85 days from TT to SV

Recruited on average 2.5 days into SV use
10 x PSV
10 x HFTP
Electrical Impedance Tomography (EIT)

No SV                      SV insitu
Initial EIT and RIP data

- Significantly increased end-expiratory lung volumes during and post 30min of SV

Does this indicate **recruitment** or **hyperinflation** in some areas of the lung?
## Results

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>PMSV</th>
<th>PMSV-T</th>
<th>Post PMSV</th>
</tr>
</thead>
<tbody>
<tr>
<td>EELI left</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean (SE)</td>
<td>586 (12.8)</td>
<td>565 (15.0),</td>
<td>766 (13.8),</td>
<td>1093 (19.8),</td>
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<tr>
<td></td>
<td></td>
<td>p=0.28 (#)</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
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<tr>
<td>EELI right</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean (SE)</td>
<td>585 (14.6)</td>
<td>702 (19.7),</td>
<td>1226 (20.9),</td>
<td>1526 (24.3),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
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<tr>
<td>EELI ventral</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean (SE)</td>
<td>532 (17.5)</td>
<td>705 (23.1),</td>
<td>1054 (22.5),</td>
<td>1427 (31.2),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>EELI dorsal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean (SE)</td>
<td>639 (12.4)</td>
<td>561 (15.3),</td>
<td>938 (16.6),</td>
<td>1192 (11.9),</td>
</tr>
<tr>
<td></td>
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<td>p=0.01 (#)</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
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</tbody>
</table>

Sutt et al 2017 JoCC
Tidal Variation

Sutt et al 2017 JoCC
EITdiag – new data analysis tool

One average datapoint per time period
Ventilated surface area (VSA)

Kernel density plot

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>PMSV</th>
<th>PMSV-T</th>
<th>Post PMSV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>363</td>
<td>376</td>
<td>383</td>
<td>384</td>
</tr>
<tr>
<td>IQR</td>
<td>257-433</td>
<td>275-442</td>
<td>288-438</td>
<td>277-451</td>
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<tr>
<td>p-value</td>
<td>0.76</td>
<td>0.74</td>
<td>0.46</td>
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</tbody>
</table>

Sutt et al 2017 JoCC
Regional ventilation delay (RVD)

Kernel density plot

<table>
<thead>
<tr>
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<th>Baseline</th>
<th>PMSV</th>
<th>PMSV-T</th>
<th>Post PMSV</th>
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<tbody>
<tr>
<td>median</td>
<td>8.73</td>
<td>7.40</td>
<td>7.71</td>
<td>7.57</td>
</tr>
<tr>
<td>IQR</td>
<td>6.0-9.88</td>
<td>4.78-12.52</td>
<td>5.96-10.31</td>
<td>4.64-10.97</td>
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<tr>
<td>p-value</td>
<td>0.81</td>
<td>0.80</td>
<td>0.50</td>
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</table>

Sutt et al 2017 JoCC
Pre SV  |  SV in-situ  |  Post SV
---|---|---
PS 10  |  PEEP 7.5  |  FiO2 40%
EIT  |  RIP  |  HR
EtCO2  |  |  SpO2
Bedside data

- Reduced RR
  \[25 \rightarrow 20\]
  \[p < 0.001\]

- Reduced EtCO2
  \[29 \rightarrow 26\]
  \[p = 0.01\]

- Stable SpO2 and HR

- Significantly improved communication

Sutt et al 2016 CC
Communication outcomes

Both patients and nursing staff report significantly greater success with communication when SV in-situ

Nurses rate patients’ success significantly higher than patients themselves when patients are non-verbal

No success                         Very successful
__________________  X  ______  X  __________________
__________________  X  ______  X  __________________
__________________  X  ______  X  __________________

*Communication success before (up) and with (down) the SV.*

X -patients; X -nursing staff

Sutt 2017, PhD thesis
**Summary and Conclusions**

SVs in cardio-thoracic ICU patients weaning off mechanical ventilation:

- Increase EELV across all lung sections / do not cause derecruitment
- Increase TVar
- Increase ventilated surface area
- Decrease regional ventilation delay
- Do not cause hyperinflation
- Improve patients’ communication
### Trache patients in TPCH ICU 2011-2014

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
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</thead>
<tbody>
<tr>
<td># of pts with TT</td>
<td>56</td>
<td>73</td>
<td>69</td>
<td>80</td>
</tr>
<tr>
<td>TT duration</td>
<td>14</td>
<td>14.2</td>
<td>13.2</td>
<td>13.6</td>
</tr>
<tr>
<td>APACHE III</td>
<td>71</td>
<td>83</td>
<td>70</td>
<td>81</td>
</tr>
<tr>
<td>% of pts using SV</td>
<td>16%</td>
<td>58%</td>
<td>78%</td>
<td>74%</td>
</tr>
<tr>
<td># of days from TT</td>
<td>18</td>
<td>9</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>insertion to SV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of SV on vent</td>
<td>0%</td>
<td>36%</td>
<td>36%</td>
<td>70%</td>
</tr>
</tbody>
</table>

*Sutt&Fraser 2015 JoCC*
Number of days from TT to SV use

- 2011: 18 days
- 2012: 9 days
- 2013: 8 days
- 2014: 6 days
SV use commenced of mechanical ventilation
Change in clinical practice

2011
• No ventilated patients talking - HARMFUL!!

The year after (2012)
• 43 ventilated trache patients talking - consultant dependent

Now
• If they’re awake, they talk!

“If not talking – what’s wrong?”
Patients thoughts about ICU
Ongoing questions / dilemmas

- Are SVs helping to wean patients off mech vent?
- Should we be using SVs when people are being mobilised?
- How long should we keep the SV in-situ at any one time?
- Is it helping with diaphragm recovery or causing fatigue? What is the physiological sweetspot for diaphragm recovery?
- How do we ensure NOONE leaves the cuff inflated when SV is put on?
- Extreme cases - VV ECMO
- SVs in obstructive lung disease
SVs – not for everyone?

**SPEAKING VALVES IN PATIENTS WITH OBSTRUCTIVE LUNG DISEASE – NOT FOR EVERYONE**

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1Critical Care Research Group, The Prince Charles Hospital, Brisbane; 2University of Queensland; 3Allied Health Research Collaborative, The Prince Charles Hospital, Brisbane; 4Griffith University

**Introduction**

A speaking valve (SV) is a one-way valve that allows tracheostomised patients to communicate. Evidence regarding the effect of speaking valves on expiratory lung volumes (ELV) is lacking. Electrical impedance tomography (EIT) is an imaging tool that has been successfully used to estimate changes in ELV. In our research we have generally seen stable or improved oxygenation associated with increased end expiratory lung volumes (EELI) in tracheostomised patients wearing off mechanical ventilation via high flow tracheostomy piece (see Figure 1). This patient presented with desaturation once the SV was inserted in-line.

**Objectives**

To investigate the changes in ELV associated with the placement of a speaking valve into a high flow tracheostomy piece (HFTP) circuit in a patient who desaturated during SV trials.

**Method**

A 51 year old emergency admission with no reported history of COPD, was tracheostomised and weaned via HFTP, monitored using EIT. End expiratory lung impedance (EELI) was measured at baseline with the cuff inflated (prior to SV being placed in situ), and during 15 minutes of valve placement which required cuff deflation. Data was analysed using a regression model with SV as a factor for global and regional EELI. SpO2 data was also monitored throughout the study.

**Results**

Global EELI increased from baseline by 851.27 (p<0.001) with the SV in situ. There was a significant increase in EELI both anteriorly and posteriorly (p<0.001). SpO2 dropped from 96% at baseline down to 86% (see Figure 2).

**Conclusions**

The placement of a SV into the patient’s HFTP circuit resulted in significant increase of EELI, but a drop in oxygenation with the SV in situ, indicating VQ mismatch (high V/Q ratio; good ventilation with poor perfusion). Hyperinflation of the lungs based on a previous chest x-ray (see Figure 3) was postulated as the likely cause. Chest x-ray post study did not reveal pneumothorax. On questioning (only possible with the SV in situ), the patient gave a strong history of undiagnosed COPD.

Safe use of SVs, in the absence of EIT, can still be ensured through combining chest X-ray results, full medical history and bedside assessment of SV. Down sizing of the tracheostomy tube might need to be considered.
This is why we do it!