THE COST EFFECTIVENESS OF MECHANICAL VENTILATION USING PAV+ MODE IN CANADA

R.J.K. Saunders[1], **K.J. Bosma**[2,3]

1 Coreva Scientific, Freiburg, Germany

2 University of Western Ontario, London, Ontario, Canada

3. Critical Care Western, London Health Sciences Centre, London, Ontario, Canada

INTRODUCTION

Mechanical ventilation (MV) is central to intensive care unit (ICU) medicine, but this life saving intervention is expensive and comes with complexities

- A patient in the ICU receiving MV costs circa $2,000 per day[1]
- Optimizing MV provision could result in substantial cost savings and improved patient outcomes
- Proportional assist ventilation plus (PAV+™) mode is a method of MV that has recently been the focus of clinical trials[2,3] and a meta-analysis[4] from Canadian institutions

AIM

To compare health and cost outcomes of PAV+ mode with pressure support ventilation (PSV) for patients receiving mechanical ventilation in the ICU

METHOD

- Literature review of MEDLINE and PubMed indexed publications
- Data analysis of identified clinical trials of PAV+ mode (5 randomized, controlled trials and 1 comparative study)

Source	Parameter	MV	ICU		Hospital		Successful weaning	Tracheotomy	Re-intubation
Paper, Year	N, PAV+ mode / PSV	Time, Days	Time, Days	Mortality, %	Time, Days	Mortality, %	Patients, %	Patients, %	Patients, %
Botha, 2018[2]	25 / 25	3.5 / 5.7	9.3 / 11.8	4 / 25	23.1 / 19.9	12 / 38	92 / 80	21 / 29	4 / 8
Bosma, 2016[3]	27 / 23	3.9 / 4.9	7.3 / 12.4	15 / 13	26.5 / 25.0	33 / 26		15 / 26	11 / 22
Elganady, 2014[5] (a)	30 / 30					3.3 / 6.7	90 / 67		10 / 33
Elganady, 2014[5] (b)	27 / 20	2.4 / 3.9	3.7 / 5.5		4.8 / 6.7				
Elganady, 2014[5] (c)	3 / 10	6.3 / 8.90	8.3 / 10.0		9.7 / 11.5				
Sasikumar, 2013[6]	13 / 10	7.0 / 7.5	9.5 / 10.0				92 / 90	7.7 / 10	
Xirouchaki, 2008[7]	108 / 100			18 / 23		23 / 30	89 / 78		
Aguirre-Bermeo, 2014[8]	20 / 20	9 / 10	13 / 14	25 / 20				10 / 15	19 / 31
Total / Mean PAV+ mode	253	4.8	8.2	16	17.706	19.9	89.8	14.4	10.6
Total / Mean PSV	238	6.4	10.8	22	16.929	26.6	76.9	22.2	23.8
Difference	**+15 pts**	**-1.67**	**-2.67**	**-5.5%**	**+0.78**	**-6.7%**	**12.9%**	**-7.8%**	**-13.2%**

(a) All patients; (b) Successful weaning; (c) Failed weaning. N, Number of patients

- Creation of decision analytic model in line with International Society for Pharmacoeconomics and Outcomes Research (ISPOR) good practice
- Cohort-level, in-silico, model that represents patient pathway from MV to discharge. Model has 40 years of follow up possible
  - Patients: mean 65 years and 40% female
  - Standard of care had a mean time in each location of: ICU on MV 8.1 days, ICU 12.6 days, and Hospital 43.5 days[9]
  - Mortality risk adjusted by patient location and complications
  - Mean care costs per day were $2,765 (ICU) and 1,019 (general ward),[1] plus treatment of any adverse events
  - Quality of life was 0.40 in the ICU, 0.52 in the hospital, and 0.55 in the first year post discharge[10,11]
- Outcome was the total cost of care for PAV+ mode and PSV, and the cost per quality-adjusted life year (QALY) gained for PAV+ mode vs. PSV
- Costs in 2017 Canadian dollars ($)

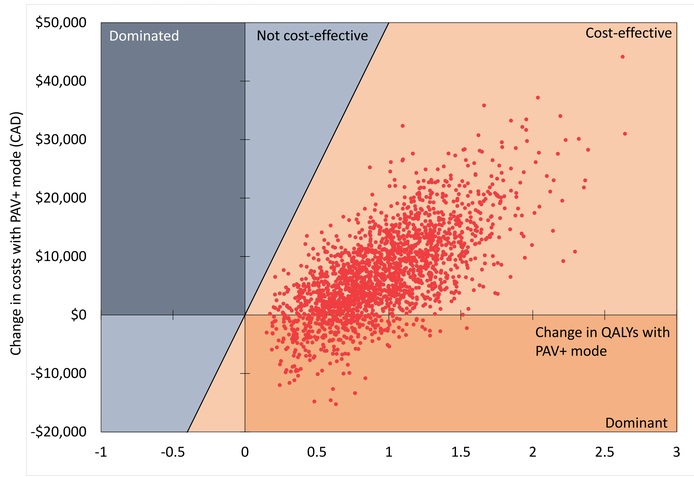
RESULTS

SHORT-TERM (1-YEAR) OUTCOMES

- The cost of healthcare after 1 year using standard MV, in this case PSV, was **$60,452**
  - Hospital costs were **$51,132**, of which treatment of complications came to $1,758
- First year healthcare costs with PAV+ mode were **$54,253**, a saving of **$6,200**
  - Hospital costs were **$43,819**, of which treatment of complications came to $975
- Outcomes reflected fewer patient safety events and lower resource use with PAV+ mode
- PAV+ mode dominated PSV at 1 year (lower cost and higher QALYs)

Outcome	PSV	PAV+ mode
MV time, Days	8.4	6.2
ICU time, Days	11.3	8.3
Life expectancy, Years	0.75	0.83
Quality-adjusted life expectancy, QALYs	0.25	0.28
Hospital costs, $	51,132	43,819

FIGURE 2. The cost-effectiveness plane for PAV+ mode versus PSV for provision of mechanical ventilation



The line differentiating cost-effective from not cost-effective is drawn at a willingness-to-pay threshold of $50,000 per QALY gained. Dominant: cheaper with more QALYs; Dominated: more expensive with fewer QALYs

LONG-TERM (40-YEAR) OUTCOMES

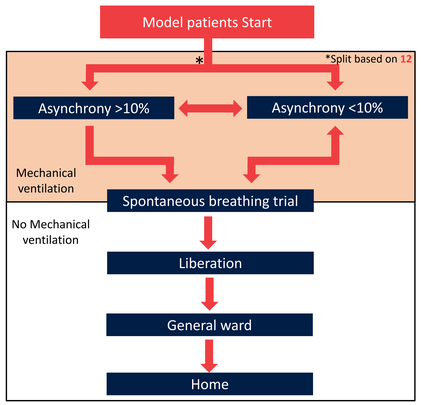
- Care practices today can have long-term impacts on healthcare costs, which is of interest to National payers
- Over 40-years, use of PSV for MV resulted in healthcare costs of **$153,610**
- In the same period, use of PAV+ mode returned costs of **$160,543**, an increase of **$6,933**
- Use of PAV+ mode led to increased life expectancy (**+1.57** years, 13.01 vs. 11.45) and quality-adjusted life expectancy (**+0.96** QALYs, 7.91 vs. 6.94)
- The mean cost per QALY gained was **$7,380** (median $4,955)
- PAV+ mode was likely (100%) to be considered cost-effective versus PSV at 40 years
- Increases in QALYs with PAV+ mode were significant (p<0.05).
- Results did not differ substantially if PAV+ mode had no impact on asynchrony, meta-analysis informed clinical effectiveness, or different cost sources were used
- If future care costs were excluded, PAV+ mode was superior to PSV
- Cost and outcomes drivers were time on mechanical ventilation and in the ICU

MODEL DESIGN

Data analysis indicated that PAV+ mode was associated with:

- Reduced asynchrony and use of tracheotomy
- Higher success in spontaneous breathing trials
- Shorter time on mechanical ventilation
- Lower in-ICU and in-hospital mortality
- Shorter time in ICU, longer time in hospital

FIGURE 1. Schematic of patient flow through the model



Two thousand probabilistic sensitivity analyses (PSA) tested response of model outcomes to realistic variations in parameter inputs.

CONCLUSIONS

- Under modelled conditions, PAV+ mode increased patient quality of life and life expectancy.
- In the first year, healthcare costs decreased with use of PAV+ mode.
- Use of PAV+ mode increased patient safety, meaning that the costs of treating complications was reduced
- Longer life expectancy with use of PAV+ mode compared with use of PSV resulted in increased healthcare costs at 40 years (the survival paradox)

ACKNOWLEDGEMENTS

This project was funded by Medtronic Inc
Proportional Assist and PAV are registered trademarks of The University of Manitoba, Canada. Used under license.

REFERENCES

1. **Evans** J, et al. Can J Anesth. 2018;65(6):627–35.
2. **Botha** J, et al. Crit Care Resusc. 2018;20(1):33–40.
3. **Bosma** KJ et al. Crit Care Med. 2016;44(6):1098–108
4. **Tirupakuzhi** Vijayaraghavan BK, et al. J Intensive Care Med. 2018;885066618769021.
5. **Elganady** AA, et al. Egypt J Chest Dis Tuberc. 2014;63(3):643–50.
6. **Sasikumar** S, et al. Indian J Crit Care Med. 2013;17:34.
7. **Xirouchaki** N, et al. Intensive Care Med. 2008;34(11):2026–34.
8. **Aguirre-Bermeo** H, et al. Med Intensiva. 2014;38(6):363–70.
9. **Sinuff** T, et al. Crit Care Med. 2013;41(1):15–23.
10. **Normilio-Silva K** et al. Crit Care Med. 2016;44(7):1327–1337
11. **Marti** J et al. J Intensive Care. 2016;4(1):56.
12. **Vaporidi** K, et al. Intensive Care Med. 2017;43(2):184–91.

CONTACT INFORMATION

1. Rhodri@Coreva-scientific.com
2. KarenJ.Bosma@lhsc.on.ca