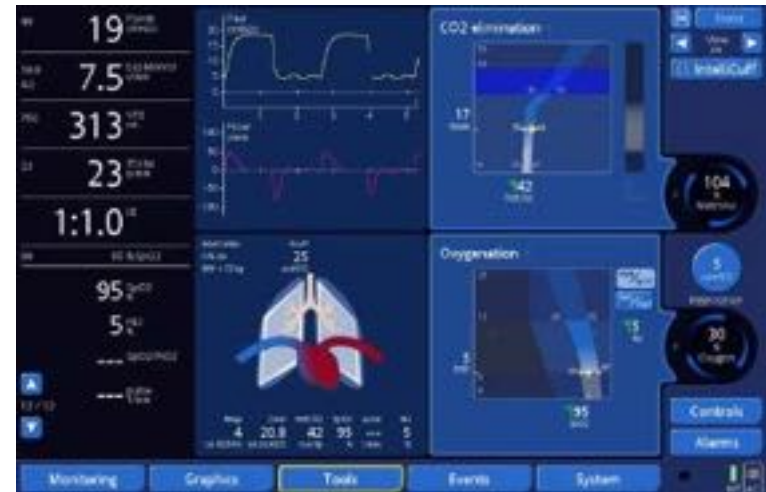




# Feasibility of fully automated closed-loop ventilation(Intellivent-ASV)for patients with traumatic brain injuries in the ICU.

Hayaki Uchino, Hiroshi Okamoto,  
Tetsunori Ikegami, Toshio Fukuoka

# INTELLiVENT-ASV



Recently released **fully** automated closed-loop ventilation.

**HAMILTON**  
**MEDICAL**

Intelligent Ventilation since 1983

# INTELLiVENT-ASV



- Automatically controls ventilator settings based on the targets for ventilation and oxygenation.
- The clinician needs to set targets for  $etCO_2$  and  $SpO_2$  for the patients.
- Automatically sets oxygenation (PEEP,  $FiO_2$ ) and ventilation (mandatory rate, inspiratory time, tidal volume, and inspiratory pressure) parameters.
- Provides an automated weaning protocol.

# INTELLiVENT-ASV



- Several studies evaluating the safety and feasibility for ventilated ICU patients have already been reported.

## ✓ RCT

- Post cardiac surgery patients
- COPD

- Other reports, including the patients with ARDS, pediatric patients and so on, have also been reported.

# Neuro-protective strategy for Traumatic Brain Injury patients

- Avoid hypotension
- Avoid hypoxemia
- **Maintain normocapnia**
- Avoid hyperthermia
- Control blood glucose
- Head elevation etc....



# Purpose

The aim of this study is to evaluate the feasibility of maintaining normocapnia by using INTELLiVENT-ASV for traumatic brain injury patients in the ICU.

# Method

- Retrospective chart review.
- Kurashiki Central Hospital in Okayama (Japan).  
8-bed medical-surgical adult ICU.  
6000 trauma patients admit to ED annually.
- From June 2014 to December 2014.

# Method

## **Inclusion:**

All consecutive patients with traumatic brain injuries requiring neuro-protective strategy.

## **Exclusion:**

- Patients under 18 years of age.
- Demised within 24 hours.





# Method

## □ Automated ventilation(AV) group:

The Intellivent system adjusts Tidal Volume(TV), respiratory rate(RR), FiO<sub>2</sub> and PEEP based on the patient's EtCO<sub>2</sub> and SpO<sub>2</sub>. Only manual setting in the AV group was the patient's height and sex to determine initial minute ventilation.

## □ Conventional ventilation(CV) group:

CV was administered by the treating intensivists. Both pressure control ventilation(PCV) and pressure support ventilation(PSV) were applied. TV was set at 8-10ml/kg, RR at 12-20/min, and PEEP at 5-8cmH<sub>2</sub>O for initial settings and adjusted on demand based on arterial blood gas assessments.

**ABG:** Every 6 hours and on demand for the first 24 hrs.

# Method

## ✓ **Primary outcome:**

- Level of PaCO<sub>2</sub>

## ✓ **Secondary outcome:**

- The numbers of manual intervention
- The numbers of time that showed unacceptable PaCO<sub>2</sub> (>45mmHg, <35mmHg)



# Method

## Statistical analysis:

- Values are expressed as median (25-75<sup>th</sup> interquartile range) or number (%).
- Continuous variables are analyzed using Wilcoxon's rank-sum test, and categorical variables are analyzed using the chi-squared test.
- The results were declared significant with p values  $<0.05$ .

# Result

## - Patients characteristics -

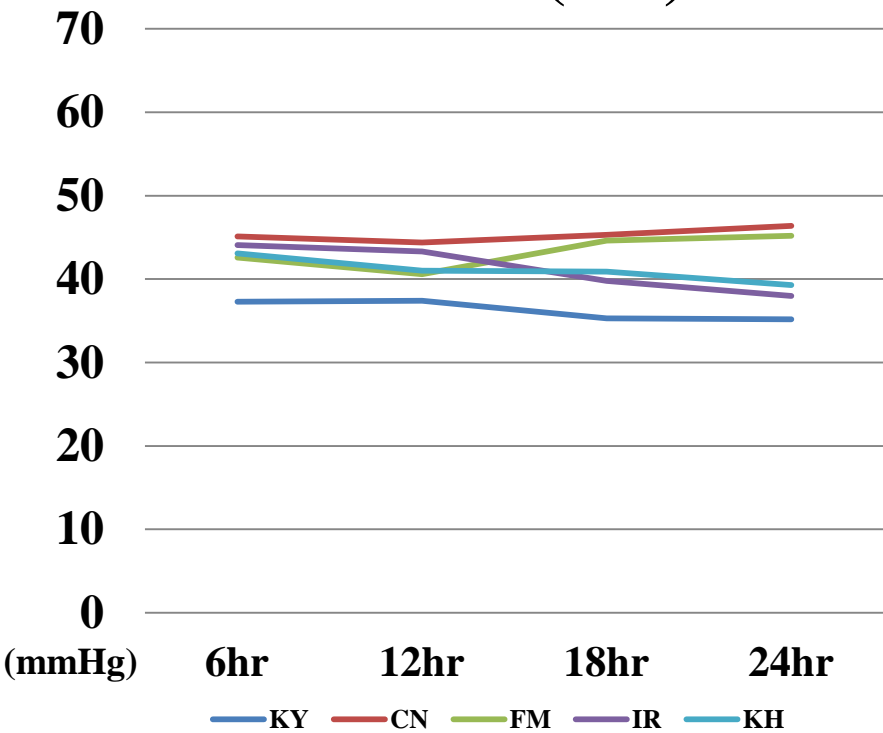
	AV	CV	P value
n	5	7	
Age	45 (21-69)	63 (27-78)	0.43
Sex(male)	5 (100%)	6 (86%)	0.38
ISS	36 (29-49)	29 (27-36)	0.34
AIS(Head)	4 (3.5-5.0)	4 (3.0-5.0)	0.76
Chest trauma	4 (80%)	5 (71%)	0.74
Smoker	1 (20%)	4 (57%)	0.20

No. (%) or Median (IQR)

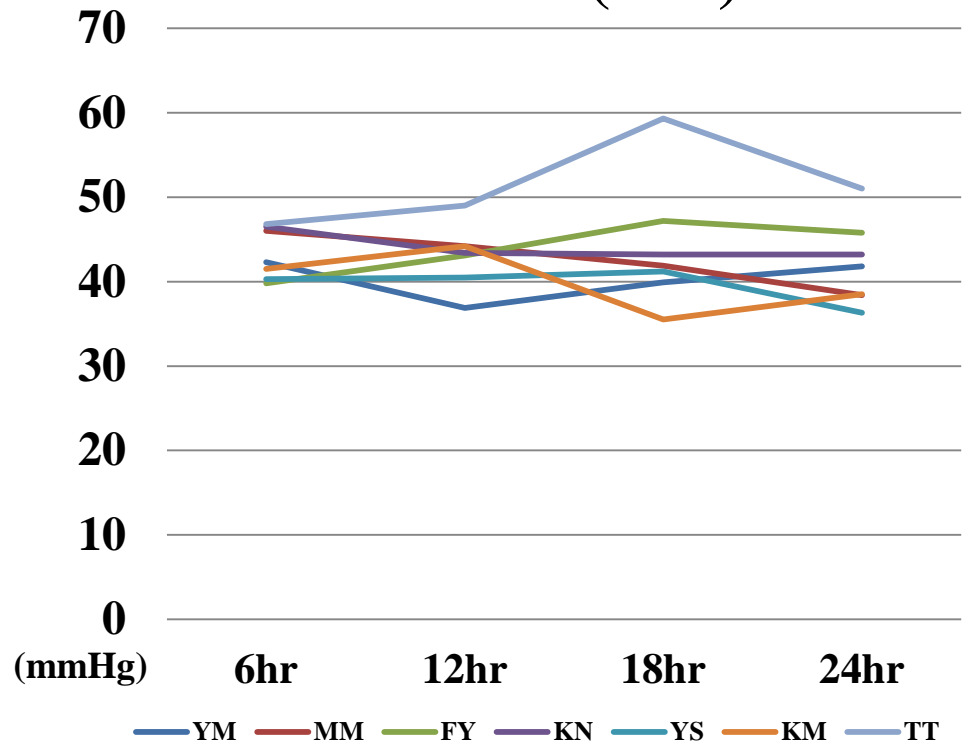
# Result

- Level of PaCO<sub>2</sub> -

## PaCO<sub>2</sub> (AV)



## PaCO<sub>2</sub> (CV)



# Result

**- PaO<sub>2</sub> and PaCO<sub>2</sub> in 24 hours -**

<AV>

	PaCO <sub>2</sub> (mmHg)	PaO <sub>2</sub> (mmHg)
KH	41(40.9-41.1)	145(143-151)
KY	35.7(35.3-37.3)	75.9(69.3-78.2)
CN	44.1(43.4-45.2)	110(104.8-115.3)
FM	43.6(40.8-45.4)	117.5(109.8-124.0)
IR	43.3(39.8-44.1)	159(146-166)

Median (IQR)

<CV>

	PaCO <sub>2</sub> (mmHg)	PaO <sub>2</sub> (mmHg)
YM	42.5(40.7-42.5)	124.5(108.8-146.3)
MM	41.6(39.4-43.6)	127.5(107-130.8)
FY	45.2(42.3-46.2)	143.5(138.3-173)
KN	43.7(43.3-44.5)	133(120.3-155.5)
YS	40.3(37.4-40.9)	158(134.5-200.5)
KM	37.5(34.3-42.2)	187(176.8-191.5)
TT	49.0(47.3-51.0)	199(195-215)

Median (IQR)

# Result

	<i>AV</i>	<i>CV</i>	p-value
PaCO <sub>2</sub> (mmHg)	43.3 (38.4-43.9)	42.1 (40.3-45.2)	0.75
Manual intervention	2 (1-2.5)	5 (3-7)	<b>0.007</b>
Unacceptable PaCO <sub>2</sub>	1 (0-2)	1 (0-3)	0.5

Unacceptable PaCO<sub>2</sub> : > 45mmHg or < 35mmHg

Median (IQR)

# Limitations

- Single center, retrospective chart review.
- Small sample size.
- The duration of neuro-protection was limited to first 24 hours post trauma.
- Closed loops in these systems rely on the availability and quality of the EtCO<sub>2</sub> and SpO<sub>2</sub> signals.





# Conclusion

- Intellivent-ASV can be alternative or even better device for maintaining adequate ventilation with TBI patients.
- The reduction of manual intervention decreases workload, the risk of human errors, and may reduce inadequate ventilation time.