

High -frequency- oscillation ventilators (HFOV)

(High frequency Oscillatory ventilation)

in clinical use in Japan.



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2) Metran Co., Ltd.

Conflict of Interest (COI) of the Principal Presenter : No potential COI to disclose.

NICU conditions in Japan (number of beds and ventilators)

- NICU total beds (with approval of Health Insurance)
1096 beds
- Max number of artificial ventilators at the same time
with same functions 1124 beds (1~25 per facility)
- Number of ventilators with HFOV function 517
* (45.9% of available ventilators)



Indication of HFOV in Japan

Patients with target conditions→94% (106 facilities)

Condition	Percentage
Persistent pulmonary hypertension of the Newborn (PPHN)	65%
Hypoplasia of lung syndrome	64%
Dry Lung syndrome	63%
Congenital diaphragmatic hernia	61%
Air Leak syndrome	55%
Chronic lung disease	51%
Respiratory distress syndrome	34%

→ **Share of extremely-low-birth weight infants 45%**
(50 facilities)

Contraindicated conditions for HFOV

Contraindication → 89% (100 facilities) established criteria.

Relative contraindications (pathology)

- Obstructing lesion (tracheal stenosis, meconium aspiration syndrome)
- Acute stage of intraventricular hemorrhage
- Severe HF (heart failure)

Basically, there is a trend to avoid using HFO in pathologies with conditions related to changes in the airway or hemodynamics instability.

HFOV application (in terms of birth weight and gestational age)

A) Weeks of gestation → Non related 53 facilities (55%)*

Less than 24 weeks 33 facilities (31%)

From 24 to 26 weeks 43 facilities (45%)

From 26 to 28 weeks 30 facilities (32%)

→ 37 weeks or more 5 facilities (5%)

B) Weight at birth → Non related 48 facilities (50%)*

Less than 500g 30 facilities (31%)

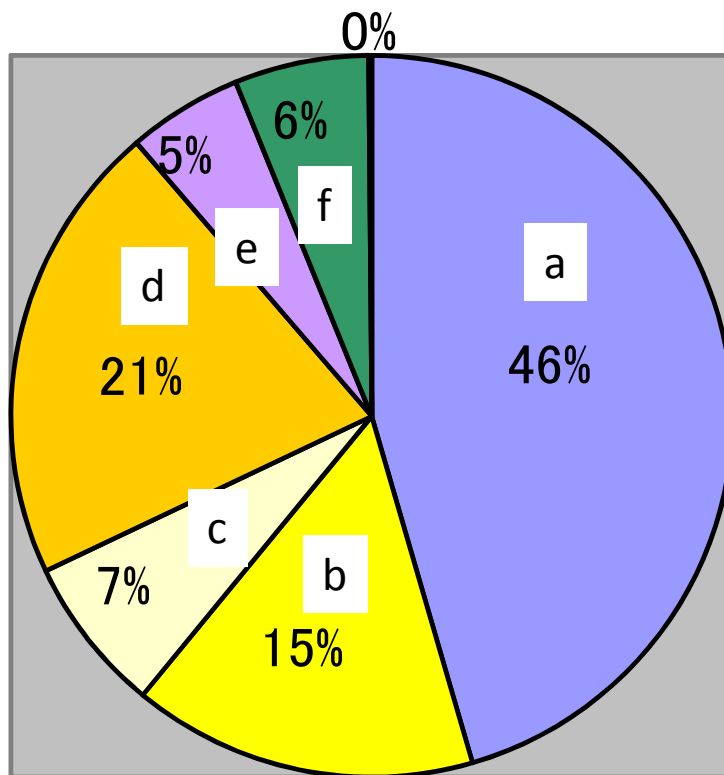
Less than 750g 44 facilities (45%)

Less than 1000g 30 facilities (31%)

2500g or more 5 facilities (5%)

➤ **Use of HFOV is no related to birth weight or gestational age for more than 50% of the institutions**

Share of different types of HFO artificial ventilator in Japan



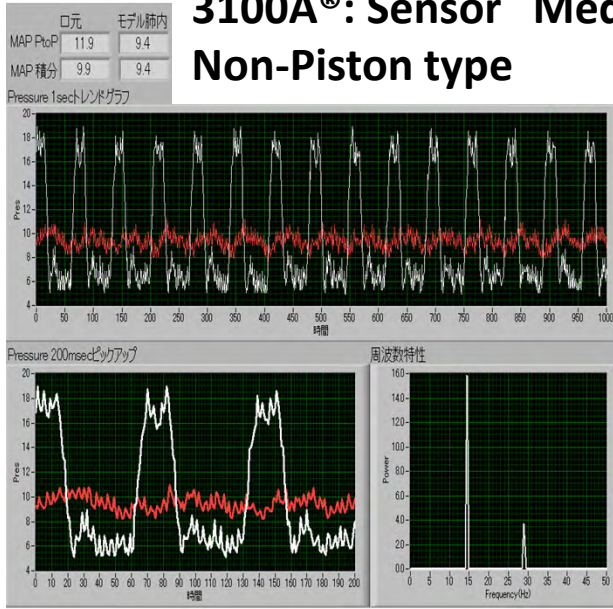
- a. Piston
- b. Spinning jet
- c. Bidirectional jet
- d. Diaphragm
- e. Interruption
- f. Cylinder (Valve-pin)

Total 517

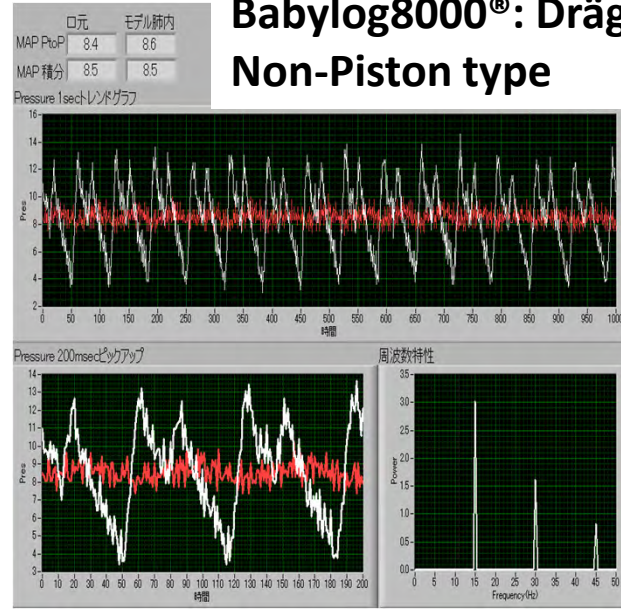
Yr 2008

HFOV devices used in Japan

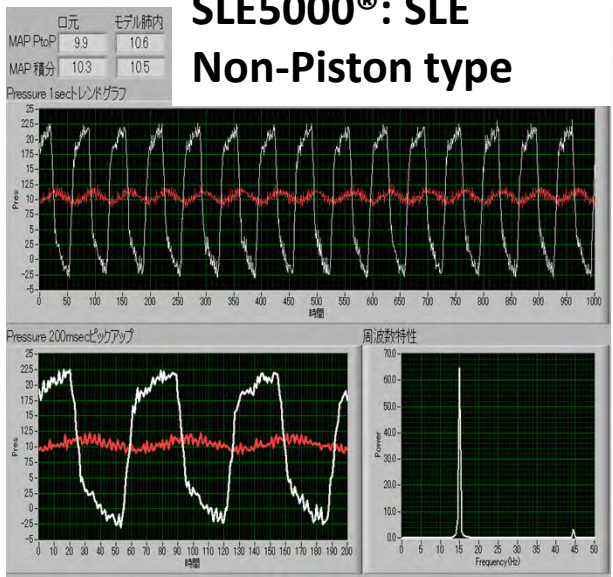
3100A®: Sensor Medics
Non-Piston type



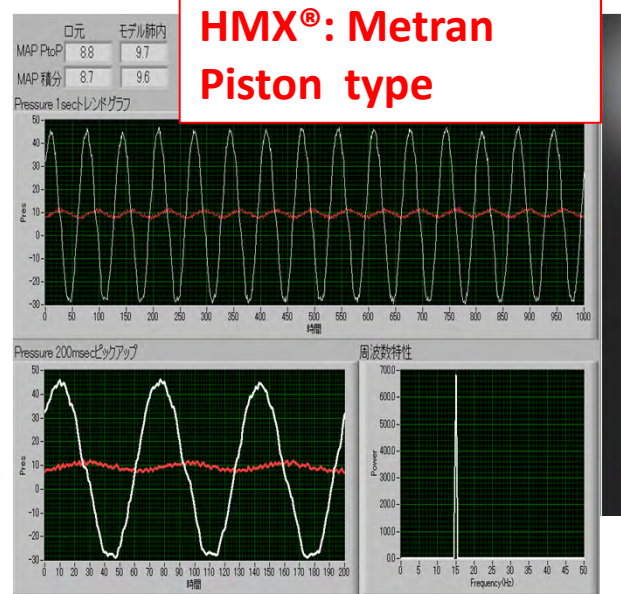
Babylog8000®: Dräger
Non-Piston type



SLE5000®: SLE
Non-Piston type

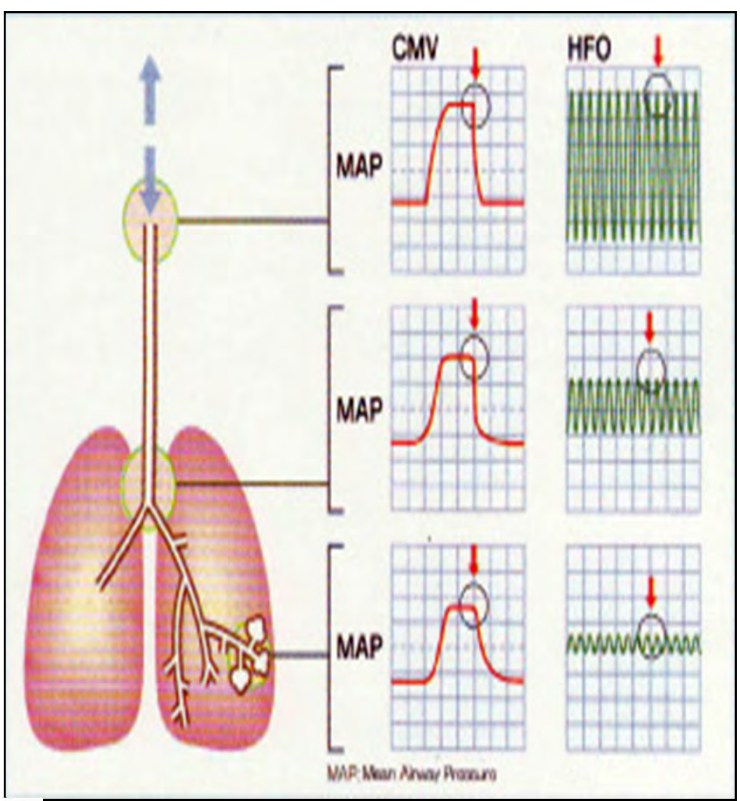
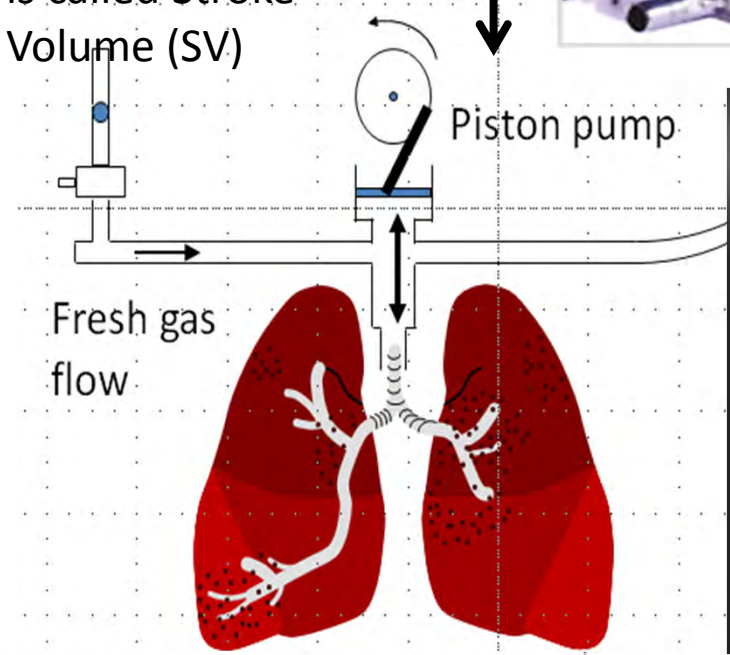


HMX®: Metran
Piston type

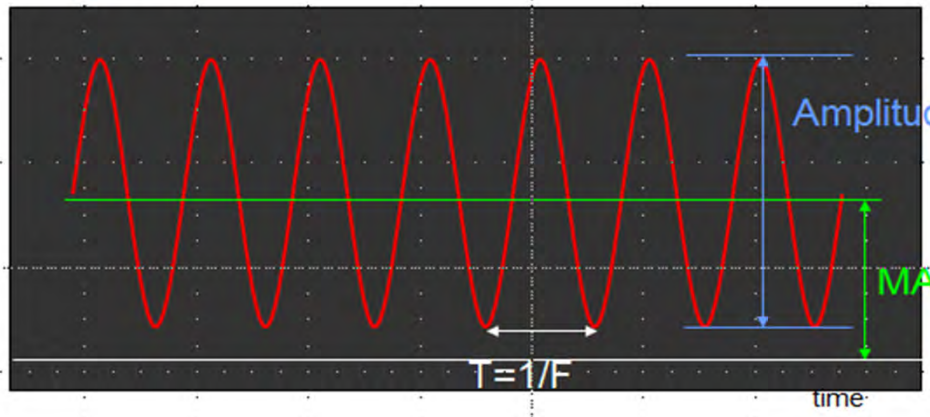


Piston type HFOV

Amount (ml) ejected by piston at one time is called Stroke Volume (SV)



pressure



Available settings

- FIO₂ (%)
- MAP (cmH₂O)
- SV (ml)

Fixed parameters

- Frequency 15HZ (basically)
- I/E ratio 1 : 1

Objectives

Analysis of special characteristics regarding tidal volume (V_{te}) of High Frequency Oscillation Ventilators (HFOV) used in Japan.

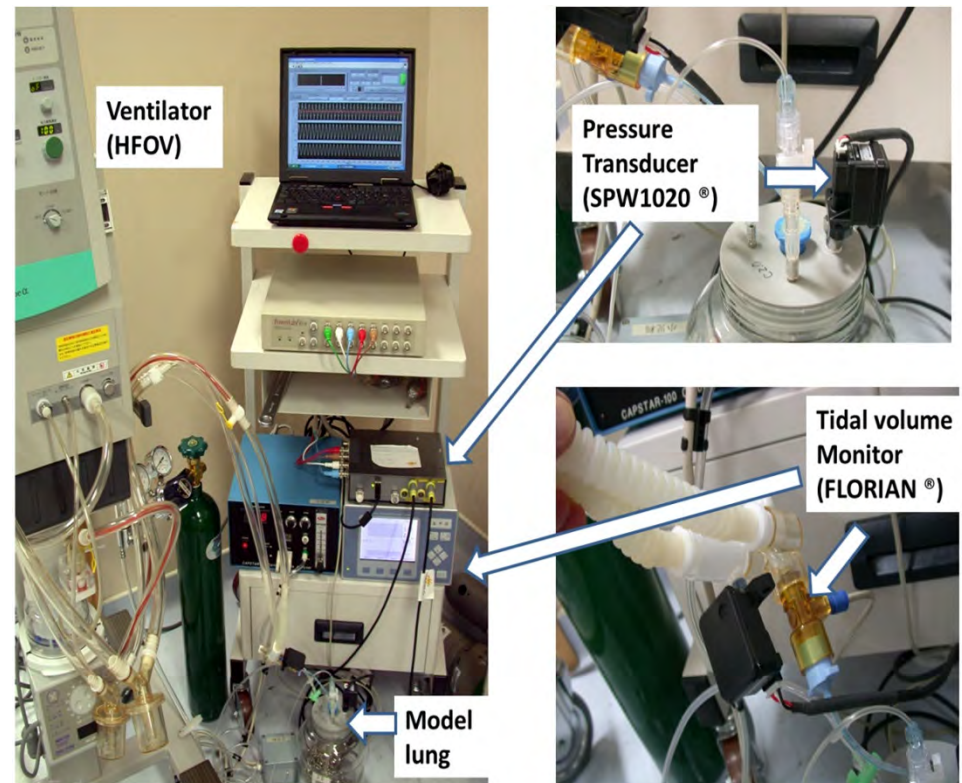
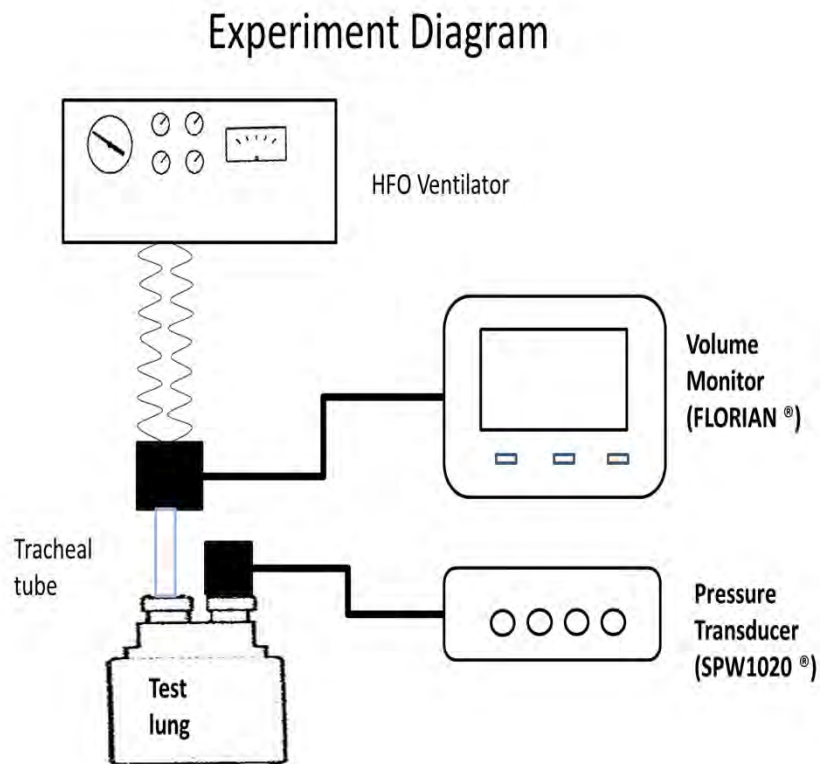


Fig.1: AMP50%HFOVte vs MAP

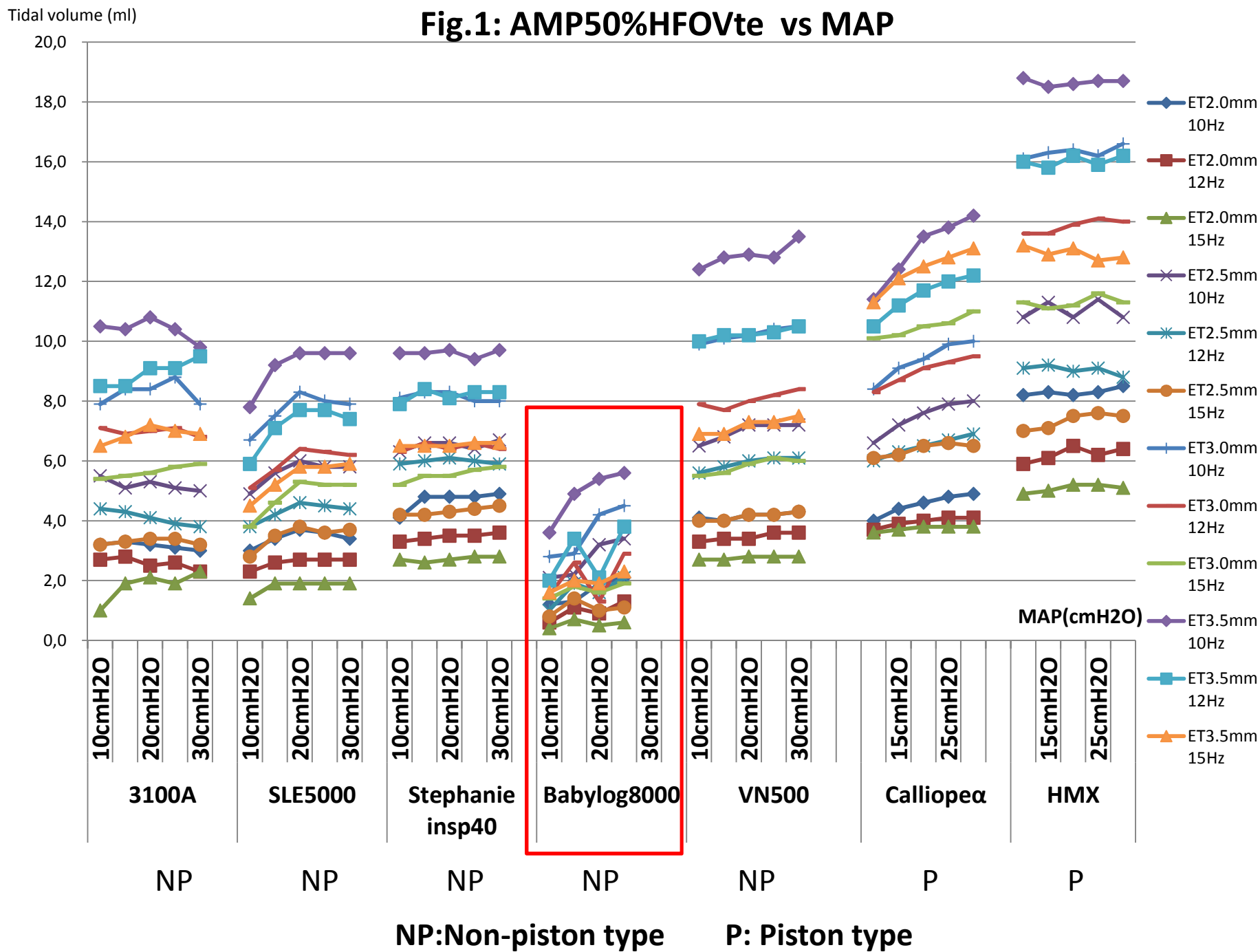
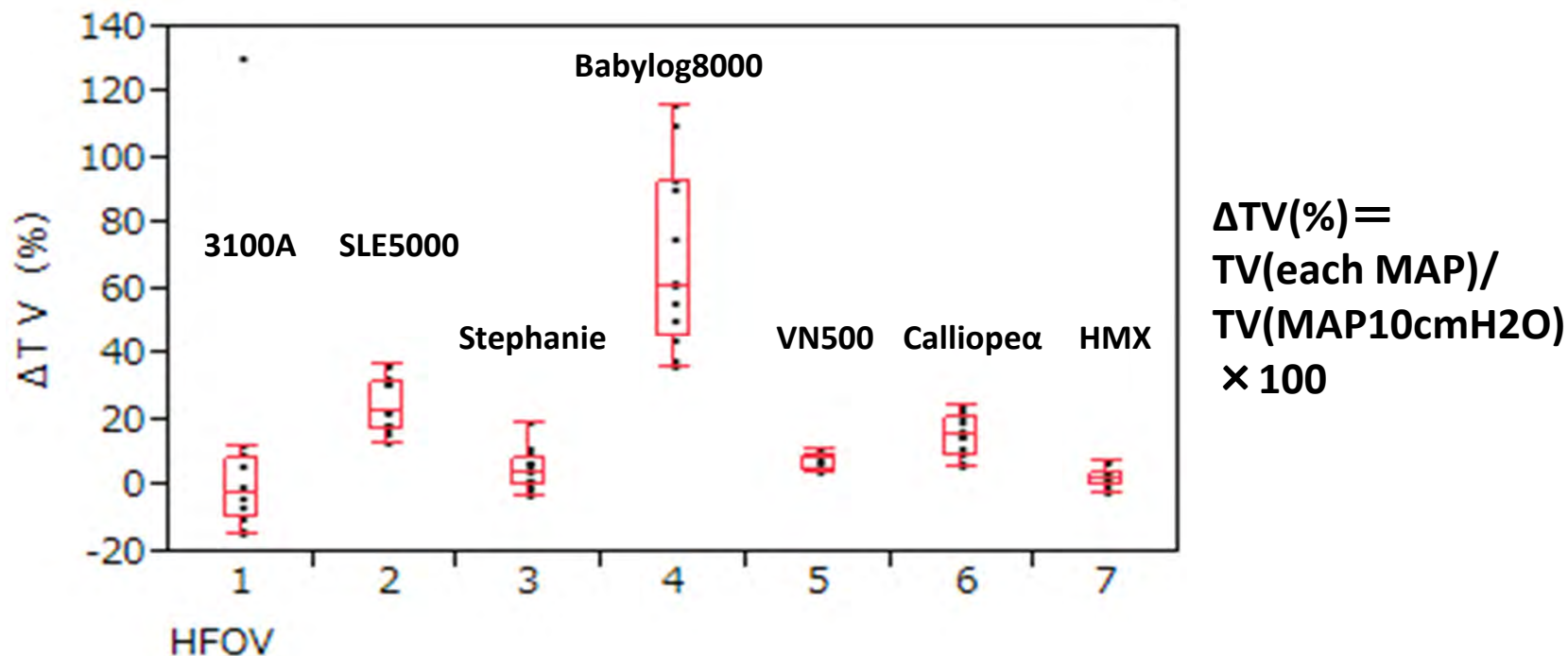


Fig.2: Comparison of tidal volume change (every models)



Ventilator	3100A	SLE5000	Stephanie	Babylog8000	VN500	Calliopeα	HMX
Mean ΔTV (%)	8.4	24.5	5	69.1	7.3	15	1.9
SD	39.2	8.3	6.2	27.5	2.2	6.2	3.3

Non-Piston Type

Piston Type

P value is ns(P=0.12) ; Piston vs Non-Piston

Tidal volume (ml)

Fig.3 :MAP10cmH2O HFOVte vs Amp(delta P)

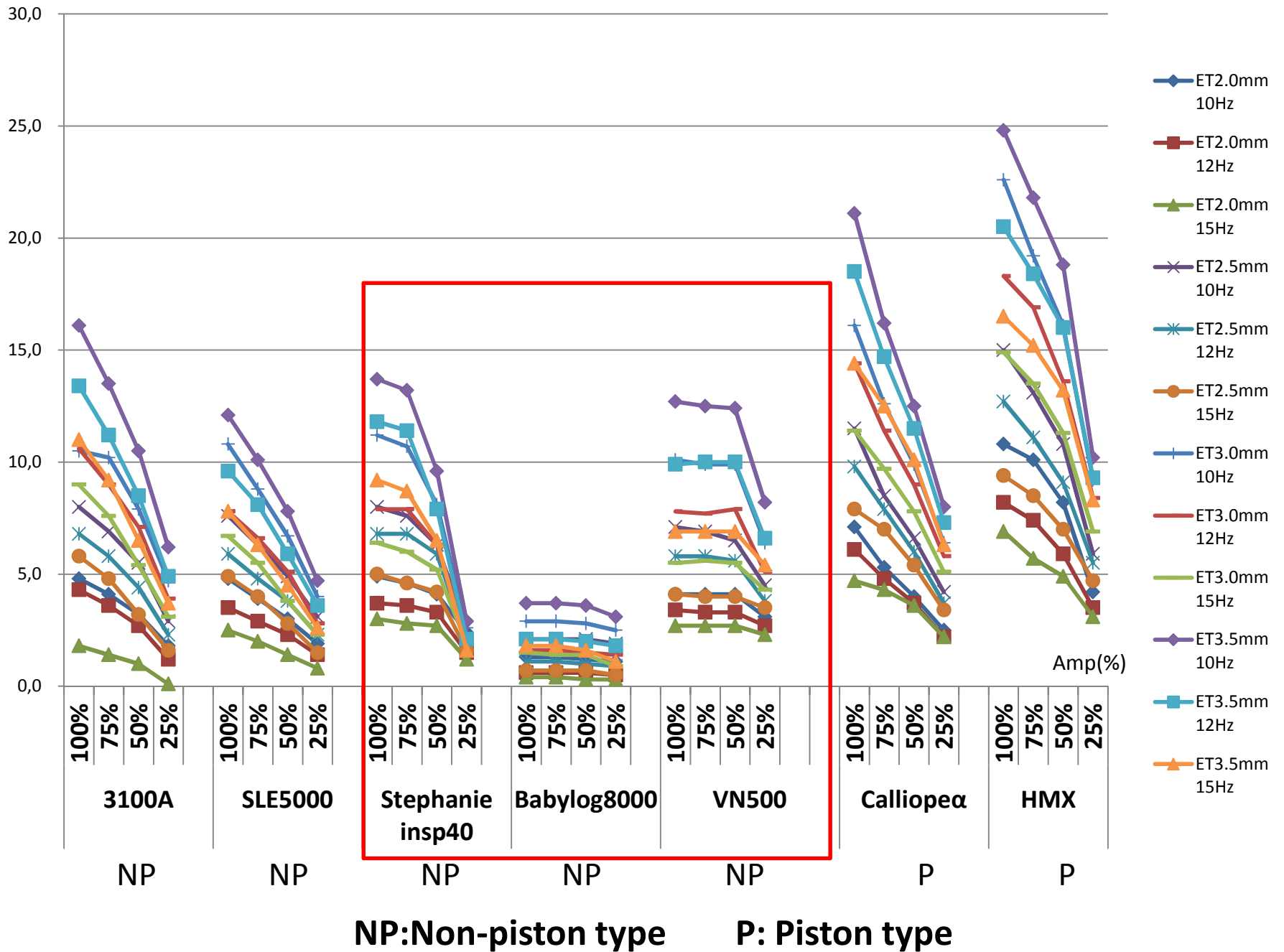
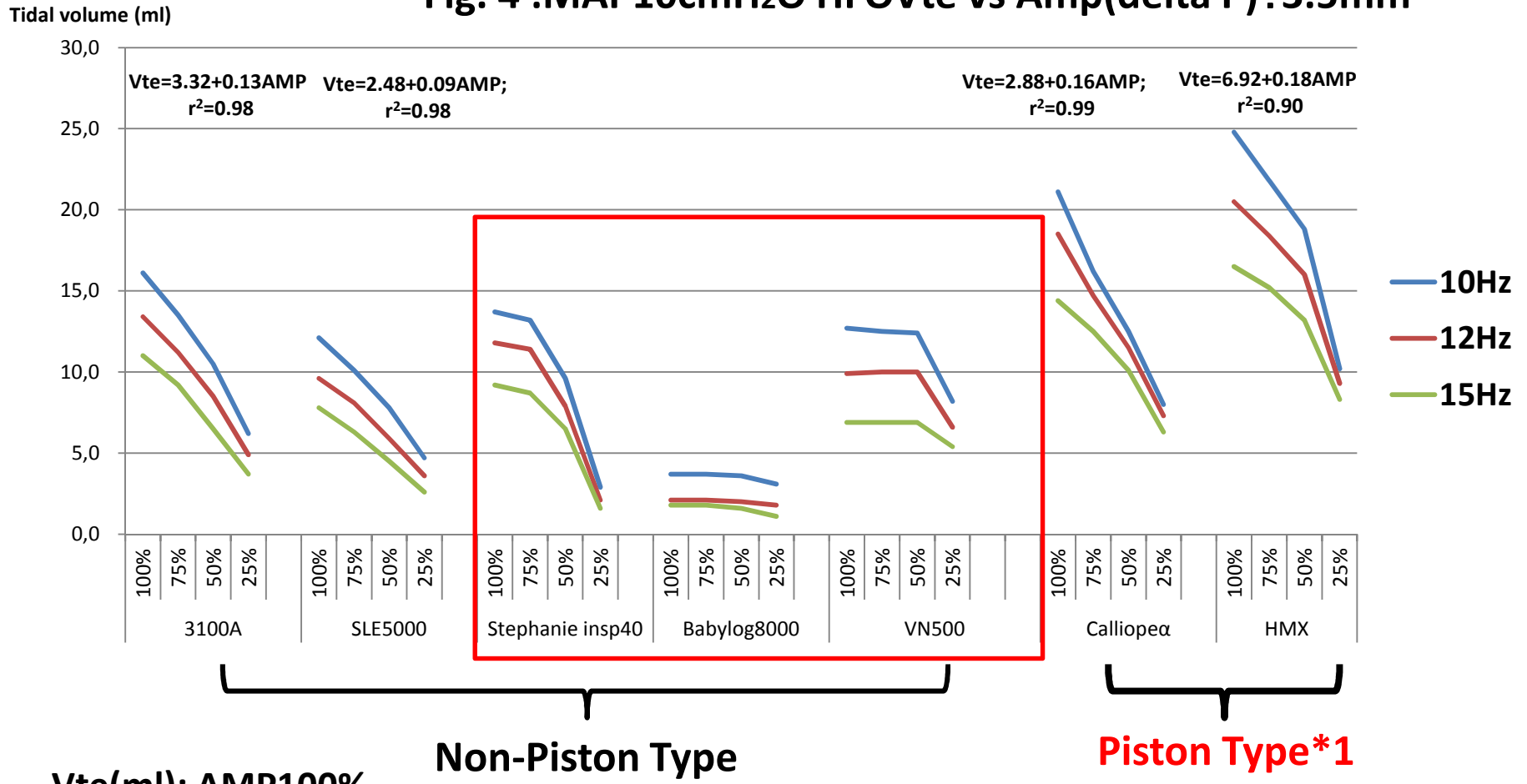


Fig. 4 :MAP10cmH₂O HFOVte vs Amp(delta P) : 3.5mm



Vte(ml): AMP100%

Vte(ml)	3100A	SLE5000	Stephanie	Babylog8000	VN500	Calliopea	HMX*2
10HZ	16.1	12.1	13.7	3.7	12.7	21.1	24.8
12HZ	13.4	9.6	11.8	2.1	9.9	18.5	20.5
15HZ	11	7.8	9.2	1.8	6.9	14.4	16.5

*1 P value<.001,Piston type vs Non-piston type

*2 P value<.001,HMX vs other HFOV of all

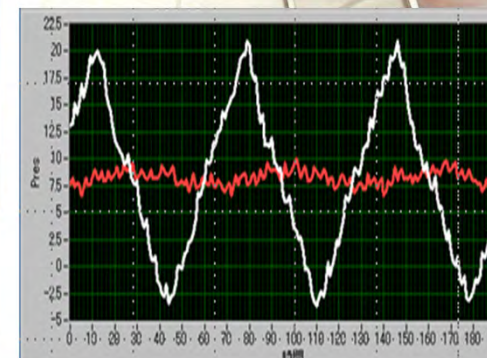
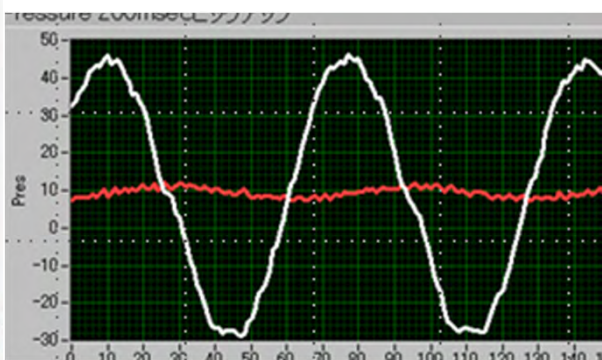
Considerations

- **Although there is no direct relation between tidal volume and the ability to exhaust carbon dioxide, piston-type HFOV Humming X[®] showed larger volume ventilation under the same conditions compared to other devices, with less changes in tidal volume due to changes in MAP, and less MAP fluctuations, making it to be easy to use in clinical applications.**
- **Moreover, the same piston-type HFO Calliope α [®] model, although it is more affected from MAP than the Humming X[®], can be considered the model with the best tidal volume and AMP correlation, increase in AMP is reflected in tidal volume.**
These results suggest that piston-type HFOV are easy to use in the neonate field.

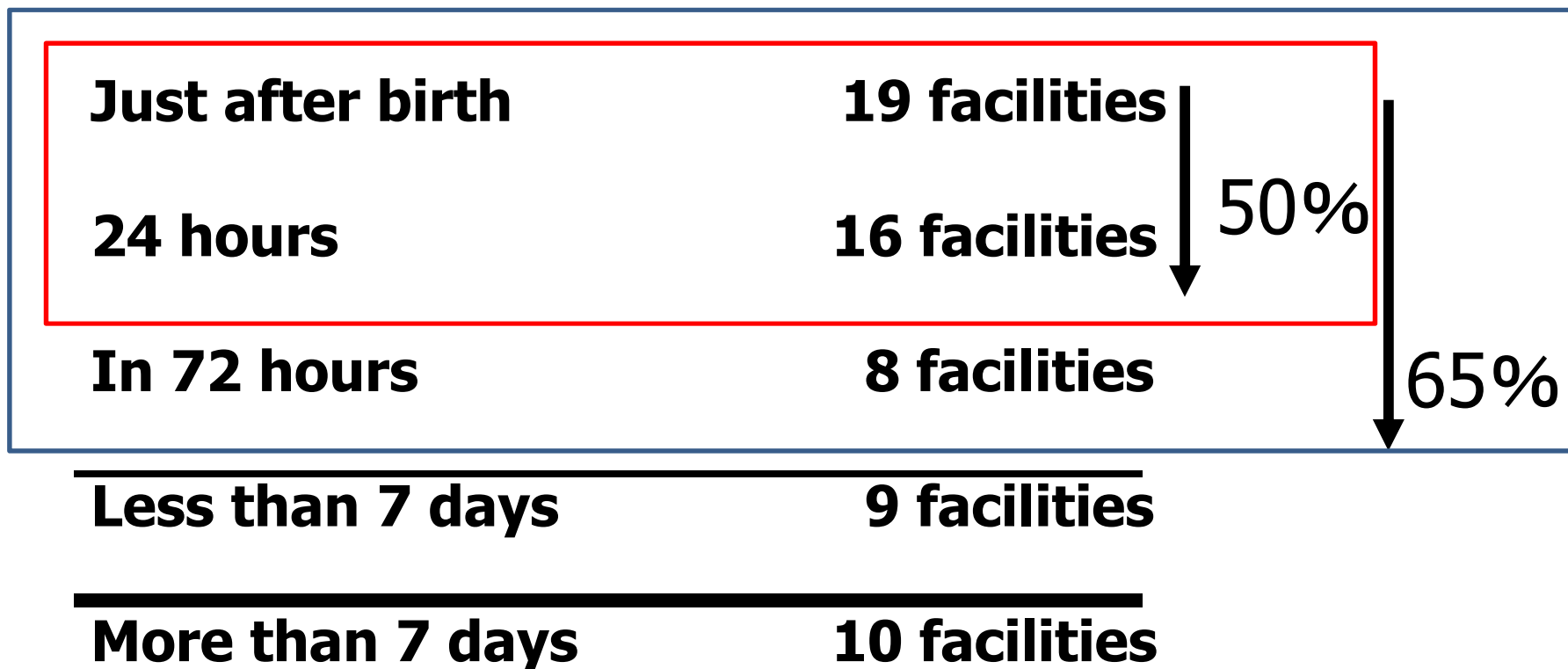
HFOV comparison (type of oscillation generation)

Type	Piston	Diaphragm – Magnet-Coil	Spinning Jet
Ventilator	Calliopea®, HMX®: Metran	VIASYS / Drager/ Sensor Medics	SLE2000HFO/5000
Features	<ul style="list-style-type: none"> ➤ Oscillation created by a piston from the expiratory side.(Sine waves, management can be done with spontaneous breaths without producing air trapping) ➤ Easy HFO settings. <p>All parameters are independent.</p> <ul style="list-style-type: none"> ➤ It provides enough ventilation at fixed15HZ. ➤ Amplitude can be finely set by changing stroke volume in increments as small as 0.1ml. ➤ Stable mean airway pressure (MAP) 	<ul style="list-style-type: none"> • Oscillation source is a speaker system. • Weak power. (volume cannot be guaranteed) • Oscillation wave becomes mixed with noise, unstable. (MAP unstable) • Parameters cannot be set independently. 	<ul style="list-style-type: none"> • Oscillation source from a jet flow with a spinning valve at the expiratory port. • Weak power(volume cannot be guaranteed) • Settings cannot be set independently. • It is likely to be affected by the compliance of the breathing circuit.

Use of HFO in low-birth weight (specially ELBW/VLBW)



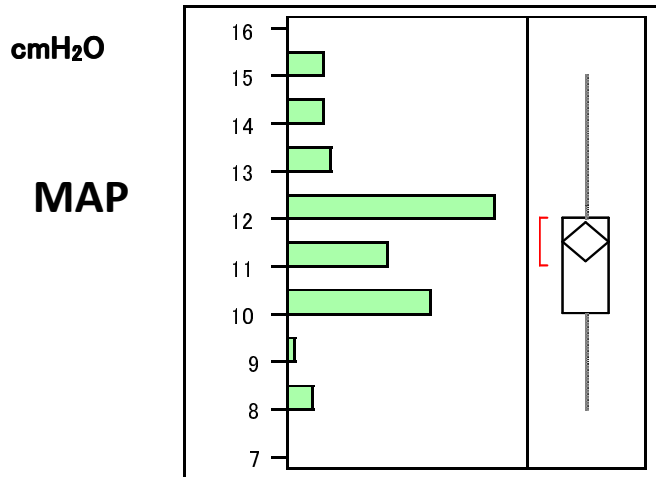
Cases for HFO ventilation in extremely-low-birth weight infant (response from 66 facilities) after birth



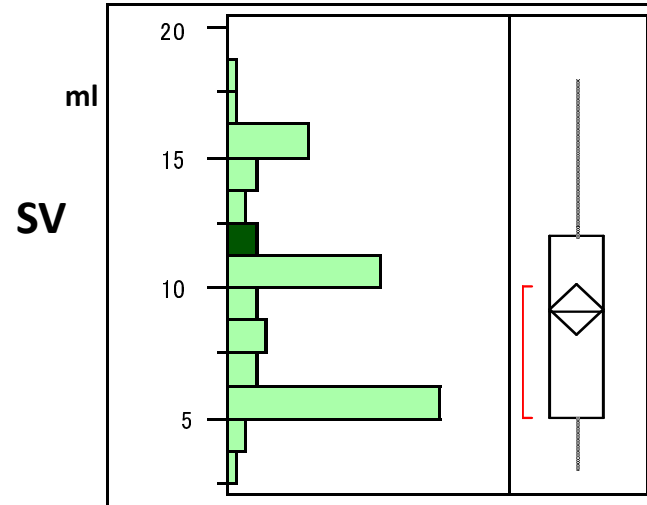
Regardless of the acute stage just after birth it were applied in more than a half cases

Starting settings of HFO in ELBW (after RDS)

Initial setting of SV and MAP of fixed frequency (N = 67): Piston HFO

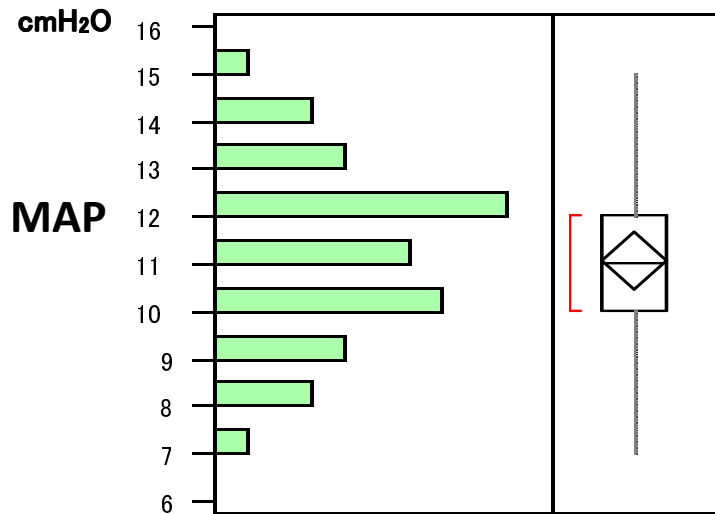


MAP : 11.5 ± 1.6 cmH₂O

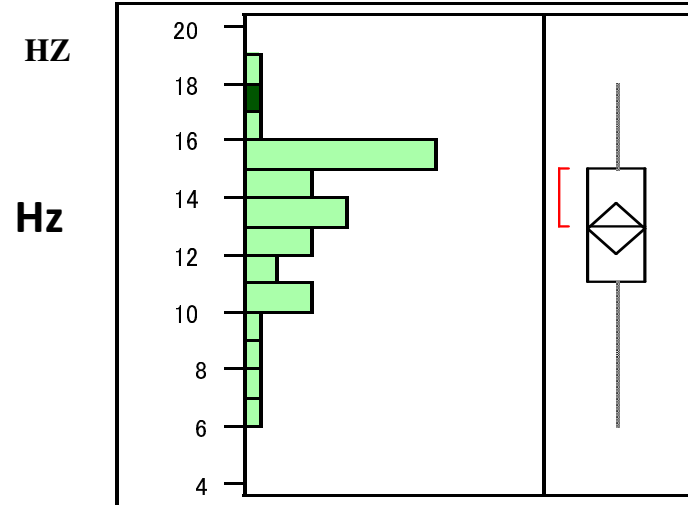


SV: 9.1 ± 3.8 ml

Initial setting of MAP and frequency (N=38): non-piston HFO



MAP 11.5 ± 1.9 cmH₂O



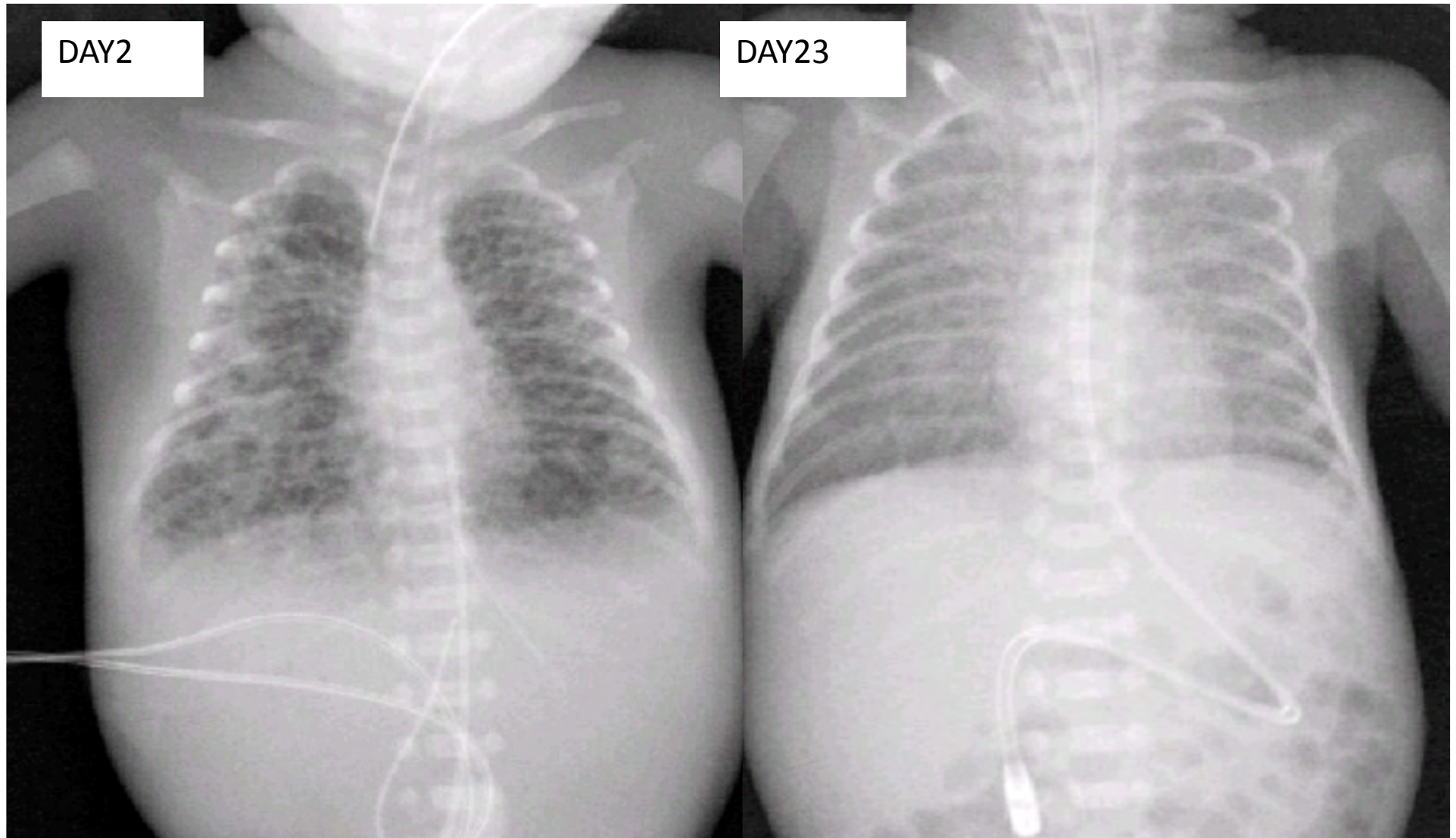
Hz 12.8 ± 2.7 Hz

There is not significance in results of MAP in HFO both types of results (P = 0.2)

Interstitial pulmonary emphysema

23 weeks 4 days 600g

Using Piston type HFOV



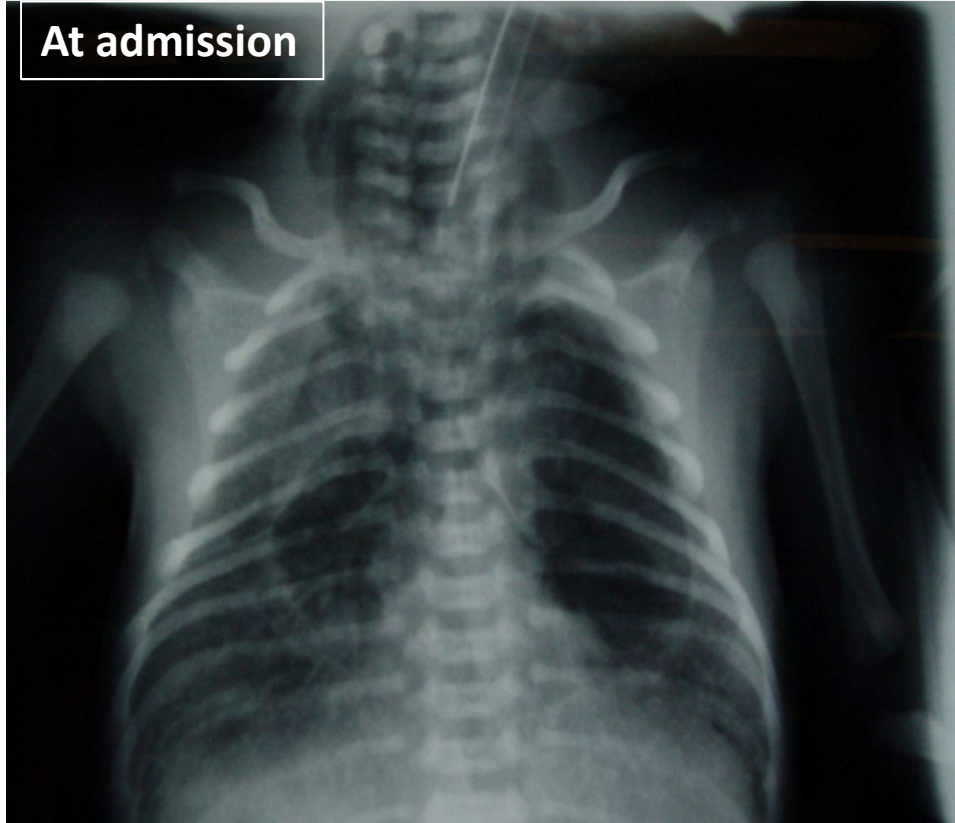
PIP/PEEP22/6 Ti0.35 IMV60 FIO₂:0.95
HFO starting sets MAP11cmH₂O SV14 FIO₂:0.8

MAP9cmH₂O SV10 FIO₂:0.25

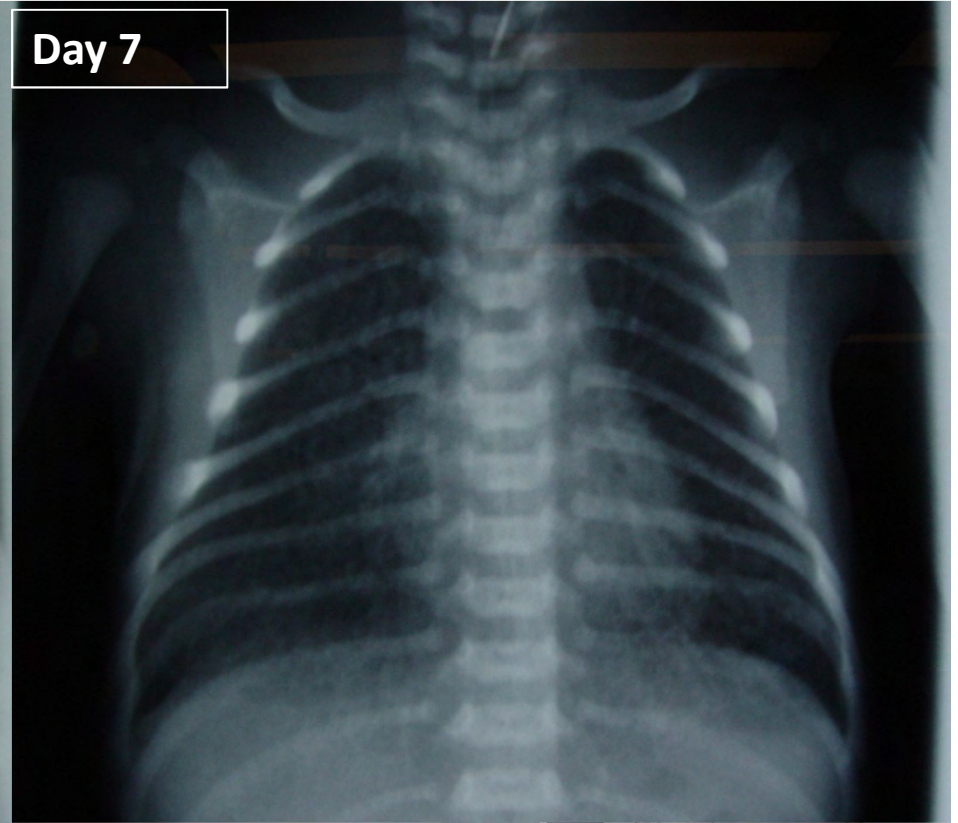
Sample of MAS, subcutaneous emphysema, pneumothorax, PPH in newborn

41W 3280g transported from other facilities by Tube&Bagging

At admission



Day 7



**Start treatment with Piston type HFOV
MAP17/SV50 and NO gas inhalation therapy
(20ppm)
NO gas therapy for 5 days, HFO for 7 days**



Reasons to use piston-type HFOV in Japan

- With fixed frequency and I:E ratio, there are very few parameters that need to be adjusted (FiO_2 and MAP for oxygenation, and SV for ventilation).
- Mean airway pressure is not affected by changes in the tidal volume.
- Close monitor of tidal volume changes due to increase or decrease in Amplitude (SV).
- Covering large demand of ventilation (from 5 to 10Kg weight without changing frequency)
- Due to sine wave ventilation (there is no air trapping in spontaneous breathing/SV adjustment resolution of 0.1ml) →ELBW can be treated without sedation.



Humming X[®] is our first choice at SCMC

