Autoregulatory adjustment range of Cuff-Keeper, a new tracheal tube cuff self-regulatory inflator

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Background and Goal of Study:

- It is recommended to maintain cuff pressure (Pcuff) within range of 20-30 cmH₂O to prevent endotracheal tube (ETT)-related complications during mechanical ventilation¹⁻³.
- Cuff-Keeper (Tokukigikenkogyo, Oita, Japan) is designed to control Pcuff with a very simple structure only by handling rotary dial without electricity.
- The purpose of this examination is to investigate the accuracy and the range of automatic adjustment regulation under simulated plastic tracheal model.

Fig. 1 An experimental setup

Results and Discussion:

- The values from CuffKeeper and the transducer consistently matched (1 hPa = 0.75 mmHg). (Fig. 2)
- With 30-60 ml of air infusion by a syringe, both CuffKeeper and transducer showed 20-30 hPa which is the appropriate range of Pcuff. (Fig. 3)

Fig. 2 Pump handle pressure and transducer pressure

Fig.3 Pressure values from CuffKeeper and the transducer with 10 ml air increment stepwise fashion

Materials and Methods:

Phase 1, Cuff Keeper pump pressure validation analysis:

Cuff keeper was connected to a pressure transducer directly. Using pump handle static pressure was given to transducer from atmospheric pressure with 4 hPa (1 hPa $\doteq$ 1 cmH₂O) increment stepwise fashion to 60 hPa. Setup pump handle pressure and static pressure measured by transducer were compared.

Phase 2, Cuff Keeper auto adjustment function test;

A syringe and ETT were connected to the experimental system to validate adjustment function by artificially causing leakage and inflation.

We tested two types of ETTs, conical shape cuff tube (Taper Guard) and cylindrical shape cuff tube (Parker) and size from internal diameter of 6.0 mm to 9.0 mm.

Once Pcuff was set at 24 hPa, auto adjustment function was tested by inflating and deflating air from the system to determine the effective adjustment limit of leakage and inflation.

- We evaluated 8 combinations of ETT size, cuff shape and the sheath of a syringe.
- Inflation or deflation of 15-18ml air maintained the Pcuff within 20-30 cmH₂O and CuffKeeper showed autoregulatory efficacy of Pcuff at 24 hPa with air inflation/deflation within 2-3ml. (Fig. 4)

Fig. 4 The effect of inflating and deflating on cuff pressure of endotracheal tube (ETT) using a CuffKeeper

- Without CuffKeeper, Pcuff indicated out-of-range value after inflating or deflating only 1-2ml air ($P < 0.01$, vs. with CuffKeeper, paired t-test).
- These results support potential usefulness of the CuffKeeper although it is not capable of holding Pcuff at completely same pressure.
- However this study is an experiment, and the efficacy at the time of coughing and moving of patient is unclear.
- Accordingly, further studies are necessary to conclude clinical usefulness and limitations of this device.

Conclusion:

CuffKeeper, which is easily operated with manual handle without electricity, may be potentially an effective device for achieving appropriate Pcuff.