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# A prototype of tracheal membrane model: A representation of sense of touch by suctioning catheter.

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## Objective:

Numerous numbers of ventilator-users have spread into the community following to vast medical technological development in Japan. It provides better quality of life with family at home; however, social demand of healthcare in the community has also risen. For instance, in 2012, Japanese Ministry of Health, Labour, and Welfare determined to commence a nationwide training system for non-medically oriented healthcare providers to perform endotracheal suctioning to satisfy the community's healthcare need. However, current endotracheal suctioning simulation system in Japan does not represent reality of suctioning risks, e.g. softness of membrane or bleeding from tissue of trachea (Fig. 1).

Therefore, the aim of this paper is to create new, cost-effective simulation system to practice endotracheal suctioning which capacitate to reduce suctioning risks to improve airway management skills.

Fig 1. Common simulation model for tracheal suctioning in Japan

## Method:

A prototype of tracheal membrane model which reproduce the physical property of airway mucosa was comprised of a clear acrylic tube (I/D 18mm), a thin stainless film, and PVA (Polyvinyl Alcohol) hydrogel which covers the stainless film put inside of the acrylic tube (Fig.2 ).The endosporium was produced electrochemically by inserting a model in an admixture of boric acid (3%), NaCl (2.5%), and 4% PVA, and applying a direct-current through the stainless film as a cathode.

Putting another electrode on a tip of suctioning catheter, this electric conductive lining membrane model enables us to detect a contact of a tip of suction catheter on the membrane by measuring the change of conductance between them. The applied voltage was 5V. The material used for an electrode was the stainless steel, and lead line was enamel coated copper wire(Fig. 3).

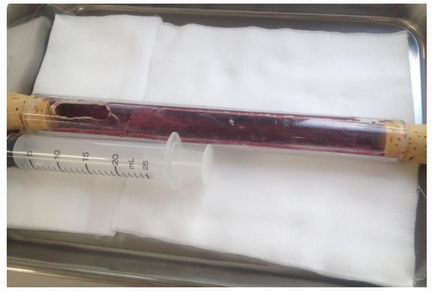

Fig.2 A prototype of tracheal membrane model.

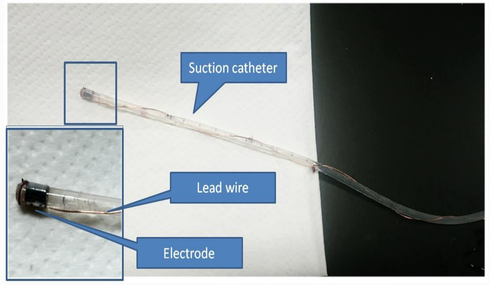


Fig 3. Overview of the prototype electrode catheter

## Results:

Instructors of the suctioning simulation could adequately control the thickness and hardness of the mucous membrane model by changing the density of PVA and the amperage.

As a result of applying our model for institutional suctioning training experimentally, reproduction of the hemorrhage by the detachment of mucous membrane (Fig.3) .

Table 1. shows the difference of conductance when an electrode catheter touched on the phlegm model, thick membrane model, thin membrane model, and stainless film.

These results imply that possibility of the acquisition/ of appropriate catheter maneuver to prevent excessive contact on a membrane was confirmed.

Table.1 Variation of conductance between the electrode of catheter and stainless film

| Position | current (mA) | Conductance (mS) |
|---|---|---|
| Phlegm | 15 | 3.0 |
| Thick membrane (2mm) | 71 | 14.2 |
| Thin membrane (<1mm) | 102 | 20.4 |
| Stainless film | 390 | 78.0 |

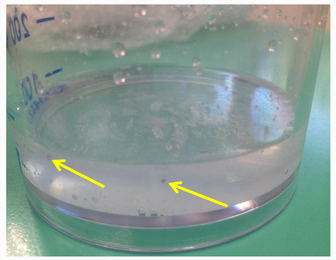

Fig.3 Removal of membrane after suctioning by 30 kPa.

## Conclusions:

Different from conventional suctioning simulation model, our model can provide opportunity to evaluate inadequate manipulation of a suctioning catheter by an appearance of the hemosputum and conductance visually. This feedback mechanism remarkably contributes to the improvement of the trainee's clinical decision-making ability as well as catheter operation skills.

To develop a simulation system reproducing instantaneous biological reaction of endotracheal suctioning technique by interlocking numerical simulation system of cardio-respiratory parameters is a future task.

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