CLINICAL PERSPECTIVE OF DEVELOPING ROBOTIC SYSTEMS FOR ASSISTING PERCUTANEOUS TRACHEOSTOMY

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Introduction

Tracheostomy is frequently performed within the Intensive Care Unit (ICU) for patients who require prolonged mechanical ventilation [1]. Compared with traditional surgical tracheostomy (ST), percutaneous dilational tracheostomy (PDT) has demonstrated its superiority and potential regarding its lower complication rates and shorter operation time [2], [3]. However, complications associated with inappropriate PDT procedures still exist and sometimes cause severe consequences, including bleeding, tracheal perforation and pneumothorax. Robot-assisted approaches are widely adapted in minimally-invasive surgeries and regarded more efficient as well as safer over manually-performed ones [4], making developing surgical robots to perform PDT feasible. Currently there's extremely limited research in robotic tracheostomy [5]. The purpose of the study is to collect clinical perspectives from stakeholders and build a design framework for robot-assisted PDT so future technologies can be developed that meet the clinical need.

Methods

An online survey with three sections was disseminated to intensivists through Qualtrics. First section of the survey collected clinical expertise and working experience related to PDT. The second section asked for evaluation of some design requirements identified from literature review. The third section clinical opinions were collected by asking for identification of challenges of the current procedure and specific objectives which robot-assisted PDT should achieve.

Results and Discussions

From Oct 2022 to Jan 2023, 15 clinicians participated in the survey. All participants had experience in directly performing PDT with average of 13.9 years. Results of clinical perspectives and their importance are illustrated in Figure 1.

Based on questionnaire results, current PDT procedure is associated with several challenges, including confined space and poor visualization of surgical site, perioperative bleeding, misposition of introducer needle, identification of puncture site and lengthy duration. Therefore if an assistive device is going to be developed, it should effectively address these issues and most significantly, demonstrate at least the equivalent level of overall safety comparing with manually-performed surgeries. Essential features tracheostomy robots should obtain were puncture and dilation so that maximum assistance can be provided with overall operation time significantly reduced. To complement drawbacks of the current procedure, perioperative image guidance and ventilation management should be adopted.

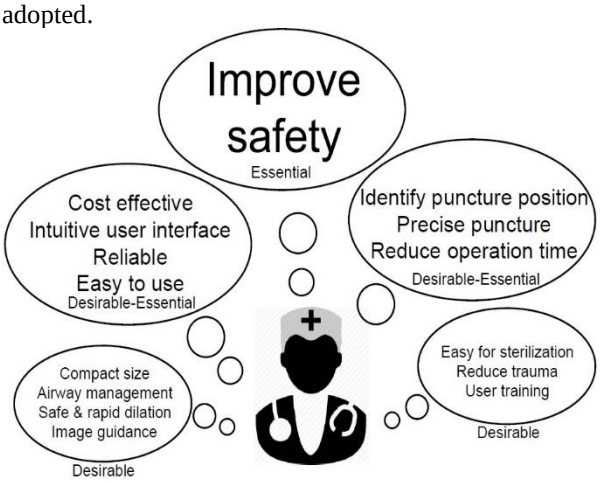

Figure 1: Clinical perspectives of the requirements of robot-assisted PDT.

In order to gain public acceptance, tracheostomy robots must be equipped with high levels of usability. Considering the operators to be non-engineering professionals, the user interface and manipulation should be intuitive with full training provided. Furthermore, the cost of manufacture, installation and maintenance must be economically viable if they are to be adopted in medical centres. Since the robots are to be used in ICU where there are numerous instruments and clinicians, systems should have a compact footprint and good portability.

Conclusion

In this study, clinical perspectives and demands for developing tracheostomy robots were collected. By consulting professionals, a design framework was built based on safety and usability requirements. It will facilitate the development of robotic solutions which efficiently and effectively meet the clinical need. Rather than the finalised version, the design requirements will be amended continuously to capture clinical needs more specifically and comprehensively..

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