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Assessing clinical reasoning in airway related cases among anesthesiology fellow residents using Script Concordance Test (SCT)

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ABSTRACT

Introduction: Clinical reasoning is a core competency for physicians. In the field of anesthesia, many situations require residents to use their clinical reasoning to make quick and appropriate decisions such as during emergency airway cases. The Script Concordance Test (SCT) is a test developed in recent years and validated that objectively assess clinical reasoning ability. However, studies involving SCT to assess clinical reasoning in airway management is scarce.

Aim: To evaluate SCT in assessing clinical reasoning for airway management in anesthesiology residents.

Method: A cross-sectional study involving residents and anesthesiology consultants from the Department of Anesthesiology and Intensive Care, Faculty of Medicine Universitas Indonesia was conducted to complete SCT. A panel of five anesthesiology consultants with more than 15 years of work experience constructed 20 SCT vignettes based on prevalent airway cases in our center from the past 10 years. Each SCT has three nested questions, with a total of 60 questions, to be answered within 120 min.

Results: The SCT of 20 case vignettes with three nested questions were tested on 99 residents from the junior, intermediate, and senior residents, compared to answers from the expert group consisting of ten anesthesiology consultants with more than 5 years of experience. There were significant differences in mean SCT scores in the junior, intermediate, senior and expert groups, 59.3 (46.1–72.8), 64.7 (39.9–74.9), 67.5 (50.6–78.3), and 79.6 (78.4–84.8); $p < 0,001$ consecutively. Cronbach Alpha 0.69 was obtained, indicating good reliability.

Conclusion: Our SCT was proven to be a valid and reliable test instrument to assess the clinical reasoning in airway management for anesthesiology residents. SCT was able to discriminate between groups of different clinical experiences and should be included to evaluate airway competencies in anesthesiology residents.

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Introduction

Clinical reasoning is a critical component for physicians. It is a complex cognitive process to integrate various kinds of information previously owned with new data leading to clinical decisions and the formulation of an effective management plan [1,2]. Clinical reasoning is important to be taught from the early years of medical school as it was found to be beneficial in increasing students' ability during their clinical placement years [3]. Adequate clinical reasoning is an essential skill for daily practice, especially in emergency conditions to prevent inappropriate decision-making that may harm the patients. In medical education, clinical reasoning skills can be trained or improved through case-based discussions, clinical case presentations, and clinical problem-solving exercises [1,2].

Educators need to be able to assess the level of clinical reasoning skills before the start of training to formulate the right teaching strategy. Clinical reasoning can be assessed using various methods; multiple-choice questions (MCQ), open short answer questions (OSAQ), key feature test, oral examination test, script concordance test (SCT), long case examination, mini-clinical evaluation exercise (mini-CEX), and portfolios [2]. Among those methods, SCT can objectively assess clinical reasoning ability and has been developed in recent years and validated. Other tests only assess factual knowledge acquired during education, whereas SCT can assess the ability to manage knowledge and clinical reasoning [4].

In anesthesia and intensive care, many situations require the use of clinical reasoning skills to make quick and appropriate decisions in emergency conditions. Airway emergency cases will lead to mortality and morbidity, if not managed promptly. Continuous evaluation of residents' clinical reasoning ability will help plan interventions to improve their clinical reasoning ability to provide the best clinical care for all

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patients [1,4]. Most residency education centers have applied multistep training for airway management. Our anesthesiology residency program in Faculty of Medicine Universitas Indonesia, based in Cipto Mangunkusumo Hospital provides education and training in airway management using various lectures, workshops, examinations and bedside teaching. Airway lectures were given in a module with discussions held every week, lasting for a month. Each month the Department of Anesthesiology and Intensive Care (Department) organized an airway day, where residents apply airway management techniques and advanced devices to patients in the elective operating room. Airway workshops and theoretical examinations were consistently held every three months. Even though this multistep training proved to help hone the skills needed in airway management, assessing the clinical reasoning skill of residents is still a challenge. Thus, SCT could provide the instrument needed to evaluate clinical reasoning.

To date, several fields of medicine have applied SCT to assess clinical reasoning in residents [5–12]. However, there is still lack of study that assess SCT for clinical reasoning in anesthesiology residents. One study was found to assess clinical reasoning in anesthesiology residents in general but not specifically for airway management [5]. This study aims to evaluate SCT performance in assessing clinical reasoning for airway management in anesthesiology residents.

Material and methods

Study design

This study was a cross-sectional study, performed in November 2021 using SCT distributed via google form to participants recruited from Faculty of Medicine Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia.

Inclusion and exclusion criteria

The inclusion criteria were residents from a minimum of second semester and consultants with minimum of five years of experience. The exclusion criteria were only if anesthesiology residents or consultants refused to participate in the study.

Script concordance test

Vignettes were made based on incidence reports and airway-related cases in Cipto Mangunkusumo Hospital over the past ten years. The cases have been analyzed comprehensively by experts through root cause analysis about the cause and solution of the cases. Previous study found that it is necessary to sample questions broadly [13,14]. Using fewer cases with three questions per case was found to improve reliability [13]. Thus, we constructed SCT that consisted of 20 vignettes (20 clinical cases), of which each vignette consisted of 3 statements (a total of 60 statements). The questions were categorized as assessment, investigation, and management. A panel of five experienced anesthesiologists with more than 15 years of experience, constructed the vignettes and list of questions for each vignette using the focus group discussion method to achieve expert consensus, ensuring the face and content validity. An example of a question on the SCT can be viewed on Table 1. Participants were anesthesiology residents from three different level of clinical experience group. Ten anesthesiology consultants with a minimum of five years of experience were selected as the 'expert'. SCT containing 60 questions were distributed using google form, to be completed within 120 minutes. Responses from residents and experts were compared and analysed.

Scoring system

The scoring involved comparing answers by residents with expert. A five-anchor Likert scale was constructed from answers provided by expert group. Previous study found that initial SCT studies were composed of seven-anchor Likert scales. However, it was found that this was not beneficial[15]. Thus, five-anchor Likert scales were used (−2, −1, 0, +1, +2) in this study. For each answer, the credit is the number of members that chose the answer, divided by the modal

Table 1. An example of an airway management vignette with Script Concordance Test (SCT) items.

A four-year old patient with ASA 1 without airway difficulty came to the hospital with a foreign body (a coin) in the esophagus. Extraction was done intraoperatively using an endoscopic probe. Induction and intubation were done without any difficulty. However, during intraoperative, oxygen desaturated gradually until 85%.

If you were thinking of …	Then you found on clinical presentation/investigation …	The hypothesis becomes …
1. Endotracheal tube dislodge	End-tidal CO2 (ETCO2) can still be read with an unchanged wave, but the value was around 25 mmHg (previously it was 38–40 mmHg)	−2, −1, 0, +1, +2
2. Change the ventilator mode to the manual bagging mode	The breathing circuit and connector were well connected, but the bellow progressively fell.	−2, −1, 0, +1, +2
3. Open draping immediately, extubate, and re-intubate	SpO2 was still not increased, ETCO2 decreased further, and there was an air leak sound from the oral	−2, −1, 0, +1, +2

Where: −2: ruled out or almost ruled out; −1: less probable; 0: neither less nor more probable; +1: more probable; +2: certain or almost certain

value of the question. The answer that received the greatest number of votes from experts was rated 1, other answers were rated as a fraction and those that were not chosen were rated 0. [1,15] For example, on one question if 6 experts of out 10 had chosen +1, a resident would receive 1 point (6/6) if they choose +1. If 4 experts had chosen +2, a resident choosing +2 would receive .67 points (4/6). Residents choosing −1, −2, and 0 would then receive 0.

Participant

During their residency, residents were trained for airway management according to their level of training and must be qualified before proceeding to the next level. 'Junior' residents received basic airway management training and they could perform basic airway management under the direct supervision of an anesthesiology consultants. After passing the basic airway management theory examination, they will reach intermediate level of residency. 'Intermediate' residents were allowed to perform basic airway management with minimal supervision, but they were only allowed to perform difficult airway management under the direct supervision of the anesthesiology consultants. Intermediate residents will have to pass the practical examination of basic airway management and the difficult airway theory examination before proceeding to the next level. 'Senior' residents were deemed capable of performing basic airway management without any supervision but still needed to report to an anesthesiologist consultant before and after the procedure. For difficult airway management, they were only allowed to perform procedures under supervision. Difficult airway management that was trained in our residency program includes the use of video laryngoscope, fibreoptic and surgical airway management.

Expert

Prior studies have shown that 10 to 20 experts were needed to ensure study's validity and there was only little gain recruiting experts more than 20 [15–17]. Therefore, ten anesthesiologists with a minimum of 5 years of experience ('experts') were selected to participate from the same institution as the residents. The experts were given the same conditions to answer the questionnaire as the residents.

Ethics approval and consent to participate

The study protocol was approved by the Ethics and Research Committee of Universitas Indonesia (1181/UN2.F1/ETIK/PPM.00.02/2021; protocol no: 20–11-1215; approval date: December 6th, 2021). Written informed consent to participate was obtained from each participant.

Sample size

The required sample size for this cross-sectional study was 92. The sample size was calculated using the validity test formula as follows:

$$n = \left[\frac{Z_\alpha + Z_\beta}{0.5 \ln\left[(1 + r/(1 - r)\right]}\right]^2 + 3$$

Legend:
n = required sample size
α = type 1 error, 5%
β = type 2 error, 10%
r = minimum correlation coefficient that is considered valid, 0.3

Outcome assessment

The study assessed the SCT results of each participant group and did a subgroup analysis based on the components of the SCT, which were assessment, investigation, and management. We also assessed the survey result based on three categories, fidelity, reliability, and clarity of the test.

Statistical analysis

The data obtained were analyzed using the Statistical Package for Social Sciences (SPSS) computer program version 26. Categorical data were presented in numbers and percentages (n (%)). In addition, numerical data were introduced using mean ± standard deviation if the data distribution is normal or the median (minimum-maximum value) if the distribution is skewed. According to data distribution, Students' T-test or Mann-Whitney test was used to analyze two numerical variables. In contrast, ANOVA or Kruskal Wallis test analyzed more than two numerical variables. The analysis results were considered significant if the p-value was < 0.05. For reliability, the Cronbach alpha test was used with more than 0.6 was deemed to be good reliability.

Table 2. Demographic of anesthesia fellow residents.

	Junior residents n = 27	Intermediate residents n = 29	Senior residents n = 43
Age	29.7 ± 1.9	29.9 ± 3.0	32.3 ± 2.7
Sex			
Male	51.8%	68.9%	62.7%
Female	48.2%	31.1%	37.3%

Table 3. SCT results and subgroup analysis.

	Junior residents n = 27	Intermediate residents n = 29	Senior residents n = 43	Expert n = 10	p-value
SCT result	59.3 (46.1–72.8)	64.7 (39.9–74.9)	67.5 (50.6–78.3)	79.6 (78.4–84.8)	< 0.001[a]
Assessment	63.7 ± 9.74	66.7 ± 14.1	73.5 ± 11.1	86.3 ± 7.4	< 0.001[b]
Investigation	51.8 ± 13.5	58.5 ± 11.6	59.8 ± 9.3	76.4 ± 7.4	< 0.001[c]
Management	58.5 ± 9.9	62.7 ± 9.8	66.7 ± 7.2	80.3 ± 3.5	< 0.001[d]

[a]Kruskal-Wallis
[b]ANOVA
[c]ANOVA
[d]ANOVA

Results

We enrolled 109 subjects, 99 anesthesiology residents, and ten anesthesiology consultants. The demographic of the participants are presented in Table 2. The mean age between each group was similar. However, most participants were male in the intermediate and senior residents group. Regarding the reliability of the test, using Cronbach alpha analysis, we found our SCT value was 0.696, which was considered good reliability.

SCT results between junior residents, intermediate residents, senior residents, and the expert group were compared using Kruskal-Wallis test, as shown in Table 3. The analysis showed that there were statistically significant differences in SCT results between the four groups ($H(2) = 44.49$, $p < 0.001$). A Mann-Whitney was conducted to determine whether different resident levels were affected based on semester and supervision levels on SCT results. The result indicated statistically significant differences between each group ($p < 0.05$). We also did a subgroup analysis based on the components of the SCT using ANOVA. The result revealed that there were significant differences in mean scores between at least three groups on the assessment component ($F(3)$, $105 = [9.870]$, $p < 0.001$). Bonferroni's post-hoc analysis found that the mean value of the SCT score was significantly different between junior – senior, junior – expert, and intermediate – expert groups. The investigation component of SCT found significant differences in mean scores between at least three groups ($F(3)$, $105 = [12.437]$, $p < 0.001$). The mean value of the SCT score was significantly different between junior – senior, junior – expert, intermediate – expert, and senior – expert groups. The management component displayed that there were significant differences in mean scores between at least three groups ($F(3)$, $105 = [17.483]$, $p < 0.001$). The mean value of the SCT score was significantly different between junior – senior, junior – expert, intermediate – expert, and senior – expert groups.

50.5% participants agreed and 33.9% participants strongly agreed that SCT was able to assess clinical reasoning and reflect their competency (Table 4). In addition, further analysis was performed on the fidelity, reliability, and clarity of SCT (Table 5). Most of the participants agreed that the SCT could portray real scenarios, and have straightforward and precise questions.

Discussion

SCT is primarily designed to evaluate the clinical reasoning abilities [18,19]. It allows objective assessment of clinical reasoning in context of uncertain situations in which other tests cannot [4,18].

In this study, the participants were divided into four groups: junior residents, intermediate residents, senior residents and experts. Compared to junior resident group, most participants in the intermediate and senior residents group were male because there were more male residents in our residency program. Previous studies involving experts and different levels of residents in various specialties have found that SCT is a valid tool to assess clinical reasoning abilities. [9–11,20–23] This study showed that our residency program training is directly proportional to the results of our SCT. We found that SCT was able to discriminate between groups of different clinical experiences in anesthesiology residents with higher mean score was found in expert group. The ability of the test to differentiate level of clinical reasoning between groups is a sign of having satisfactory construct validity. The founding of this study also supported the results of previous study by Ducos, et al [5] 2015 who found that with increased level of experience and training, the higher the SCT scoring.

Table 4. Survey of SCT on clinical reasoning assessment.

	Junior residents n = 27	Intermediate residents n = 29	Senior residents n = 43	Expert n = 10
Very Agree	10/37.0%	12/41.4%	12/27.9%	3/30.0%
Agree	11/40.7%	13/44.8%	25/58.1%	6/50.0%
Neutral	5/18.5%	3/10.3%	5/11.6%	0/0.0%
Disagree	1/3.7%	1/3.4%	1/2.3%	1/10.0%

Table 5. Survey of fidelity, reliability and clarity of SCT.

	Junior residents n = 27	Intermediate residents n = 29	Senior residents n = 43	Expert n = 10
Fidelity *(agree/neutral)*	88.9%/11.1%	100%/0%	95.3%/4.7%	100%/0%
Reliability *(agree/disagree)*	77.7%/3.7%	86.2%/3.4%	86%/2.3%	90%/10%
Clarity *(agree/disagree)*	59.2%/11.1%	62%/0%	55.9%/14%	70%/0%

However, Ducos, et al [5] 2015 designed the SCT only to assess clinical reasoning in anesthesiology residents in general, while this study focused more on evaluating airway management clinical reasoning in anesthesiology residents.

This is the first study to constructed SCT for airway management in anesthesiology residents in Indonesia. We assessed the reliability of SCT as a valuable tool using Cronbach's alpha. The result showed Cronbach's alpha of 0.696, indicating that SCT appeared to be reliable in assessing clinical reasoning for airway management in anesthesiology residents. Previous studies have also shown good reliability of SCT in various field of medicine with Cronbach's alpha value of 0.63–0.80 [12,24,25].

The test in our study was formed by five anesthesiology consultants with more than fifteen years of experience using the focus group discussion method to ensure good face and content validity [13]. Items were constructed from the prevalent cases in our hospital over the past 10 years. Exposure to high intensity real-life scenarios that were constructed offer unique opportunities for residents to develop authentic learning opportunities with no risk to actual patients [26]. It also allows residents to be more readily understand the situations when presented with the same case in real life. The key answers were provided by expert group consisted of ten anesthesiology consultants with a minimum of five years of experience. At the end of the test, we asked the participants whether SCT was suitable in assessing the clinical reasoning skills. Most of the participants from junior to senior residents group and expert were agreed that SCT was considered to be suitable to assess the clinical reasoning skills.

Regarding multistep learning in our institution for airway case management, based on this study's result, SCT allows assessment of clinical reasoning at the end of the learning curriculum. Objective measurement for clinical reasoning allows planning of further interventions for residents who need to improve their clinical reasoning abilities in airway management. Goldmann, et al [27] 2005 mentioned that several approaches can be used to improve the airway management clinical reasoning abilities such as through workshops using manikins, human cadavers, animals, virtual reality airway simulators and high-fidelity full-scale simulators. In our center, residents with low score were given additional course comprising of case-based discussion and structured workshops followed by further assessment. In the future, it would be interesting to continue further research on SCT by evaluating whether an increase in clinical reasoning would help in the development of clinical skill by performing further studies that allows assessment of both clinical skill (using OSCE or mini-CEX) and clinical reasoning (SCT).

Limitations

There were some limitations in this study. First, the questions were all in text form. Even though the questions in our SCT were sufficient to be easily understood by the participants, previous studies on the use of online SCT found that integrating pictures and videos would enhance the SCT's quality and display more realistic cases [28–31]. Another limitation was the lack of familiarity of the participants to the type of questions, especially since our center was the first to constructed SCT in Indonesia. Several studies also mentioned the same problem [8–10].

Conclusion

This study provides more evidence that SCT is a valid and reliable tool to evaluate clinical reasoning abilities for airway management in anesthesiology residents. We suggest that the SCT could be a standard for medical institutions in Indonesia. SCT could discriminate between groups of different clinical experiences and can be used to determine residents that are in need of remediation in airway training based on their level of knowledge.

List of abbreviations

MCQ	Multiple-Choice Questions
Mini-CEX	Mini-Clinical Evaluation Exercise
OSAQ	Open Short Answer Questions
SCT	Script Concordance Test
SPSS	Statistical Package for Social Sciences
OSCE	Objective Structured Clinical Examination

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