Comparison between lecture-based approach and case/problem-based learning discussion for teaching pre-anaesthetic assessment

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Summary

Background and objective: The case/problem-based learning discussion method was recently introduced into the theory-based training program for residents run by the Catalan Society of Anaesthesiology. This study was designed to assess and compare its effectiveness with that of the lecture-based approach for teaching pre-anaesthetic assessment, applying an objective tool for knowledge evaluation before and after teaching.

Methods: A prospective randomized study of two consecutive year groups of first year anaesthesiology residents was conducted. Twenty-nine residents attended a lecture, and 25, a case/problem-based learning discussion session. Their knowledge of pre-anaesthetic assessment was assessed before and after the teaching session with tests on four different clinical cases measuring six fields: (1) 'recognizing clinical data with anaesthetic implications'; (2) 'reasoning clinical data with anaesthetic implications'; (3) 'ASA class'; (4) 'Mallampati class'; (5) 'choice of anaesthetic technique'; (6) 'reasoning choice of anaesthetic technique'.

Results: Before the teaching session, the lecture group scored significantly higher on field 1 (P = 0.006). Both teaching methods improved scores on fields 1, 2 and 4. The case/problem group also improved on fields 3 and 6. After the teaching session, the field 1 score was still significantly higher in the lecture group (P = 0.005), and the field 3 score was significantly higher in the case/problem group (P = 0.044).

Conclusions: The effectiveness of lecture and case/problem-based learning discussion differed little in terms of improving participants' immediate knowledge of 'pre-anaesthetic assessment'.

Keywords: EDUCATION; RESEARCH DESIGN; PROSPECTIVE STUDIES; RANDOMIZED CONTROLLED TRIALS; METHODS; EDUCATIONAL MEASUREMENT, knowledge; ANAESTHESIA; INTERNSHIP AND RESIDENCY; TEACHING, lectures, problem-based learning.

Introduction

Pre-anaesthetic assessment is a subject that is common to all training programs for residents in Anaesthesiology. It is a complex process in which information must be sought, compiled and analysed. As the topic involves more than the mere acquisition of theoretical knowledge, it provides an ideal context for the assessment of the effectiveness of new teaching methods.

The methodological aspect of teaching anaesthesiology is an under-explored research field. The design of assessment methods that are able to measure and compare teaching effectiveness in complex areas such as 'pre-anaesthetic assessment' is especially difficult. Traditionally, a lecture-based approach has been used to transmit theoretical
knowledge, though its effectiveness has been questioned \[1,2\]. In recent years, new teaching techniques have been introduced with the aim of enhancing learning and professional competence, including simulators, online teaching, seminars, video recordings and problem-based learning discussions. There is currently no consensus on the best teaching method.

Several types of problem-based learning have emerged \[3\], for the most part, in response to the need to adapt this approach to learning programs. Case/problem-based learning discussion \[4\] is a method that is easy to implement and readily accepted by students without the need for increased educational resources; indeed, the American Society of Anesthesiologists (ASA) has included case/problem-based learning discussion in its continuous medical education courses since 1991 \[5\]. However, no studies have been published on the use of case/problem-based learning discussion to teach subjects in resident training programs, for example, the topic of 'pre-anaesthetic assessment'.

This study was designed to assess and compare the effectiveness of the case/problem-based learning discussion method and the traditional lecture method in the teaching of the subject 'pre-anaesthetic assessment', using an objective tool for knowledge evaluation before and after teaching.

Methods

The study population included first year anaesthesiology residents in Catalonia from 2 consecutive years. Participation in the study was voluntary, anonymous and had no effect on academic assessment. Residents who did not complete all the stages of the study were excluded. All residents included in the final analysis (Fig. 1) provided written informed consent. The study took place over 2 days of 2 consecutive years during the 'pre-anaesthetic assessment' class within the theoretical training program for first year anaesthesiology residents run by the Catalan Society of Anaesthesiology. A schematic representation of the study is shown in Figure 2.

The teaching contents of the class (Table 1) were previously defined and agreed on by the teaching committee of the program. The two participating teachers had teaching experience in this topic and met before the class to agree on the procedures to apply.

The teaching session lasted 60 min in both groups. The lecture group was allowed 50 min plus additional 10 min for questions, whereas the case/problem group had 60 min for discussion in class. The teacher who taught the case/problem group was an expert in this teaching technique. The lecture comprised a narrative account with overhead projection, without the participation of students except for the final 10 min for questions. The case/problem discussed in the case/problem group was a patient with high perioperative risk owing to the medical history, with concomitant medication that needed to be readjusted for surgery and difficult airway management; the patient was first scheduled for elective urological surgery, and months later, required emergency surgery following trauma shock.

Four tests were designed, based on four similar clinical cases which, in pairs, met the teaching contents (Appendix 1). The clinical cases simulated four patients scheduled for surgery. The tests were validated 4 months before the study by the two faculty members, three second year anaesthesiology residents, one third year resident and another fourth year resident, and were scored by the same two raters who would later evaluate participants in the study. The raters confirmed that the tests were comprehensible, had the same level of difficulty and could be completed in 20 min. This validation was used to exclude the data or questions in the tests which caused dissent among the raters, and thus to produce four final tests. On the first day, it was randomly decided, with the residents from the first year of the study, which pair of tests would be taken by each group before the teaching session (tests 1 and 2 = pre-tests) and which ones after the teaching session (tests 3 and 4 = post-tests). The order was repeated for the residents from the second year of the study. The maximum time allowed to complete the pre- and post-tests was 20 min. The pre- and post-tests were completed immediately before and after the teaching session (Fig. 2). Students were not allowed to make comments related to the tests until the post-tests were over.

The variables measured in the tests were six knowledge fields in the topic 'pre-anaesthesia assessment': field 1, 'recognizing clinical data with anaesthetic implications'; field 2, 'reasoning clinical data with anaesthetic implications'; field 3, 'ASA class'; ASA physical status classification; field 4, 'Mallampati Class': Mallampati classification of the oropharynx to predict difficult tracheal intubation; field 5, 'choice of anaesthetic technique'; field 6, 'reasoning choice of anaesthetic technique'.

Each field had a fixed number of items for which the total number of correct answers was counted (Appendix 1). Each correct item scored 1 point, while wrong or unanswered items scored 0 points. We calculated the score obtained for each of the fields in the pre- and post-tests, and the difference in score between the post- and pre-tests. We then established whether there were differences in score.
between and within groups, and whether differences in the results could be caused by the year of the study considered. All tests were scored by two raters (blinded to group assignment) other than the teachers. Individual items on which no agreement was reached were omitted.

**Statistics**

Closed envelopes with a number between 1 and 25, for the residents from the first year of the study, and between 26 and 57, for the residents from the second year of the study, were randomly allocated immediately after the pre-test (Fig. 1). Residents were randomized by a computer-generated procedure (two blocking restriction) to receive either a lecture session (lecture group, 13 residents from the first year of the study and 16 residents from the second year of the study) or a case/problem-based learning discussion session (case/problem group, 12 residents from the first year of the study and 16 residents from the second year of the study). Residents and teachers were not blinded to the educational method applied.

The final sample size was determined by the number of first year anaesthesiology residents in both groups who attended the 'pre-anaesthetic assessment' class, who agreed to participate in the study and who completed the pre- and post-tests. Statistical calculations were performed using the SSPS 10.0 package (SSPS Inc., Chicago, IL, USA). All variables were classified numerically and
Teaching pre-anaesthetic assessment

Definition of educational objectives  
Pre-test  
Class: 'pre-anaesthetic assessment'  
Randomization  
Written informed consent  
Lecture  
Case/problem-based learning discussion

Figure 2. Outline of the methodology followed in the study. Pre-test: evaluation before the teaching session; post-test: evaluation after the teaching session.

Table 1. Teaching contents of the class 'pre-anaesthetic assessment'.

Perioperative risk evaluation and measures to reduce morbidity and mortality
Analysis of the information obtained from the clinical history
Physical examination and complementary studies
Assessment of the difficulties encountered in airway management
Mallampati classification [6] of the oropharynx to predict difficult tracheal intubation
ASA physical status classification [7]
Patient optimization before surgery
Anaesthetic strategy
Patient information and informed consent
Pre-medication
Analgesia and postoperative care

Table 2. Scores obtained before the teaching session (pre-test) and after the teaching session (post-test) according to fields of knowledge measured.

<table>
<thead>
<tr>
<th>Field</th>
<th>Test</th>
<th>Lecture group (n = 29)</th>
<th>Case/problem group (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field 1 ‘Recognizing clinical data with anaesthetic implications’</td>
<td>Pre</td>
<td>9 (8-10)*</td>
<td>8 (7-9)*</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>10 (9.5-11)**</td>
<td>10 (8-10)*</td>
</tr>
<tr>
<td>Field 2 ‘Reasoning clinical data with anaesthetic implications’</td>
<td>Pre</td>
<td>5 (4-6)</td>
<td>4 (4-6)</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>7 (6-9)*</td>
<td>8 (7-9)*</td>
</tr>
<tr>
<td>Field 3 ‘ASA class’</td>
<td>Pre</td>
<td>1 (0-1-5)</td>
<td>1 (0-1)</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>1 (0-1)*</td>
<td>1 (1-2)**</td>
</tr>
<tr>
<td>Field 4 ‘Mallampati class’</td>
<td>Pre</td>
<td>0 (0-1)</td>
<td>0 (0-1)</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>1 (1-1)*</td>
<td>1 (1-1)*</td>
</tr>
<tr>
<td>Field 5 ‘Choice of anaesthetic technique’</td>
<td>Pre</td>
<td>1 (1-1)</td>
<td>1 (1-1)</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>1 (1-2)</td>
<td>1 (1-2)</td>
</tr>
<tr>
<td>Field 6 ‘Reasoning choice of anaesthetic technique’</td>
<td>Pre</td>
<td>2 (1-2)</td>
<td>2 (1-2)</td>
</tr>
</tbody>
</table>

Data are expressed as medians and 25th–75th percentiles. |U|-test, P < 0.05 between groups. *Wilcoxon signed rank sum test, P < 0.05 within group. (n): number of cases analysed.

Results

The study included 54 residents, 29 in the lecture group and 25 in the case/problem group (Fig. 1). Results of pre- and post-tests are summarized in Table 2. The scores obtained on the pre-tests were similar in the groups for all measured fields except for field 1, which was significantly higher in the lecture group (P = 0.006).

After the teaching session, field 1, field 2 and 4 scores improved significantly in the lecture group (P = 0.001, P = 0.001 and P = 0.000, respectively). In the case/problem group, significant improvements were found in field 1 (P = 0.001), field 2 (P = 0.000), field 3 (P = 0.042), field 4 (P = 0.001) and field 6 (P = 0.022) scores.

The field 1 post-test score was significantly higher in the lecture group (P = 0.005), while the field 3 post-test score was significantly higher in the case/problem group (P = 0.044). We found no significant differences between the groups for the other fields when comparing post-test scores. Analysis of the difference between pre- and post-test scores revealed no significant differences between the two groups for any of the fields studied.

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Discussion

The study shows that both lecture and case/problem-based learning discussion obtain satisfactory results regarding the immediate acquisition of knowledge of 'pre-anaesthetic assessment'. The results demonstrate that case/problem-based learning discussion is a suitable teaching method for this topic and that, unlike other forms of problem-based learning [8], it does not require many organizational changes.

Despite the interest shown in problem-based learning, there is no consistent evidence that this teaching method is superior to the lecture in increasing practitioners' knowledge [8,9]. In our study, case/problem-based learning discussion produced better results only for the acquisition of knowledge about the ASA risk scale. Some authors have reported better reasoning ability with problem-based learning methodology [10,11]. Although our results do not support this conclusion, we did observe that case/problem-based learning discussion improved the two fields related to clinical reasoning, whereas the traditional lecture improved only one. The limitations of our study do not allow to generalize our observation to other topics of the teaching program and there are no data in the literature to recommend either of the two teaching methods for specific topics. Our study tried to implement a tool to assess the results of teaching methods, therefore, the conditions of the study were better controlled by limiting the analysis to only one specific topic. According to our results, we can only conclude that either method can be used to teach a 'pre-anaesthetic assessment' topic; the choice may depend on the preferences of the faculty or the residents themselves [12].

Problem-based learning is now being introduced into anaesthesiology training programs, especially in undergraduate [13] and continuous medical education [5]; however, for resident training, only the applicability of the teaching method and the degree of satisfaction among students have been addressed [14] without exploring knowledge acquisition. As the good acceptance of problem-based learning has already been established [5,15], therefore, we did not assess it in our study.

The prior evaluation of any teaching method is essential for assessing its effectiveness and, if carried out sufficiently in advance, also allows curriculum designers to adjust the teaching contents and improve the learning objectives for each group. In our study, the evaluations were performed immediately before and after the teaching session, so as to make sure that the students did not receive any information on 'pre-anaesthetic assessment' other than that taught in class. Despite immediate knowledge acquisition being only a part of the complex professional learning process, it offers the possibility to attribute the results obtained to the teaching method applied without external influences. To our knowledge, there are no randomized controlled studies of 'pre-anaesthetic assessment' that include the evaluation of knowledge before and after a teaching session. Therefore, we are unable to compare our results.

As recognizing, reasoning, memorizing and selection are the different processes in the integration and application of knowledge, they were scored separately in our study. We think that the present study introduces a readily applicable and reproducible evaluation model that allows an objective evaluation of the students' knowledge.

A small sample size is a flaw typical of educational studies and one that is difficult to solve. In our study, the sample size and, therefore, its statistical power, was determined by the number of residents attending the class. Fifty-four first year anaesthesiology residents could be considered small from the perspective of statistical power, but relevant in terms of representation specially compared with data in the literature.

No assessment methods have been described that measure all facets of clinical competence, that is, knowledge, skills and attitudes. Indeed, we did not evaluate skills or attitudes and, therefore, we do not know whether the teaching session helped enhance the participants' clinical competence. Moreover, the potential for improving the communication skills of each method, essential in the pre-anaesthetic professional performance assessment, was not evaluated. Rodrigues de Oliveira demonstrated the applicability and effectiveness of a checklist based on answers to performance items to evaluate residents' competence in 'pre-anaesthetic assessment' [16]. To be able to conclude whether a resident is capable of performing 'pre-anaesthetic assessment', we must have instruments to measure how he/she performs in a real situation (performance assessment in vivo) [17].

Other methodological drawbacks in studies of this kind, and also in ours, include the difficulty of studying homogeneous adult groups, the impossibility of conducting blind studies [18], the possible improvement in performance, students and teachers, when subjects are aware of being observed [19] and the difficulty of evaluating long-term knowledge retention.

In our study, the lecture group had scored higher in the field 'recognizing clinical data with anaesthetic implications', in the initial evaluation. Though participants' knowledge improved in the
same proportion in both groups, this means that the two groups were not homogeneous, emphasizing the fact that in adults education, a previous evaluation of knowledge is required to objectively assess the effectiveness of any teaching method. Although the teaching session improved participants’ knowledge in this study, we were surprised by the previous high scores in both groups. The finding suggests that the teaching contents of ‘pre-anaesthetic assessment’ are, for the most part, already known by medical postgraduates; indeed, the contents covered are basic medical issues [20] and, therefore, the teaching objective here should not be to increase residents’ knowledge, but rather to encourage them to apply it to the perioperative medicine approach.

Education requires a great deal of planning, time and resources. The design of studies of this kind presents considerable methodological difficulties, but research into the effectiveness of educational interventions in training anaesthesia residents must be based on objective evidence. The uses of fields of knowledge with pre- and post-teaching session evaluations can be a useful tool to quantify and compare the effectiveness of different teaching methods in the area of ‘pre-anaesthetic assessment’. In this group of first year anaesthesiology residents, the effectiveness of lecture and case/problem-based learning discussion differed little in terms of improving participants’ immediate knowledge of the topic of ‘pre-anaesthetic assessment’. More studies are needed to test our results for other topics in anaesthesiology, and to determine the effect of different teaching methodologies on long-term retention of knowledge, skills, attitudes and clinical competence. An appropriate methodology for this research must be developed.

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References


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Appendix 1

Pre-tests and post-tests: questions, fields of knowledge measured, correct answers and score criteria

Pre-tests

Test 1: An 84-yr-old patient with a history of poorly controlled hypertension and congestive heart failure. One month previously, he had an explorative laparotomy for acute abdomen, suffering a myocardial infarction in the immediate postoperative period. Emergency intervention for colectomy.

Test 2: A 60-yr-old female patient, 155 cm, 120 kg, allergic to latex. History of bronchial asthma, requiring treatment with inhaled bronchodilators and prednisone 10 mg day$^{-1}$ for several years. Physical exploration: limited mouth opening, only tongue and hard palate visible. Baseline blood gas analysis: PaO$_2$ 56 mmHg. Scheduled for hiatus hernia surgery.

Post-tests

Test 3: Full-term pregnancy, requiring Caesarean section due to delay in labour. Family history of breast neoplasm. Smoker, one cigarette pack per day for past 10 yr. Appendectomy 4 yr previously. Mallampati reveals hard palate and a small part of soft palate without pillars or uvula.

Test 4: A 50-yr-old patient. Aortic valve replacement 2 yr previously, with a good functional result; since then treated with oral anticoagulants. Emergency surgery required for tibia and fibula open fractures. Physical examination revealed cutaneous-mucous pallor, tachycardia 150 beats min$^{-1}$ and systemic blood pressure (BP) 75/50 mmHg. Mallampati Class I.

Question 1

'Underline the items in the text which in your view have implications for planning patient anaesthesia'.

Field measured: Field 1, 'recognizing clinical data with anaesthetic implications'.
Correct answers (test 1): 'age 84', 'hypertension', 'heart failure', 'myocardial infarction', 'colectomy'.
Correct answers (test 2): 'allergy to latex', 'asthma', 'prednisone', 'limited mouth opening', 'PaO$_2$ 56 mmHg', 'hiatus hernia'.
Correct answers (test 3): 'full-term pregnancy', 'Caesarean section', 'smoker', 'Mallampati score'.
Correct answers (test 4): 'aortic valve replacement', 'oral anticoagulants', 'tibia and fibula open fractures', 'pallor', 'tachycardia', 'systemic BP 75/50 mmHg', 'Mallampati Class I'.
Score system for pre- and post-tests: 1 point for item underlined correctly. Score range: 0–11.

Question 2

'For each item that you underlined, explain why you think it is relevant for anaesthesia'.

Field measured: Field 2, 'reasoning clinical data with anaesthetic implications'.
Correct answers: a correct reasoning for each one of the items correctly underlined.
Score system for pre- and post-tests: 1 point for each item correctly underlined and a correct explanation.
Score range: 0–11.

Question 3

'Evaluate the risk for the patient according to the ASA classification'.

Field 3, 'ASA class'.
Correct answer (test 1): 'ASA Class IV'.
Correct answer (test 2): 'ASA Class III'.
Correct answer (test 3): 'ASA Class II'.
Correct answer (test 4): 'ASA Class III'.
Score system for pre- and post-tests: 1 point for each correct item. Score range: 0–2.

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Question 4 (only for tests 2 and 3):
'What is the patient's Mallampati classification?'

Field 4, 'Mallampati class'.
Correct answer (test 2): 'Mallampati Class IV'.
Correct answer (test 3): 'Mallampati Class III'.
Score system for pre- and post-tests: 1 point for each correct item. Score range: 0–1.

Question 5 (only for tests 1 and 3):
'What anaesthetic technique (general or local/regional) would you choose in this case?'

Field 5 'Anaesthetic technique choice'.
Correct answer (test 1): 'local/regional anaesthesia'.
Correct answer (test 3): 'local/regional anaesthesia'.
Score system for pre- and post-tests: 1 point for each correct item. Score range: 0–1.

Question 6 (for tests 1 and 3):
'Explain your choice of anaesthetic technique'.

Question 6 (for tests 2 and 4):
'Why do you think the best technique for this patient is general anaesthesia?'

Field 6, 'Reasoning choice of anaesthetic technique'.
Correct answers: A correct reasoning to indicate local/regional anaesthesia (for test 1 and 3) or general anaesthesia (for tests 2 and 4).
Score system for pre- and post-tests: 1 point for each item correctly reasoned. Score range: 0–2.