



Original article

Effectiveness of a blended learning course and flipped classroom in first year anaesthesia training

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ABSTRACT

Background: Blended learning, which combines internet-based platform and lecturing, is used in anaesthesiology and critical care teaching. However, the benefits of this method remain unclear.

Methods: We conducted a prospective, multicentre, non-randomised work between 2007 and 2014 to study the effect of blended learning on the results of first year anaesthesia and critical care residents in comparison with traditional teaching. Blended learning was implemented in Rouen University Hospital in 2011 and residents affiliated to this university corresponded as the blended learning group. The primary outcome was the resident's results as measured with multiple-choice questions between blended learning and control groups after beginning blended learning (post-interventional stage). The secondary outcomes included residents' results between pre and post-interventional stages and homework's time. Moreover, comparison between control and blended learning group before beginning blended learning (pre-interventional stage) was performed.

Results: From 2007 to 2014, 308 residents were included. For the pre-interventional period, the mean score in the blended learning group ($n = 53$) was 176 (CI 95% 163 to 188) whereas the mean score in the control group ($n = 106$) was 167 (CI 95% 160 to 174) (no difference). For the post-interventional period, the mean score in blended learning group ($n = 54$) was 232 on 300 (CI 95% 227–237) whereas the mean score in the control group ($n = 95$) is 215 (CI 95% 209–220) ($P < 0.001$). In the two groups, comparison between pre and post-interventional stages showed the increase of mean score, stronger for blended learning group (32% and 28% in blended learning and control group, $P < 0.05$). The average time of homework in the blended learning group was 27 h (CI 95% 18.2–35.8) and 10 h in the control group (CI 95% 2–18) ($P < 0.05$).

Conclusions: This work suggests the positive effect of blended learning (associating internet-based learning and flipped classroom) on the anaesthesia and critical care residents' knowledge by increasing their homework's time.

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1. Introduction

In France, the official program regarding specific anaesthesia and critical care training is available in the first stage of residency. This is established by the department of higher education, research

and technology, set by order of the 26th July 2002. Lecturing supported by slide presentation is the most common teaching method used during short courses, but this causes a lack of attention from the students and may limit the knowledge acquisition [1]. Over the last few years, an interest has grown to rethink the existing traditional educational paradigm which is teacher-centred (a teacher delivers lectures in a classroom) and highlight the evolution to a new educational paradigm with learner-centred strategies and active student engagement

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[2,3]. Compared to student-centred learning, the conventional didactic lecturing model with teacher-centred learning seems to be less interesting for students in terms of motivation and achievement [4]. Otherwise, e-learning is defined as a computer-based learning method, including on-line learning platforms, computer programs or multimedia contents. This method does not necessarily include a classroom or a teacher and enhances active student engagement. Currently, it is becoming more and more popular in medical teaching [5]. As stated by de Cook et al. in their meta-analysis, e-learning is associated with large positive effects compared with no intervention. However, effects compared with non-Internet instructional methods are heterogeneous and small, suggesting an effectiveness similar to traditional methods [6].

In the field of anaesthesia, few studies have assessed the effectiveness of e-learning in medical teaching [7]. For instance, Chu et al. described an e-learning program to prepare 22 interns for anaesthesiology residency training [8]. The successful transition to anaesthesia residency training (START) is a longitudinal intervention during 10 months with 10 learning modules. The START program enabled improvement between pre- and post-quiz scores. However, when we focus on the acquisition of theoretical knowledge and an on-line evaluation, results from other studies show an unconformity. A study evaluated the effectiveness of on-line quizzes with surgical residents on an exam performance [9]. There was no significant relationship between the time spent on-line and the exam results. Another work aimed to investigate the impact of online quizzes on undergraduate students in a physiology course. The scores on on-line quizzes were predictive of outcome on examination [10].

As those studies often include small numbers of learners and have inconsistent results, we decided to conduct a study on the effectiveness of on-line courses on the acquisition of theoretical knowledge. We have developed a blended learning course that combines internet-based platform and lecturing for basic anaesthesia teaching to first year anaesthesia and critical care residents. This lecturing was designed as flipped classrooms intended to be a summary of this teaching. We hypothesised that this blended program could enhance a resident's academic knowledge by the end of the first year of curriculum compared to traditional teaching methods.

2. Material and methods

2.1. Resident selection

This prospective, controlled, non-randomised study was conducted among residents in anaesthesia and critical care from three French university hospitals (Rouen, Caen and Amiens) during eight years (2007 to 2014). Two resident groups were made up without randomisation. The control group attended lectures with computer support (Amiens and Caen University). The blended learning group attended a blended learning course combining Internet tools and lectures (Rouen University). The residents were included in the blended learning group or control group depending on the university hospital they were affiliated. In Amiens and Caen, they were no change in prior teaching. For the two groups, we performed a pre-interventional (2007–2010) and a post-interventional (2011–2014) comparison. The implementation of blended learning is defined as the intervention between 2010 and 2011. We chose to include residents even before the beginning of blended learning to evaluate if first year residents' results (who were all attending classic lecture courses) were different from a University Hospital (Rouen, where blended learning was implemented) from the others (Amiens and Caen, where traditional teaching was maintained) (Fig. 1.). Due to the lack of randomisation, this

comparison was necessary to ensure that the results of the students at the end of the first year were comparable.

The Ethics and Evaluation Committee for Non-Interventional Research of Rouen University Hospital approved the study (CERNI E201215). All participants received information before any study procedures were undertaken. Then, residents in the anaesthesia and critical care training program were invited to willingly participate as subjects in the study. An oral consent was received.

The two groups had the same learning objectives. In both the control group and the blended learning group, each resident's knowledge was commonly assessed by the same assessment with multiple-choice questions (MCQs) in June of each year.

2.2. Study procedures

2.2.1. Learning objectives

In the three university hospitals, the learning objectives for anaesthesia and critical care residents followed the French National Guidelines for anaesthesia teaching, given to all participating residents at the beginning of their five-year anaesthesiology program. The teaching schedule was similar for the three centres and included basic knowledge of anaesthesia and critical care. The two main teaching subjects were pharmacology (anaesthetic agents effects on the central nervous system, general pharmacokinetics and pharmacodynamics knowledge, intravenous hypnotics, opiates and neuromuscular blockades pharmacology, non-opioids analgesics), cardio-vascular physiology (central nervous system and cardiac function, cardiac electrophysiology, cardiac output, blood pressure regulation, coronary circulation, ischaemia-reperfusion phenomenon, blood volume, anaesthetic agents effects on cardio-vascular function) and respiratory physiology (ventilation regulation, respiratory mechanics, oxygen and carbon dioxide exchange and transport, mechanical ventilation, effects of mechanical ventilation and surgery on respiratory function, cardiopulmonary interactions). Except for the new teaching method (blended learning), the teaching schedule was similar for the three centres. The training program included several types of learning according to the university hospital the students belonged to. They attended one or two days of specific topic lectures throughout the academic year. In addition, a weekly journal club was organised.

2.2.2. Traditional teaching

Traditional teaching consisted of four days of classroom teaching; each day consisted of 6 hours of classes. Students attended traditional classroom courses, with different teachers using computer support such as electronic slideshows. Teaching schedules and objectives were identical in the three university hospitals; however local teachers presented lessons. In the three hospitals, teachers prepared their own lessons but there were no common courses for the three universities. During this course, an electronic voting system was used to enhance interactivity with the students.

2.2.3. Blended learning

The blended learning course consisted of an association of computer-based teaching and face-to-face lectures designed as flipped classrooms. The computer-based teaching was composed of a pattern based on the UniversiTICE modular object-oriented dynamic learning environment (Moodle) platform with basic interactivity (<https://universitice.univ-rouen.fr/course/view.php?id=1615>; 2017/08/23). A password was required for admittance and the program was in French. Students followed a pre-defined course composed of each topic in the anaesthesia syllabus. For each topic, documents (texts written by the teachers belonging to the university hospital of the blended learning group or chapters extracted from references books) and references were available.

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