



Simulation and education

Pediatric resuscitation training—Instruction all at once or spaced over time?



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ARTICLE INFO

Article history:

Received 5 September 2014

Received in revised form 8 November 2014

Accepted 1 December 2014

Keywords:

Education

Spaced training

Pediatric Resuscitation

ABSTRACT

Aim: Healthcare providers demonstrate limited retention of knowledge and skills in the months following completion of a resuscitation course. Resuscitation courses are typically taught in a massed format (over 1–2 days) however studies in education psychology have suggested that spacing training may result in improved learning and retention. Our study explored the impact of spaced instruction compared to traditional massed instruction on learner knowledge and pediatric resuscitation skills.

Methods: Medical students completed a pediatric resuscitation course in either a spaced or massed format. Four weeks following course completion students completed a knowledge exam and blinded observers used expert-developed checklists to assess student performance of three skills (bag-valve mask ventilation (BVMV), intra-osseous insertion (IOI) and chest compressions (CC)).

Results: Forty-five out of 48 students completed the study protocol. Students in both groups had similar scores on the knowledge exam spaced: (37.8 ± 6.1) vs. massed (34.3 ± 7.6) ($p < 0.09$) and overall global rating scale scores for IOI, BVMV and CC; however students in the spaced group also performed critical procedural elements more frequently than those in the massed training group

Conclusion: Learner knowledge and performance of procedural skills in pediatric resuscitation taught in a spaced format is at least as good as learning in a massed format. Procedures learned in a spaced format may result in better retention of skills when compared to massed training.

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1. Introduction

1.1. Background

Resuscitation is a complex and important intervention typically taught through cardiopulmonary life support courses. Healthcare providers demonstrate limited retention of knowledge and skills in the weeks to months following resuscitation courses, and certainly well before the usual 2-year retraining period.^{1–6} There is

limited evidence on specific interventions that may enhance learning and retention following cardiopulmonary life support courses.¹ Courses with varying approaches (e.g., varying course length, self-paced modules) are equally efficacious for acquiring skills in CPR; however retention of those skills seems to be poor regardless of the teaching method used.² There is growing interest in educational interventions that may enhance learning and retention in cardiopulmonary life support courses.

While resuscitation courses have traditionally been taught using ‘massed’ instruction, that is, instruction occurring within a constrained period of time (e.g., typically within a day or a few days), research in psychology has suggested the pedagogical merit of ‘the spacing effect’: the finding that educational encounters spaced over time result in more efficient learning and improved learning retention.^{7–9} Studies in education psychology examining the

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spacing effect have shown improved outcomes in simple skills such as word repetition, picture recognition or discrete motor tasks. In medical education, application of the spacing effect has been shown to improve residents' retention and transfer of new surgical skills; however the spacing effect has never been applied in an advanced life support resuscitation course.^{1,10} Even though massed training conditions offer clear logistical advantages with regards to participant and instructor scheduling, educational material availability and attendance compared to spaced conditions; demonstration of a clear learning advantage in favor of spaced education would present a strong argument to reconsider design of resuscitation education programs.

1.2. Goals of this investigation

The objective of this study was to evaluate the impact of the spacing effect on learning of pediatric resuscitation. Our research question was whether a 5-h case-based pediatric resuscitation course for medical students delivered in spaced format results in better knowledge and practical skills compared to the identical course given in a massed format.

2. Materials and methods

2.1. Study design and setting

A prospective cohort study was conducted at the Montreal Children's Hospital—McGill University Health Centre. The study sample consisted of third-year medical students (clinical clerks) completing their core clinical rotation in pediatrics.

The Institutional Review Board of the Faculty of Medicine, McGill University, granted ethical approval for the study. Written informed consent was obtained from each participant. The study took place from March to June 2012.

2.2. Selection of participants

Potential participants were approached on the first day of their 8-week core clinical rotation. The study consisted of a convenience sample of participants (two 8-week blocks) with participants being allocated based on the timing of their rotation in pediatrics. For logistic reasons (instructor availability) the spaced group included all participants completing their pediatrics rotation from March–April 2012 and the massed group included all participants completing their pediatrics rotation from May–June 2012. Upon enrolment, participants were asked to complete a brief pre-course survey that included baseline demographic information, intended training program for residency and their motivation to learn pediatric resuscitation on a 5-point Likert scale (1 = Not at all motivated and 5 = Extremely motivated)

Prior to clinical training, students were certified in Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) for adults ensuring a basic understanding of resuscitation upon which the Pediatric Resuscitation course could build. Exclusion criteria included prior successful completion of a PALS course, completion of the pediatrics core clinical rotation at a rural site or a *priori* inability to attend the teaching or assessment sessions.

2.3. Course development

A 5-h Pediatric Resuscitation course was created based on the learning objectives and teaching methods of the complete Pediatric Advanced Life Support (PALS) course delivered by the Heart and Stroke Foundation of Canada and the American Heart Association. Delineation of course objectives has been previously described.¹¹ Two content-expert authors (CP and FB) developed an introductory

lecture, eight core-content interactive resuscitation cases and three practical skill stations (intra-osseous insertion, bag-valve mask ventilation and chest compressions) used to achieve the objectives (see Appendix 1 for a brief outline of course) and were designed to be delivered to groups of up to six students.

2.4. Course delivery

The pediatrics resuscitation course was delivered in two formats (spaced vs. massed). All sessions were held in teaching venues at the Montreal Children's Hospital—McGill University Health Centre. The content and length of the two training formats were identical. In the spaced group the content was delivered over 4 weekly 1.25 h sessions while in the massed group the content was delivered in a single 5-h session. Fig. 1 outlines the specific details and timing of each course format. The course was delivered by five instructors all of who were certified PALS or ACLS instructors. One instructor (CP) delivered the 50-min introductory session in a standardized format. The remainder of the course consisted of 8-core content cases and three practical skills stations. In the spaced training conditions, each of the three skills (intra-osseous (IO) insertion, bag-valve mask ventilation (BVMV) and chest compressions (CC)) was taught during each of the four teaching sessions (i.e., students were taught and practiced IO insertion at each of the 1.25 h weekly sessions etc.); however the total time spent on each skill was identical in both training conditions. We attempted to achieve consistency of instruction for the remainder of the course by providing instructors with clear objectives, curriculum outlines, case and practical station teaching guides. Additionally, instructors were rotated so that each participant had equal amounts of contact with at least four different instructors. Upon completion of the course, participants (regardless of assigned training condition) were asked to rate on a 5-point Likert scale their preference for either spaced (1) vs. massed (5) instruction

2.5. Assessment

Participant assessment occurred 4 weeks following the completion of the last session of either course (i.e., 4 weeks after the massed course or 4 weeks after the final session of the spaced course). The assessment session consisted of a written multiple-choice exam and three practical skill stations.

2.6. Multiple-choice exam (MCE)

Questions were taken directly from the multiple choice exams used in the PALS course. All potential questions from the two 2011 versions of the written test of the PALS course were pooled and assessed for relevance to the defined learning objectives by two of the authors (CP and FB). Duplicate or similarly worded questions were eliminated. All questions (relevant and irrelevant to the course objectives) were included. The multiple-choice exam consisted of 57 questions of which 9 questions were considered not relevant to the Pediatric Resuscitation Course objectives. Scoring of the tests was 1 mark for correct answers, no marks for unanswered questions or incorrect answers.

2.7. Practical skill assessment

There were no validated tools available to assess intra-osseous (IO) insertion, bag-valve mask ventilation (BVMV) and chest compressions (CC). Following extensive review of the literature, the authors (FK, CP and FB) along with two additional content experts, (DC and AD) developed tools to assess each of the skills. Each assessment tool consisted of a checklist of items followed by a global rating scale assessing overall performance of the task on a 5-point

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