Avoiding Surgical Skill Decay: A Systematic Review on the Spacing of Training Sessions

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OBJECTIVE: Spreading training sessions over time instead of training in just 1 session leads to an improvement of long-term retention for factual knowledge. However, it is not clear whether this would also apply to surgical skills. Thus, we performed a systematic review to find out whether spacing training sessions would also improve long-term retention of surgical skills.

DESIGN: We searched the Medline, PsycINFO, Embase, Eric, and Web of Science online databases. We only included articles that were randomized trials with a sample of medical trainees acquiring surgical motor skills in which the spacing effect was reported. The quality and bias of the articles were assessed using the Cochrane Collaboration's risk of bias assessment tool.

RESULTS: With respect to the spacing effect, 1955 articles were retrieved. After removing duplicates and articles that did not meet the inclusion criteria, 11 articles remained. The overall quality of the experiments was "moderate." Trainees in the spaced condition scored higher in a retention test than students in the massed condition.

CONCLUSIONS: Our systematic review showed evidence that spacing training sessions improves long-term surgical skills retention when compared to massed practice. However, the optimal gap between the re-study sessions is unclear. (J Surg Ed 75:471-480. © 2017 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: spacing effect, surgical skills, long-term retention, distributed practice, simulation training, medical education

COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement

INTRODUCTION

Traditionally, surgical skills have mostly been taught through mentoring and apprenticeship. Recently, McGaghie[1] stated that the underlying assumption of apprenticeship-based clinical training is that students gain competence over time simply by exposing them to patients and experience. He argued that it lacks structured learning objectives, skill practice, and objective assessment with feedback. In the past decades, medical skills training has been shifting toward simulation-based mastery training,[2,3] and currently it is appreciated that deliberate practice in a simulation lab is a valuable add-on to learning surgical skills.[4] This type of training lays emphasis on achieving defined learning objectives and offers students an opportunity to practice skills without time restrictions.[5] It can be tailored to individual student's needs concerning skills, knowledge, attitudes, and the decision-making process, which, in turn, allows students to learn at their own pace in a safer, more ethical environment.

Surgical skills training requires a large amount of instructor time, effort, and resources. Furthermore, an acquired surgical skill will decay over time after periods of nonuse, which could potentially be a threat to patient safety. Most skills training sessions focus on student learning rather than long-term retention.[1] Research revealed that some students had not been able to proficiently perform the required skill 1,[6] 6,[7,8] or 12 months[7] after they had finished their training. These findings imply that practicing until proficiency may not be

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enough to guarantee long-term retention. Thus, improving long-term retention of surgical skills becomes crucial to safeguard patient care. Based on cognitive psychology, several guidelines for medical skills training suggest the spacing effect as a way to avoid skills decay.

The spacing effect refers to spacing training sessions over time rather than training in just 1 session (massed learning).[9] A comprehensive review that investigated several learning techniques showed that the spacing effect was the most effective strategy for students' learning when compared to other techniques.[10] Spaced training has been shown to improve long-term knowledge and skills retention, for instance, in tasks concerning verbal recall,[11] English as a second language,[12] computerized spelling,[13] reading,[14] biology,[15] mathematics,[16] medical knowledge,[17] arm movements,[18] command-and-control simulation,[19] and dynamic balance.[20]

The key to improve long-term retention is the time between training sessions, which is known as the intersession interval. The space between the training sessions will determine the retention interval, which is the time between the last training session and the final test. The longer the required retention interval, the longer the intersession intervals should be.[11] A review from the psychology literature suggested that, for the best knowledge retention, the intersession interval should be approximately 10%-15% of the retention interval.[9]

In the medical education literature, some authors recommend spacing the training sessions to increase skills retention,[21,22] but it remains unclear how often trainees should practice or what the duration of the intervals between the training sessions should be. To optimize skills training and foster retention, we performed a systematic review to answer the following research questions:

(1) Is spaced practice better than massed practice for acquiring and retaining surgical skills?
(2) If so, what would be the optimal intersession interval?

To answer our research questions, we conducted a systematic review on studies on the spacing effect related to surgical skills retention. We strived to identify underlying theories as well as aspects of the spacing effect that were taken into account in the design of skills training programs.

METHODS

We conducted a systematic review using principles of the PRISMA Guidelines[23] and guidelines provided in Medical Education.[24]

Search Strategy and Data Sources

We searched the Medline, PsycINFO, Embase, Eric, and Web of Science online databases in February 2016. No language or other limitations were imposed on the search. We first searched the terms *skills retention*, *skills acquisition*, and *spacing effect*. As we noticed that the terms *distributed* and *retrieval* were often used as synonyms for *spacing* and *testing*, we included these words as key words. The search strategy used for Medline was as follows:

(1) ((((“skill* retention” OR “skill* development” OR “skill* retrieval” OR “skill* acquisition” OR “skill* retrain*”)))) AND (distribut* OR spac* OR massed)
(2) (“distributed practice”) AND skill*
(3) (“spacing effect”) AND skill*

The search strategy was adapted for the other databases. Subsequently, we hand-searched the reference lists of identified articles for citations of additional relevant articles. Web of Science and Google Scholar were searched for citing articles of all included articles.

Inclusion Criteria

Studies were included if they met the following criteria:

(1) *Population*: Medical trainees.
(2) *Intervention*: The intervention had to be on surgical skill acquisition.
(3) *Comparison*: Comparisons had to include at least 2 of the following conditions: control, massed, and spaced.
(4) *Outcomes*: Change in surgical task performance as measured by motor skill performance.
(5) *Study design*: Randomized trial.

Study Selection

Two authors (D.C.-F. and R.T.) independently reviewed the titles and abstracts of the retrieved publications. Each article was initially categorized as “maybe” or “excluded” based on the information of the titles and abstracts. If one of the reviewers had classified an article as “maybe,” the full text was retrieved to verify whether the article met the inclusion criteria. In the subsequent stage, the same authors independently reviewed the full articles. All articles that matched the inclusion criteria were included in the review.

Data Extraction

The first author extracted and documented information about the type of task, design of the experiment, participants, groups and practice schedule, length of the retention interval, measures, spacing, and main findings. The other authors verified the retrieved information.

Quality Criteria

We assessed the quality and bias of the articles using the Cochrane Collaboration's risk of bias assessment tool based on