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To cite this article: Stephen D. Schneid, Hal Pashler & Chris Armour (2018): How much basic science content do second-year medical students remember from their first year?, Medical Teacher, DOI: 10.1080/0142159X.2018.1426845

To link to this article: https://doi.org/10.1080/0142159X.2018.1426845

Published online: 23 Jan 2018.
SHORT COMMUNICATION

How much basic science content do second-year medical students remember from their first year?

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ABSTRACT
While most medical students generally perform well on examinations and pass their courses during the first year, we do not know how much basic science content they retain at the start of their second year and how that relates to minimal competency set by the faculty. In the fall of 2014, before starting their second-year courses, 27 medical students volunteered to participate in a study of long-term retention of the basic sciences by taking a “retention exam” after a delay of 5–11 months. The overall mean performance when the students initially answered the 60 multiple choice questions (MCQs) was 82.8% (standard deviation (SD) = 7.4%), which fell to 50.1% (SD = 12.1%) on the retention exam. This gave a mean retention of 60.4% (SD = 12.8%) with the retention for individual students ranging from 37 to 81%. The majority of students (23/27; 85%) fell below the minimal level of competency to start their second year. Medical educators should be more aware of the significant amount of forgetting that occurs during training and make better use of instructional strategies that promote long-term learning such as retrieval practice, interleaving, and spacing.

Introduction
One of the many goals of a medical school curriculum is to help students achieve a strong mastery of the basic sciences and retain this foundational knowledge for more advanced coursework, licensing exams, and ultimately taking care of patients. This basic science content is typically delivered to students in the form of organ system blocks or discrete courses that occur over a relatively short period of weeks, which may promote forgetting. This is of great concern because approximately one-third of unrehearsed knowledge is expected to be lost over the course of 1 year, resembling the forgetting curve first described by Ebbinghaus in the late 1800s (Custers and Ten Cate 2011). One important way to blunt forgetting is to provide frequent opportunities for students to engage in retrieval practice (Roediger and Karpicke 2006). Therefore, medical educators should consider long-term retention when designing curricula so that students maximize their learning within the limited time available.

The purpose of this study was to build upon the limited medical student long-term retention research by looking at how much student performance declines between the first and second year, and relate it to minimal competency based on pass–fail lines set by the course faculty.

Methods
This was a longitudinal study using a within-subjects design. Medical students at the beginning of their second year (MS2s) were given an exam to test their retention of basic science concepts from four of their first year courses. The institutional review board granted ethical approval for this study.

Construction of the “retention exam”
At the beginning of the fall quarter in 2014, all 126 MS2s starting their second year were solicited, via a class announcement, to participate in a study of long-term retention of the basic sciences by taking a 2-hour “retention exam”. A total of 27 students participated in the study, resulting in a participation rate of 21%. Informed consent was given before the students participated in the study. They were unaware that they would be retaking multiple choice questions (MCQs) from four first-year course final exams after a delay of 5–11 months depending on when they took the final exam for the particular course. The four courses were the following: cardiovascular system (CV), renal system, mind/brain/behavior (MBB), and endocrinology/reproduction/metabolism (ERM), and each course was taught as an integrated “block” that included physiology, pharmacology, anatomy, and histology. The students were given two hours to complete the 60 MCQ “retention exam”, which contained 15 randomly selected MCQs from each course’s final exam. The number of questions and exam time were the same as a typical course final exam. Students were able to withdraw from the study at any time.

Calculation of retention
To calculate retention, student responses on the selected MCQs from the initial exams were compared with their responses on the same MCQs on the retention exam. Retention was calculated by dividing the performance on the retention exam by performance on the selected MCQs from the initial exams.
Determination of minimal competency

The students’ overall score on the retention exam was compared to the pass–fail lines set for the four courses, which ranged from 60 to 70%. Overall scores falling below 65% were considered below minimal competency.

Results

The 27 MS2s participating in this study appeared to be similar to the remaining 99 students in the class with respect to exam performance. The means of their initial scores on each course’s final exam were not significantly different from the scores for the rest of the class. For all of the course final exams combined, the participants had a mean of 82.0% [standard deviation (SD) = 10.0%] and the remainder of the class had a mean of 81.9% (SD = 9.8%). The p-value comparing the two means was 0.89.

The 60 randomly chosen MCQs used to construct the retention exam had a similar level of difficulty when compared to the other 132 MCQs on the course exams. The initial means of the MCQs from each course included in the study were not significantly different from the means of the MCQs that were not used. For all of the courses combined, the retention exam MCQs had a mean of 82.7% (SD = 11.9%), the remaining MCQs had a mean of 82.5% (SD = 14.4%), and the p-value comparing the means of the two sets of MCQs was 0.92. An index of the internal consistency of the exams was calculated using the Kuder–Richardson Formula 20 (KR20). The KR20 calculated for the retention exam was 0.79, which was similar to the reliability coefficients of the four initial course exams.

Figure 1 shows the mean performance by the participants when they initially answered the MCQs, the mean performance of the same MCQs answered a second time after a retention interval, and the mean retention. The decay in performance from 82.8% (SD = 7.4%) to 50.1% (SD = 12.1%) was statistically significant (p < 0.01) with an effect size Cohen’s d = 3.3. The retention for the individual courses ranged from 45.8% to 68.8% with an overall retention of 60.4% (SD = 12.8%). For individual students, the overall retention ranged from 37 to 81%. When the students initially took the course exams, all 27 students scored above 65% overall on the questions from the four subject areas. After the retention interval, 23 students (85%) fell below the minimal competency line of 65%.

Discussion

The overall retention of 60.4% is within the range of 48–80% seen in other studies of preclinical medical student basic science knowledge retention (D’Eon 2006; Custers and Ten Cate 2011; Weggemans et al. 2017) and the 66–75% reported by most educational studies from other disciplines (Custers 2010). The decrement in performance was significant enough for 85% of the students participating in this study to be considered below the minimal level of competency at the start of their second year, with ~25% of the participants falling below 40% overall. While this may be considered normal forgetting, it does raise serious concerns if educators expect medical students to be competent in these areas entering their second-year courses.

At our institution, second-year courses focus on pathophysiology and pathology of the major organ systems taught in the first year and have a review component scheduled at the beginning of each course. This “two-pass” curricular structure facilitates reactivation of knowledge from the first year and may have helped all of the students who participated in this study pass their second-year courses related to the first-year courses assessed by our retention exam despite a significant amount of forgetting between the first and second year. These students also went on to pass the United States Medical Licensing Exam (USMLE) Step 1. Differences in course structure that provided additional opportunities for retrieval practice and spacing may have enhanced students’ long-term retention and explain the variability of retention observed between courses. For example, the two courses with the highest retention (CV and MBB) were longer (4 and 5 weeks, respectively) and had a midterm and cumulative final.
whereas the other two courses were shorter (3 weeks) and only had a final exam.

This study has some limitations. First, only four of the ten courses from the first year were studied, which does not provide retention data across the entire first-year medical school curriculum. However, the four blocks selected for this study were the taken by the students widely spread out throughout the first year to give a more broad temporal perspective. Second, it is possible that some topics came up again in other courses and reactivated some of the knowledge from some of the courses used in this study. However, this would have lead to an overestimation of retention. Third, since long-term retention was estimated by simply comparing the students’ percentage of correct answers on their initial performance to that on a later retention exam, we may have overestimated retention due to guessing (Weitman 1964).

Our study addresses some of the weaknesses of the few basic science retention studies that have been published. For example, one study used retention questions that were different from questions the students had taken the first time (Custers and Ten Cate 2011) and in another study original scores were “not available” for comparison (D’Eon 2006). In a recent study (Weggemans et al. 2017), students were “allowed to consult their books” in a computerized testing format for half of the original questions but the retention exam was administered by paper and no books were allowed. Also, the authors stated there was “a clear volunteer effect”, with an overrepresentation of above-average students. Since all of the studies mentioned above were conducted in Canada and the Netherlands, our study provides current retention data from a United States medical school.

Conclusions

Medical educators should be more aware of the significant amount of forgetting that occurs during training and incorporate retention exams as part of the overall evaluation of the curriculum assuming the content learned is essential to medical practice. Collection of baseline retention data as we have done is important so that the effectiveness of curricular changes can be better assessed. We recommend introducing teaching practices and curricular structures that have strong evidence backing effectiveness for student learning and long-term retention, such as incorporating frequent opportunities for retrieval practice that are interleaved and spaced out over longer periods of time (Olusola et al. 2017). Ideally, if students are able to retain more basic science from their first year, the learning process during the second year will be more efficient and students will rely less on outside resources to compensate for their loss of knowledge.

Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

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References


D’Eon MFD. 2006. Knowledge loss of medical students on their first-year basic science courses at the university of Saskatchewan. BMC Med Educ. 6:5.


