

# Nephrology fellows show consistent use of, and improved knowledge from, a nephrologist-programmed teaching instrument

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## ABSTRACT

**Introduction:** Teaching nephrology through a traditional classroom-based approach has significant time and place limitations. In the 21st century, these limitations are more prevalent and harder to resolve. Fortunately, online teaching instruments can overcome these restrictions. On this basis, we hypothesized that a nephrology-focused online teaching instrument, programmed and maintained by nephrology educators, would result in sustained use by, and improved test scores for, nephrology fellows.

**Methods:** To test this hypothesis, we programmed and managed a 3-tiered Web-based teaching instrument based on the Blackboard platform. Nephrology fellows from Emory University, from the Classes of 2008-2010, were the primary subjects asked to use this instrument. We tracked their use of every teaching resource for 20 months. In addition we tested their knowledge of nephrolithiasis before and after using our interactive teaching module.

**Results:** Both the e-Library and Discussion forums showed increases in total use from years 1 to 2 (31% and 91% increases, respectively). When stratified by category or year in training, the changes in average monthly use of all online teaching resources were non-significant. Eight of 10 renal fellows showed increases in postmodule test scores (42.3% increase for the Class of 2009; 10.7% increase for the Class of 2010).

**Conclusions:** Our results demonstrate sustained use in all 3 tiers of the online instrument. There was a significant improvement in knowledge after using the online module. The results indicate that nephrology educators can program sustainable online teaching tools that improve fellows' knowledge of nephrology.

**Key words:** E-learning, Internet education, Medical education, Nephrology education, Online education, Web learning

## INTRODUCTION

The time-tested and reliable classroom-based approach to teaching students, including physicians, has been used for decades. Its successes, however, are predicated on physicians being at the right place at the right time. In the 21st century, meeting these criteria concurrently is increasingly difficult (1). As a result, learning failures occur, manifested as poor attendance, suboptimal focus and student dissatisfaction. Physicians want to learn in a model that is flexible, with around-the-clock access to rich educational resources from any location. The Internet meets these requirements but has not had tremendous success in educating physicians (2, 3). The reasons for this include a lack of rich multimedia, the

inability to consolidate resources into one site, poor content organization and questionable reliability of educational material. If executed correctly, an Internet-based teaching tool can improve physician knowledge (4). We hypothesized that a nephrology-focused online teaching instrument that is programmed and maintained by nephrology educators would result in sustained use by, and improved test scores for, nephrology fellows.

## MATERIALS AND METHODS

Our Web site was built upon the Blackboard Academic Suite (<http://www.blackboard.com/>). The first author was the primary programmer for the 3 tiers: electronic library, discussion forum and interactive module. Initial programming occurred from July to August 2007, and the Web site was activated for general use in September 2007.

The electronic library (e-Library) was divided into 10 categories. Each provided links to clinical trials, review articles, lecture slides and audio or video files of institutional conferences. A search feature using tags was added for quick access. The e-Library was updated 2-3 times per week. Faculty members reviewed material for quality and relevance. Links allowed for direct viewing of teaching resources online; downloading was not required. Lecture slides were converted into Flash video using Slideshare.net (<http://www.slideshare.net>). Users were tracked through an online global relational database if they had begun to work with a teaching resource.

The discussion forum (forum) was divided into 5 topics of conversation (threads). The creator of a thread was its moderator. Each user could create a thread and post messages in other threads, but they could not modify or delete messages or threads generated by other users. Messages within a thread were organized in a hierarchy. This allowed users to identify the initial message and subsequent responses. Each thread was linked to an educational resource in the e-Library or World Wide Web. Individuals could link additional educational resources to their messages. Users were tracked through the same online global relational database and divided into hits (user reads only) and posts (user creates a message).

The teaching module in nephrolithiasis consisted of 65 PowerPoint slides converted into Flash video. Sixty references were used to build the module, and all slides were linked to the abstract or full-text of the corresponding reference. Thirty multiple-choice questions were divided equally into premodule and postmodule examinations. Questions were derived from NephSAP 2002-8, the journal *Hospital Physician* (5) and the Pediatric

Nephrology Board Review. Fellows participating in this study gave informed consent prior to entry. After completing the premodule exam, fellows were given access to the module and postmodule examination for 30 days. Scores and number of accesses were recorded on the online database.

The Web site underwent weekly maintenance, which included updating hyperlinks and tags, adding new educational content and integrating resources across the tiers. We used the Rice Virtual Lab in Statistics (<http://onlinestatbook.com/rvls.html>) and Microsoft Excel 2008 to calculate 95% confidence intervals, correlated and independent *t*-tests, and *p* values.

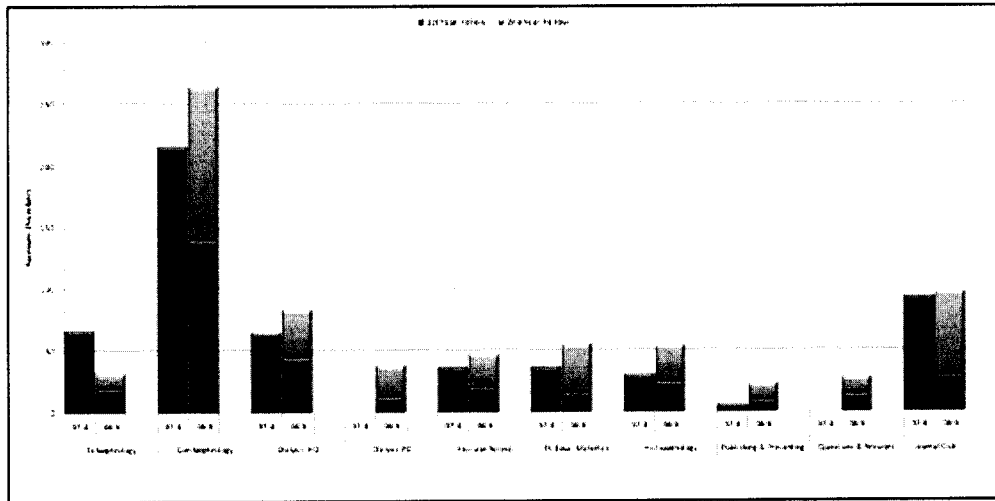
## RESULTS

A maximum of 18 nephrology fellows had the opportunity to access the Web site during the study period, with 12 (66%) accessing the Web site more than once during the study period. Table I shows demographic characteristics of the study population. Secondary subjects included faculty and hemodialysis nurses. Forty-three percent and 44% accessed the Web site at least once, respectively.

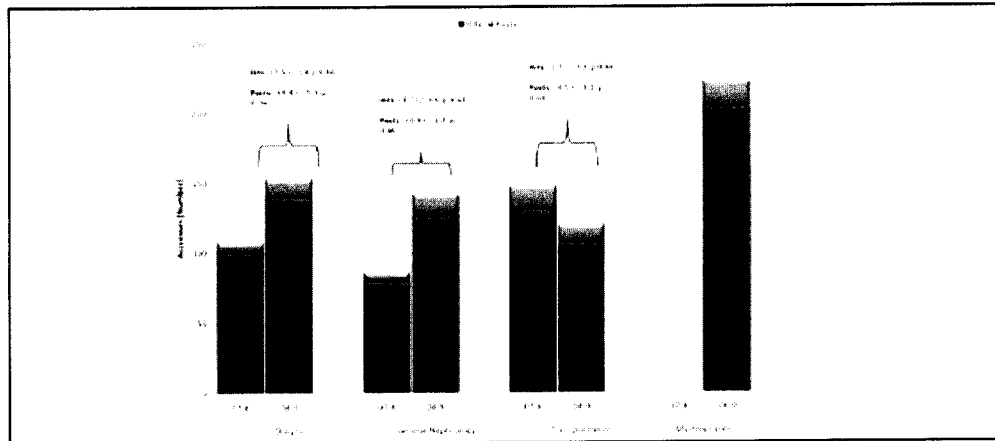
There were 1,471 accesses of the e-Library in the 20 months of investigation, with an increase of 31% from year 1 to 2. This represented approximately 2.37 accesses per user per month. Of the 10 categories represented, only 8 existed in both academic years. General Nephrology showed the greatest activity (36% of total accesses), while Publishing and Presenting showed the least (2.2% of total accesses). When stratified by category, the average monthly use did not differ from year 1 to 2. First-year fellows showed a nonsignificant decrease in average monthly use for all categories. In contrast, second-year fellows showed a nonsignificant increase in average monthly use for all categories. These data are presented in Figure 1.

There were 930 hits and 103 posts during the study period. This represented a 91% and 97% increase from academic year 1 to 2, respectively. Average monthly hits and posts were increased from years 1 to 2 in the Dialysis and General Nephrology threads. The Transplant Nephrology thread showed a nonsignificant decrease in hits and posts. Although the Mystery Cases thread did not exist in academic year 1, 22% of all hits and 18% of posts occurred in this thread. These data are presented in Figure 2.

Ten out of 12 nephrology fellows completed the premodule and postmodule examinations. One fellow in the Class of 2010 declined participation, and another in the Class of 2009 was excused because of his participation in this study.



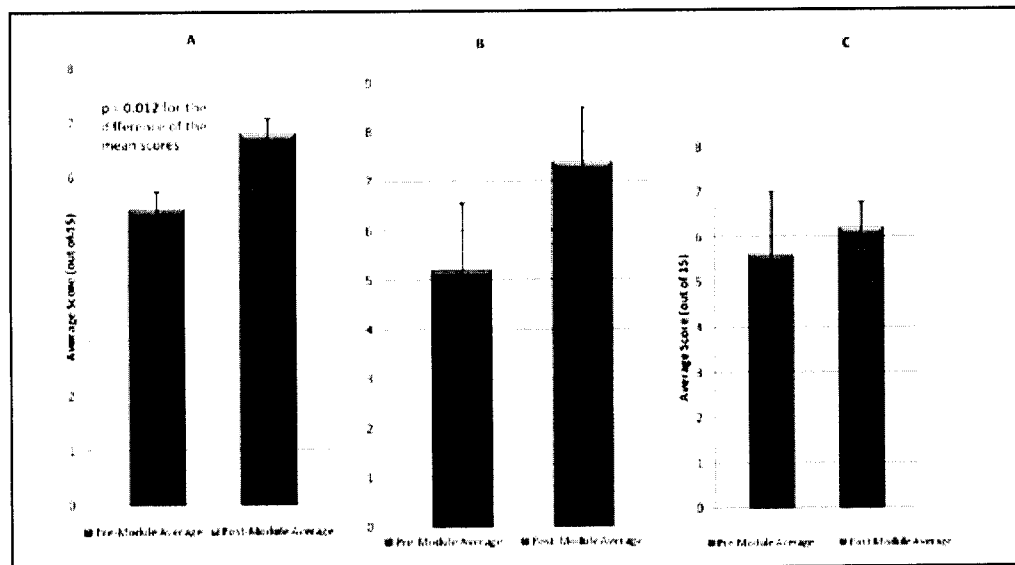
**Fig. 1 - Electronic library utilization by academic rank and year. Data are means  $\pm$  SEM. Excluding the Dialysis-PD and Questions & Answers categories, all categories showed nonsignificant changes from 2007/2008 to 2008/2009. Average monthly use of resources in all categories by first-year fellows decreased ( $-22 \pm 12.9$ ;  $p=0.10$ ) and by second-year fellows increased ( $+32.8 \pm 6.5$ ;  $p<0.05$ ) from year 1 to 2. HD = hemodialysis; PD = peritoneal dialysis; Tx = transplantation.**



**Fig. 2 - Discussion Forum utilization by academic rank and type of use. Data are mean differences  $\pm$  SE mean difference. Hits and posts were unchanged from 2007/2008 to 2008/2009 for the threads Dialysis, General Nephrology and Transplantation.**

**TABLE I**  
DEMOGRAPHICS OF NEPHROLOGY FELLOWS

Class	No. of Fellows	Sex	Years between residency & fellowship
2008	6	50% male	50% - 0 years
		50% female	50% - 1 year
2009	6	83% male	100% - 0 years
		17% female	
2010	6	83% male	17% - 0 years
		17% female	66% - 1 year
			17% - 2 years



**Fig. 3 - Premodule and postmodule examination scores. Data are means  $\pm$  SEM. The p values were calculated by the difference of the means. A) The overall change in test scores. B) The change in test scores for the Class of 2009. C) The change in test scores for the Class of 2010.**

Premodule examination scores were not different between the Class of 2009 and 2010 ( $5.6 \pm 0.51$  points versus  $5.2 \pm 0.49$ ;  $p=0.35$ ). Eight fellows showed an improvement in their postexamination scores. One student showed no change, and 1 student had a decrease in the score. In total, there was a statistically significant increase in test scores after use of the interactive module. Stratification of the scores revealed a statistically significant increase only in the Class of 2009 (42.3% increase;  $p=0.02$ ). Scores in the Class of 2010 increased by 10.7% ( $p=0.30$ ). Pearson's product correlation revealed no association between the number of module accesses and improvement in test scores ( $r=0.19$ ). These results are presented in Figure 3.

## DISCUSSION

There are 2 key and equally important findings in this study. First, a nephrology-focused online teaching instrument, designed and managed completely by nephrology educators, showed a sustained use by nephrology fellows. Second, such an online teaching instrument improved fellows' knowledge of a nephrology-specific topic.

The e-Library showed sustained use in the 20-month study period. All 8 categories that existed in both the first and second academic years showed no significant changes in online use. Among those 8, the 3 categories with the widest appeal were General Nephrology, Journal Club and Hemodialysis. A similar pattern developed in the Forum. Fellows consistently read and posted to the General Nephrology and Dialysis threads. Notably, fellows' use of

these online resources was not tied to a training program mandate/requirement or a tangible reward or punishment. Although inconclusive, this fact suggests that the fellows valued the educational content of both tiers enough to continue using the online instrument.

Similar to the e-Library and Forum, the nephrolithiasis teaching module was designed, programmed and maintained by nephrologists. We chose nephrolithiasis because fellows of previous years requested more teaching in this subject. This study confirmed that Emory fellows were not learning enough about nephrolithiasis through conventional means between years 1 and 2. Our interactive module increased test scores regardless of training year. In such a situation, the module can be used to fill in the gaps not addressed by traditional teaching methods. The average monthly use of e-Library resources is in line with other online instruments. The Walter Reed Army Medical Center Web site recorded 1,007,103 accesses from 12,175 users over an 11-month period. This is equivalent to 7.5 accesses/user per month (6, 7). The Society of Critical Care Medicine recorded  $664 \pm 290$  audio podcasts downloads in 7 months, but did not mention the number of users accessing their resources (8). An internal medicine-focused Web site recorded 3,088 accesses over 26 months for 81 users, equating to 1.5 accesses/user per month (9). However, it is not clear how heavily dependent these instruments were on information technology departments or personnel, and whether that dependency influenced their results.

A key feature of the Forum's success was its design. The prototypical medical blog details the comments of 1 or a few

users. Only the blogmaster or his/her delegates can initiate a thread. The majority of users are limited to responding to the blogmaster. Our Forum allowed all users to initiate threads. This critical feature gave all users equal opportunity to utilize the Forum and was instrumental in its success (10).

We were pleasantly surprised that our teaching module increased test scores in ways that were in line with other investigations. A study of hospitalists' knowledge of topics in cardiology resulted in exam score increases of 25%-52% (11, 12). Internal medicine residents exposed to an online teaching instrument that was centered on improving post-myocardial-infarction care scored 9%-10% higher after its use. Other instruments have shown similar increases in test scores to our results (12-15).

A number of notable study limitations require mention. First, we did not directly assess user satisfaction with our teaching instrument. Fellows may have used our online instrument for reasons other than that it was appealing, informative or useful. Second, our study may have overvalued sustainability. It is known that a variety of Web-based teaching tools become defunct because of a lack of sustained use. Although sustainability is not an accurate measure of value or usefulness, it is a necessary prerequisite for assessing these qualities. Third, each fellow served as his/her control during the teaching module experiment. We made a strategic decision not to create a formal control group. We could not reliably keep such a group from using the Web site. Even if specific IP addresses were blocked or individual accounts were deactivated, fellows could easily use a computer with a dynamic IP address configuration or share usernames and passwords.

## CONCLUSION

Our first attempt at programming and managing a nephrology-focused online teaching tool showed sustained

use and test score increases on a par with other instruments. Administrators of fellowship training programs now know that they can develop, program and manage a successful teaching Web site, without dependency on IT services or personnel. Each nephrology training program will value this independence differently, but all can be increasingly confident that physicians with limited computer programming knowledge can develop an informative and useful teaching tool.

Finally, readers may be concerned about replacing the traditional classroom-based approach with Web-based tools. The Accreditation Council for Graduate Medical Education mandates 150 hours of conference-based didactics yearly (Section IV, Part B, No. 3) (16). The Council does not mention how or if Web-based instruments can replace traditional didactics. Recognizing that Web-based teaching tools are in their infancy and given the Council's recommendations, we do not advocate replacing classroom-based teaching. A wiser approach would be to supplement the traditional didactics with Web-based teaching tools, while further investigations are conducted to determine the appropriate place for the latter.

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