

Pre-class versus In-class Video Lectures for the Flipped Classroom in Medical Education: A Non-randomized Controlled Trial

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ABSTRACT

Objective: The objective was to test the effectiveness of the two different teaching models focusing on pre-class preparation.

Methods: This study was a single-center, post-test only, non-randomized, controlled trial. The fourth-year medical students were assigned to attend either flipped classroom (FC) or in-class video classroom (IVC). The FC students watched a pre-class video lecture individually. In contrast, IVC students viewed the video together during class time. Both groups had the same in-class interactive activities, including case quizzes and discussion. The primary outcomes were a post-test score and student satisfaction.

Results: Of 105 students, 53 were assigned to the FC group and 52 to the IVC group. 77% of the FC students reported video viewing. There was no significant difference in the post-test score between the FC and the IVC groups ($p = .107$). However, the subgroup analysis showed that the post-test score of the IVC group was significantly higher than the FC subgroup who did not view the video ($p = .024$). The total satisfaction score was not significantly different between the FC and the IVC groups ($p = .945$). 83% of the FC who did not view the video claimed they had too many out-of-class workloads.

Conclusion: There were no differences in the effectiveness between the FC and IVC approach. However, the IVC students showed better knowledge acquisition over the FC subgroup, who did not watch the video. Hence our study emphasized an essential role of the knowledge preparation on the successful flipped classroom.

Keywords: Flipped classroom; medical education; nonrandomized controlled trials (Siriraj Med J 2020; 72: 476-482)

INTRODUCTION

Medical knowledge is rapidly expanding, diseases are newly emerged and more complicated, and patient care is increasingly individualized. In medical education, a teaching model like a traditional didactic lecture may not be suitable. In contrast, many believe that an active-learned, critical thinking-based technique such as flipped classrooms (FC) is more efficient. Its characteristics promote higher cognitive learning, not only memorization. The results

of a meta-analysis study supported the effectiveness of the FC on learning.¹ It concluded that the FC approach yields a significant improvement in student learning compared with traditional teaching methods. However, its effectiveness in medical education is inconsistent in the previous systematic review.² The key to the FC approach's success is that students take responsibility for their learning and prepare before class.³ The pre-class assignment was aimed to master the factual knowledge

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in preparation for the in-class interactive experiences. This preparatory work also makes students control their learning process by defining learning goals and monitoring their progress in achieving them.⁴ Failure to do so leads to compromise the knowledge acquisition when finishing the FC. The previous studies, including our teaching experience, found that many students did not comply with the pre-class assignment, making the FC fail.^{5,6} Our research question was whether the well-prepared teaching material could be effectively used as a pre-class self-study for the flipped classroom. We compared the learning outcome using PowerPoint recording video as the teaching material between pre-class self-study and in-class study (FC vs. in-class video classroom (IVC)).

MATERIALS AND METHODS

Study design and participants

This study was a static-group comparison, post-test only, non-randomized controlled trial. The trial was done at the Faculty of Medicine, Srinakharinwirot University, Thailand. Its six-year Doctor of Medicine (MD) program is split into two parts. The first half is the pre-clinical phase, and the second is the clinical phase. The population of interest was medical students, while the study participants were fourth-year medical students (clerkship). Eligible criteria included students who registered for the Seizures and Epilepsy module during the academic year 2018-19. Students were excluded if they did not attend the class, did not complete a post-test, or did not give the student feedback on teaching. Four student groups (A, B, C, and D) were preexisting formed for medical rotations. Grade point averages (GPAs) in pre-clinical years were evenly distributed across the groups. We assigned these groups to expose two different teaching styles. The study intervention cohort included groups A and C, while the comparison intervention cohort included groups B and D. The study was approved by the Human Ethics Committee of Srinakharinwirot University, Bangkok, Thailand (SWUEC/E-368/2017), and all participants provided written informed consent.

Interventions

The interventions were two different teaching methods regarding student pre-class preparation. The study intervention was an FC approach. Pre-class 30-minute video lecture watching was assigned two weeks in advance. The students could individually view the streaming online video lecture on their own devices via the provided link. We used the PowerPoint slide presentation as a video format. The content encompassed basic knowledge of seizures and epilepsy (definition,

etiology, and mechanism), video clips of seizure types, diagnostic approach, and treatment principle. During the 40-minute class time, the students participated in the problem-solving activity and large-group interactive discussion. There were 26 to 28 attendees in each class. This in-class session contained short diagnostic quizzes with answer choices on ten common epileptic case scenarios. The students were able to discuss with nearby classmates and voted via their own devices. The screen in front of the class showed the voting results. The teacher explained the answers while students could freely give the comments or ask the questions.

For the comparison intervention in the IVC, there was no pre-class assignment. Alternatively, students were assigned to view the video lecture together at the beginning of the class. Unlike the FC group, this step ensured that everyone got preparatory knowledge before the interactive session. After that, they did the same as the FC group's in-class activity, including case quizzes with discussion. The critical difference between the study intervention and the comparison intervention was how students prepared for the interactive class, i.e., out-of-class or in-class video lecture viewing. The in-class duration of the FC was 40 minutes, while that of the IVC was 70 minutes (Fig 1). Only one teacher taught all the study groups.

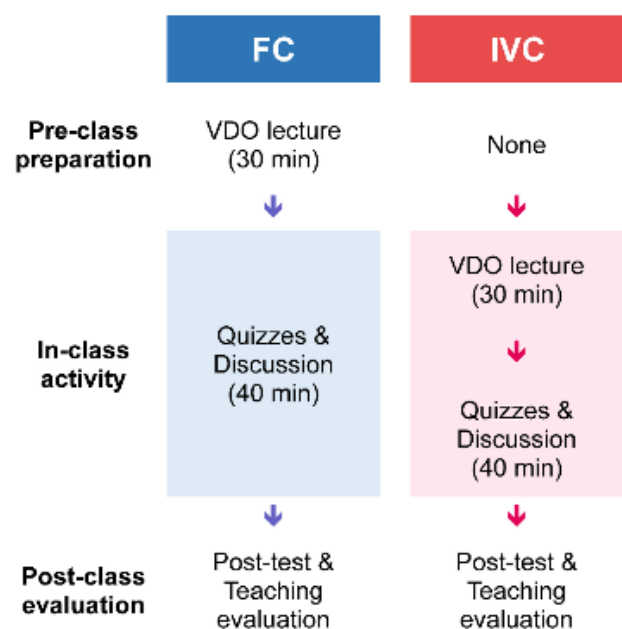


Fig 1. Class protocols

Pre-class video lecture viewing was assigned for the FC group, while IVC students watched the video lecture together at the beginning of the class.

Abbreviations: FC = flipped classroom, IVC = in-class video classroom

Outcomes

There were two primary outcomes, including a post-test score and a total satisfaction score. The students did the 10-item MCQs post-test at the end of the class. All questions were application type. They were told that it was not an examination and done on the purpose of research only. They had to complete the test individually, and the discussion was not allowed at this stage. Student feedback on teaching was also anonymously given at the same time. This feedback included ten aspects of teaching quality using a five-point Likert scale as the point. The total satisfaction score was the sum of these points. The feedback also included the other three open-ended questions about what they were satisfied or not, and the video watching information.

Statistical analysis

There was no sample size calculation. All students who registered for the Seizures and Epilepsy module in the academic year 2018-19 were enrolled. Quantitative variables (post-test score, student satisfaction scores, video watching duration) were reported as mean with SD or median with IQR. Independent-samples t-test or

one-way ANOVA was used to compare variables with a normal distribution. Mann-Whitney *U* test or Kruskal-Wallis test was chosen to compared variables with non-normal distribution. A post hoc test was performed using Bonferroni correction. Spearman's rho correlation was selected for the association between the post-test score and the video watching duration. Categorical variables (video watching proportion, reasons for not viewing the video, what students like or dislike about teaching) were reported as a percentage. All statistical analyses were done with IBM SPSS Statistics for Windows, Version 25.0. Statistical significance was set at a two-sided α of 0.05.

RESULTS

Between May 28, 2018, and January 6, 2019, 105 students were assessed for eligibility. All 105 students were enrolled and nonrandomly assigned to attend either an FC ($n = 53$) or IVC ($n = 52$). No one was excluded. A total of 105 participants were finally included in the analysis of outcomes (Fig 2). The student characteristics were similar between groups at baseline (Table 1).

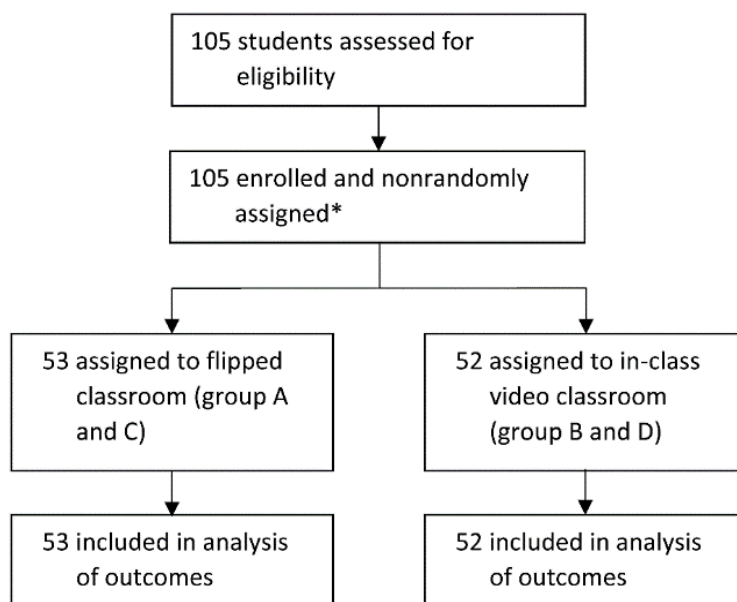


Fig 2. Trial profile

*Groups (A, B, C, and D) were preexisting formed with the purpose of medical rotations.

TABLE 1. Baseline characteristics of the students.

Characteristic	Flipped classroom (n=53)	In-class video classroom (n=52)	p-value
Age, years	18 (17-18)	18 (17-18)	0.576
Female sex, n (%)	29 (54.7)	29 (55.8)	0.912
GPA*	3.09 (0.50)	3.10 (0.46)	0.882

Data are median (IQR) or mean (SD) unless otherwise indicated.

*Grade point averages (GPAs) in the pre-clinical years were presented.

41 (77%) students, who participated in the FC, reported watching the pre-class video lecture. The median viewing duration was 80 (IQR = 40-100) percent of total video length. Of 12 students who did not watch the video, 83% claimed that there was not enough time for viewing, 8% forgot the assignment, and 8% preferred reading a pre-class handout.

The primary outcomes were demonstrated in Table 2. We found no significant difference in the post-test score between the FC group ($Mdn = 7$) and the IVC group ($Mdn = 8$), $U = 1130.00$, $p = .107$, $r = .16$, Mann-Whitney test. The total satisfaction score was not significantly different between the FC group ($M = 43.2$, $SD = 4.4$) and the IVC group ($M = 43.3$, $SD = 4.9$), $t(95) = .07$, $p = .945$, $d = .02$. Moreover, the satisfaction scores for each of the ten aspects of teaching qualities did not show the significant differences between the two groups (Table 2).

The subgroup analysis (FC, who did not view the video; FC, who viewed the video; and IVC) were illustrated in Fig 3. A Kruskal-Wallis H test showed a statistically significant difference in the post-test score between the subgroups, $\chi^2(2) = 7.03$, $p = .030$. The post hoc test using Bonferroni correction showed a significant difference in the post-test score only between the FC

subgroup, who did not view the video ($Mdn = 6.5$), and the IVC group ($Mdn = 8$), $p = .024$. There was no significant correlation between the duration of pre-class video viewing and the post-test score, as determined by Spearman's rank-order correlation ($r_s = .265$, $p = .103$). There was not a significant difference in total satisfaction score between three subgroups ($F(2,94) = .004$, $p = .996$, one-way ANOVA). The reliability index (KR-20) of the post-test was 0.51.

The students' favorites, including things that need improvement in the FC and IVC groups, were illustrated in Fig 4. Quizzes with discussion were the top favorite in the FC and IVC group (51% vs. 27%). 42% of the FC students listed the pre-class video lecture as the favorite. Of those, the additional positive comments were as follows:

1. The video watching was self-paced.
2. Students could view the video again later.
3. The video helped them understand in-class time easily.

19% of IVC students gave the negative vote on the in-class video lecture. Some said that the video lecture's speed was too fast, and the video could not be rerun.

TABLE 2. Primary outcomes.

Variable	Flipped classroom (n=53)	In-class video classroom (n=52)	r or mean difference (95% CI)*	p-value
Post-test score	7 (6-9)	8 (6.25-9)	0.16	0.107
Total satisfaction score	43.2 (4.4)	43.3 (4.9)	0.07 (-1.82 to 1.95)	0.945
Understanding of subject	4 (4-5)	4 (4-5)	0.11	0.271
Applying to the clinical practice	4 (4-5)	4 (4-5)	0.07	0.490
Teacher's knowledge of the subject	5 (4-5)	5 (5-5)	0.08	0.423
Opportunity for asking and discussion	5 (4-5)	5 (4-5)	0.14	0.145
The teacher answers the questions clearly	5 (4-5)	5 (4-5)	0.03	0.724
Teacher demonstrates objectives	4 (4-5)	5 (4-5)	0.14	0.140
Video lecture†	4 (4-5)	4 (4-5)	0.14	0.174
Handout	4 (4-4)	4 (3-4)	0.18	0.072
Classroom environment	4 (4-5)	4 (4-5)	0.08	0.402
Class time	4 (4-5)	4 (4-5)	0.04	0.655

The table shows the post-test scores, total satisfaction scores, and satisfaction scores for each aspect of teaching qualities. Data are median (IQR) or mean (SD) unless otherwise indicated.

*For medians, r is given; for means, the difference is given with 95% CI. The r-value is calculated from Z/\sqrt{N} , where the Z value is computed from the Mann-Whitney U test, and N is the total number of the samples.

†Pre-class video lecture for the flipped classroom and in-class video lecture for the in-class video classroom

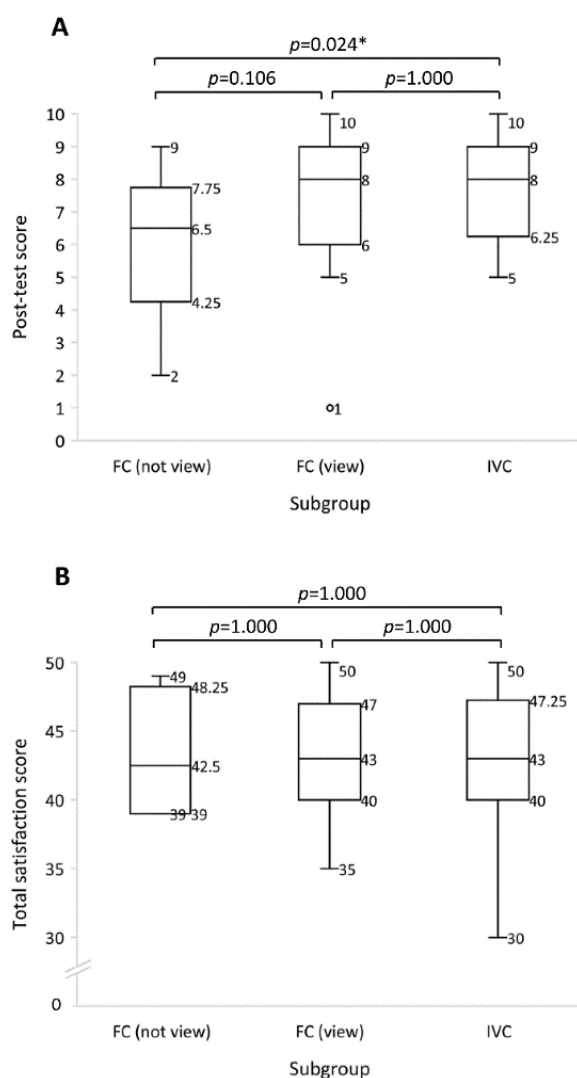


Fig 3. Scores for the subgroups (FC (not view), FC (view), and IVC)

Boxplots show (A) post-test scores and (B) total satisfaction scores

*Statistically significant difference (Kruskal-Wallis H test, post hoc test using Bonferroni correction)

FC (not view) = flipped classroom subgroup who did not view the video lecture, FC (view) = flipped classroom subgroup who viewed the video lecture, IVC = in-class video classroom

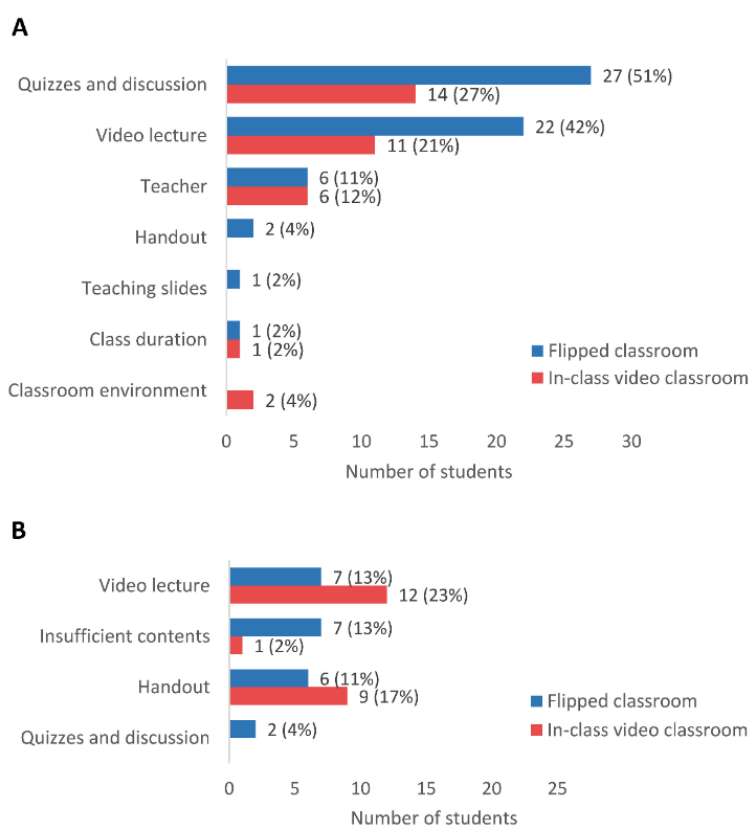


Fig 4. The number of students that give feedback on teaching components in the flipped classroom and in-class video classroom.

Graph shows numbers of students (with percentage) who were satisfied (A) and unsatisfied (B) with teaching components in two teaching groups.

DISCUSSION

The present study supported the strength of the FC approach. The pre-class online video lecture remained the favorite because students were able to study at their own pace. In other words, they could view the video as often as needed, anytime, and anywhere. Pre-class preparation also helped students understand more easily in class. In-class activity, i.e., case quizzes with interactive discussion, was voted the favorite from the FC students. Its problem-solving style stimulated the learners' critical thinking process. Moreover, some students compared such activity to a game, and they enjoyed it.

Although there were many benefits of the FC, however, the present study showed no differences in post-test scores, including total satisfaction scores between the FC and IVC groups. One explanation is probably related to students' compliance with the FC protocol. Our subgroup analysis found that the post-test score for the IVC group was significantly higher than the FC students who did not watch the pre-class video. These non-compliant students did not master their knowledge before class, so they might not catch up with others during the interactive class. Our result showed a significant non-compliance (23%), which could compromise the FC group's effectiveness.

Several previous studies also found the problems of non-compliance on the FC protocol, where the incidences ranged from 20 to 31.3 percent.⁵⁻⁷ Many students express concern about time management for the FC. There may be several out-of-class assignments from different modules in the same period. They need to balance the out-of-class assignments and their personal lives, while some saw the pre-class preparation as a burden.⁸ One study found that half of the students who would not like to take another FC cited the pre-class work as a reason.⁹ As a result, the out-of-class time spent is essential for the success of the FC model. Some non-health professionals FC studies demonstrated that most students spent up to 20 to 25 minutes viewing pre-class video lectures.^{10,11} These results supported our data which the estimated time of video watching was 24 minutes, i.e., 80% (median) of 30-minute video length. Future research should focus on the out-of-class workloads and how to improve the compliance of the FC protocol.

Another possible reason why the FC and IVC groups did not show significant differences in knowledge and satisfaction is that the IVC was not the same as a traditional lecture. The in-class activity of the IVC in our study included case quizzes with the interactive discussion, which would enhance student engagement

and effectiveness. This explanation is supported by our study's result, which the quizzes were the most favorite for the IVC group.

The present study had several limitations. Firstly, the study design was post-test only, non-randomized controlled study. No randomization means that unknown baseline characteristics between the FC and IVC groups may not be similar; although, GPAs in pre-clinical years were evenly distributed across the groups. No pre-test done indicates that the post-test score only may not reflect the knowledge students gained from the intervention. Secondly, the effectiveness of teaching, i.e., the satisfaction and post-test scores were categorized based on Kirkpatrick's classification as just level 1 (perceptions of intervention) and 2b (changes in knowledge and skills), respectively.¹² The post-test done immediately indicates only knowledge acquisition, which may not correlate with long-term knowledge retention. The higher level of the effects, such as changes in behaviors or professional practice, is more valid and needed in future research. Thirdly, the post-test reliability index was relatively low; however, a small number of the test items (ten) may affect this value.

Moreover, some components of our FC protocol may not meet the quality that delivers the highest effectiveness. The 30-minute duration of the video seemed too long for the students to concentrate, as discussed above. Moreover, the video lecture was the only format we provided for the pre-class assignment. One student who did not view the video said that reading was a preferred assignment. Therefore, giving various forms of study materials would be suitable for different learning styles. The pre-class phase also lacked quizzes that students could ensure their mastery of knowledge before class. Our students' ratio to teachers (26-28:1) was rather large than the ideal suggestion, i.e., 4:1 to 25:1.¹³

Although there were many advantages of the FC model, the present study showed no differences in effectiveness between the FC and IVC approach. Moreover, the IVC group was superior to the FC subgroup, who did not view pre-class video for the knowledge acquisition. Therefore, the present study confirmed the crucial role of compliance with the FC protocol in successful teaching. Most non-compliant students were concerned about the out-of-class assignment. Future research should focus on the FC protocol concerning student compliance and how to improve it.

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REFERENCES

1. Hew KF, Lo CK. Flipped classroom improves student learning in health professions education: a meta-analysis. *BMC Med Educ* 2018;18:38.
2. Chen F, Lui AM, Martinelli SM. A systematic review of the effectiveness of flipped classrooms in medical education. *Med Educ* 2017;51:585-97.
3. Kennedy C. Update on the flipped classroom2013 01/12/19. Available from: <https://amee.org/getattachment/Marketing-Toolkit/flipped-classroom>. 2013 [cited 2019 Dec 1].
4. Rutherford RH, Rutherford JK, editors. Flipping the classroom: Is it for you? Proceedings of the 14th annual ACM SIGITE conference on Information technology education. 2013. doi: 10.1145/2512276.2512299.
5. Heitz C, Prusakowski M, Willis G, Franck C. Does the concept of the “flipped classroom” extend to the emergency medicine clinical clerkship? *West J Emerg Med* 2015;16:851-5.
6. Morgan H, McLean K, Chapman C, Fitzgerald J, Yousuf A, Hammoud M. The flipped classroom for medical students. *Clin Teach* 2015;12:155-60.
7. Maneeratana K, Singhanart T, Singhatanadgid P, editors. A preliminary study on the utilization and effectiveness of a flipped classroom in Thailand. 2016 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE). 2016. doi: 10.1109/TALE.2016.7851819.
8. Cotta KI, Shah S, Almgren MM, Macías-Moriarty LZ, Mody V. Effectiveness of flipped classroom instructional model in teaching pharmaceutical calculations. *Curr Pharm Teach Learn* 2016;8:646-53.
9. Murphy J, Chang J-M, Suaray K. Student performance and attitudes in a collaborative and flipped linear algebra course. *Int J Math Educ Sci Technol* 2016;47:653-73.
10. McGivney-Burelle J, Xue F. Flipping calculus. *Primus* 2013;23:477-86.
11. Vazquez JJ, Chiang EP. Flipping out! A case study on how to flip the principles of economics classroom. *IAER*. 2015;21:379-90.
12. Boet S, Sharma S, Goldman J, Reeves S. Medical education research: an overview of methods. *Can J Anaesth* 2012;59:159-70.
13. Prober CG, Khan S. Medical education reimaged: a call to action. *Acad Med* 2013;88:1407-10.