Increasingly, medical educators are developing Web-based curricula,\textsuperscript{1-6} and there is evidence that students may learn more efficiently from such programs, although they have not proved superior to traditional methods in learner knowledge acquisition or satisfaction.\textsuperscript{7} Most studies reporting on knowledge gains with Web-based learning (WBL) have reported changes in pretest/posttest scores.\textsuperscript{7} However, we have found no reports on the impact of WBL on student performance on common clerkship evaluation measures, such as the National Board of Medical Examiners (NBME) exam and/or standardized patient (SP) cases.

We incorporated Web cases concerning common clinical problems into our decentralized community-based clerkship curriculum to promote a standard educational experience across sites. With funding from the Health Resources and Services Administration (HRSA), we developed the Design-A-Case template\textsuperscript{8} authoring software for creating interactive Web-based cases. These cases, which take approximately 1 hour to complete, encourage diagnostic and clinical reasoning skills and facilitate independent learning using Web-based resources. A typical case includes 8–10 modules (eg, History of Present Illness, Background History, Physical Exam, Management Plan), incorporating 12–14 questions with free text for students to type in their answers. After submitting their answers, students can access the faculty response to the same question. These question-and-answer scenarios have been enriched with the use of clinical pearls and links to resources.

This study’s purpose was to determine if completing the cases improved student performance as measured by our clerkship assessment tools.
Methods
Our subjects were 196 third-year medical students who completed our 4-week family medicine clerkship in the 2002–2003 academic year. Unavailability of US Medical Licensing Exam (USMLE) Step 1 scores reduced the pool of subjects to 179. Our Institutional Review Board approved the study.

The Intervention
We assigned three out of eight Web-based cases to each rotation group. Students were informed that completing the cases would not contribute numerically to their final grade but was a necessary but not sufficient condition for receiving a grade of honors.

Study Design
We classified students into two groups. Those who completed all three cases were labeled the YES group. Those who did not complete all three cases were labeled the NO group. We used USMLE Step 1 scores and rotation sequence (periods 1–12) as covariates. At our institution, students complete the USMLE Step 1 exam just before beginning the clerkship year. We used first-attempt scores to control for differences in prior academic achievement between groups. We used the rotation sequence of the family medicine clerkship during the clerkship year (periods 1–12) to control for timing of matriculation differences between groups, since studies have reported that students scored higher on clerkship assessments at the end of the clerkship year than at the beginning. The dependent variables were three clerkship assessment tools: the preceptor’s Clinical Rating Form (CRF), the NBME Subject Examination-Family Medicine, and an SP-based Clinical Competence Examination (CCE).

Data Analysis
We analyzed scores for the YES and NO groups on all three assessments using ANCOVA with USMLE Step 1 scores and period of matriculation (periods 1–12) as covariates. SYSTAT 11 software was used for all data analyses.

Results
Of the 179 students in the study, 155 completed the three cases (YES group). Students matriculating early in the year were in the YES group more frequently than students matriculating later in the year (95 of 100 in periods 1–6, compared to 60 of 79 in periods 7–12, test for significance of the difference between proportions yielded \( z = 3.755, P < .001 \)). Students in the YES group tended to have higher USMLE Step 1 scores than students in the NO group (group means were 214.3 and 206.5 respectively, \( t = 1.47, P = .14 \)).

Table 1 shows group means and standard deviations, adjusted group means, \( F \) ratios, and \( P \) values for the three ANCOVA analyses. There was a statistically significant difference in the scores between the two groups on the NBME subject exam and on the SP-based CCE (\( F = 14.071, P < .000 \), and \( F = 11.522, P < .001 \), respectively). In both cases, students in the YES group earned significantly higher scores than the students in the NO group. There was no statistically significant difference in the scores between the two groups on the preceptor CRF.

Discussion
In our institution, students who spent 3–4 hours completing three cases during a 4-week clerkship scored significantly higher on the NBME subject exam and SP-based CCE than those who did not complete the cases. The finding of no effect for case completion for the preceptor’s CRF in this study probably speaks to the poor reliability and problematic characteristics of preceptor CRFs in general.

Our study has several limitations. Students self-selected to

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<tr>
<td>Group Means and SDs, Adjusted Group Means, ( F ) Ratios, and Probabilities for ANCOVA Analyses</td>
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<tr>
<td>Raw Score Means (SDs)</td>
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<tr>
<td><strong>NBME Exam</strong></td>
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<td>YES</td>
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<td>NO</td>
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<td><strong>SP-based CCE</strong></td>
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<td><strong>Preceptor’s CRF</strong></td>
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1 The coefficients for both covariates were significant for this analysis (\( F = 61.13, P < .000 \) for USMLE Step 1, and \( F = 15.21, P < .000 \) for rotation order).

2 The coefficient for the rotation order covariate was significant for this analysis (\( F = 20.95, P < .000 \); the coefficient for the USMLE Step 1 covariate was not significant (\( F = 0.468, P < .495 \)).

3 The coefficients for both covariates were not significant for this analysis (\( F = 0.064, P < .801 \) for USMLE Step 1, and \( F = 0.904, P < .343 \) for rotation order).

SD—standard deviation
NBME—National Board of Medical Examiners
SP—standardized patient
CCE—Clinical Competence Examination
CRF—Clinical Rating Form
the YES and NO groups. Without random assignment of students to groups, there is a possibility that the groups were different in ways that we could not control. USMLE Step 1 scores were used as a covariate in ANCOVA to neutralize initial differences between the YES and NO groups represented by USMLE Step 1 scores. Coding the rotation order (periods 1–12) and using this as a covariate in ANCOVA was used to neutralize timing effects resulting from a disproportionate frequency of the NO group toward the end of the clerkship year. It is possible that the decision to complete the cases is an indicator for some unidentified variable affecting student performance that our covariates did not neutralize. Also, for our comparisons, we used the gross score on each assessment tool rather than abstracting subscores that reflected the specific content of the cases. Finally, our results are from a single year at one institution, which may limit generalizability.

Further studies are needed using larger groups of medical students in different settings over a longer time period to see if these results can be replicated for both total scores and abstracted content specific scores.

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