Patient exposure in the basic science classroom enhances differential diagnosis formation and clinical decision-making

Justin G. Peacock, Joseph P. Grande

Purpose: The authors proposed that introducing real patients into a pathology classroom early in medical education would help integrate fundamental principles and disease pathology with clinical presentation and medical history.

Methods: Three patients with different pathologies described their history and presentation without revealing their diagnosis. Students were required to submit a differential diagnosis in writing, and then they were able to ask questions to arrive at the correct diagnosis. Students were surveyed on the efficacy of patient-based learning.

Results: Average student scores on the differential diagnosis assignments significantly improved 32% during the course. From the survey, 72% of students felt that patient encounters should be included in the pathology course next year. 74% felt that the differential diagnosis assignments helped them develop clinical decision-making skills. 73% felt that the experience helped them know what questions to ask patients. 86% felt that they obtained a better understanding of patients' social and emotional challenges.

Discussion: Having students work through the process of differential diagnosis formulation when encountering a real patient and their clinical presentation improved clinical decision-making skills and integrated fundamental concepts with disease pathology during a basic science pathology course.

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Running title
Patient exposure in pre-clinical course.

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32 education would help integrate fundamental principles and disease pathology with clinical presentation

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Introduction

A major challenge during medical school is making the leap from the basic science years to patient

encounters in the clinical setting. One difficulty involves forming differential diagnoses for a patient's

problem. Forming a differential diagnosis is critical to ordering proper clinical testing and

appropriately managing clinical disease. Unfortunately, most differential diagnosis education comes

during the third-year clerkships when the medical student is thrown into unfamiliar clinical situations

and responsibilities. Few attempts have been reported in the literature aimed at teaching differential

diagnosis and clinical decision-making in the early "basic science" years of medical education (Fulop,

1985; Duque, Gold & Bergman, 2003; Gesundheit et al., 2009; Jacobson et al., 2010; Gunning & Fors,

2012).

Some approaches in "early clinical exposure" have focused on the use of clinical cases and

standardized or virtual standardized patients to train medical students in clinical reasoning (Gesundheit

et al., 2009; Jacobson et al., 2010; Gunning & Fors, 2012). The use of clinical cases and standardized

patients has been well studied and documented in the medical education literature (Tamblyn et al.,

1991; TAMBLYN et al., 1991; Ainsworth, 1991; Colliver et al., 1998; Williams, 2004). While

standardized patients have a long history in medical education, their use also has identified problems,

including subjective biases in the standardized patients, inaccuracies, and unrealistic portrayals of

patient experiences (Tamblyn et al., 1991; Williams, 2004).

At the Mayo Medical School, we have been teaching differential diagnosis in the context of the

first-year Pathology course for a number of years. Students are taught how to form differential

diagnoses and begin the initial steps of clinical decision-making (Martin et al., 2014). In the past,

differential diagnosis was taught in the context of short patient cases that illustrated common human

73   pathologies. We wanted to try a pilot study to bring actual patients with true pathologies into the basic

74   science classroom, early in undergraduate medical education, to see if students could delineate a

75   differential diagnosis for their pathologies. We wanted to help students integrate fundamental

76   principles of the basic sciences with a patient's clinical presentation, disease pathology, and course of

77   disease. We also wanted to increase students' awareness of the important aspects of clinical histories

78   and appropriate diagnostic testing or questioning in arriving at an accurate diagnosis. We hypothesized

79   that actual patients with clinical pathologies would provide even more important learning with regard

80   to clinical decision-making for the students.

81

82   **Materials and Methods**

83   This study was submitted to the Mayo Clinic Institutional Review Board for approval. It was

84   determined in verbal communications not to require IRB approval, because it was conducted in the

85   context of required assignments in an educational course.

86   In this pilot study, 47 first-year pathology students were introduced to three different volunteer

87   patients with actual disease pathologies to present their clinical histories. The patients had previously

88   expressed an interest in sharing their clinical history with medical students to faculty and staff at the

89   clinic. The three patients came into the classroom on three different occasions during the course and

90   spent approximately 30 minutes discussing the history and clinical scenario leading up to their

91   diagnosis, without revealing their diagnosis. Immediately after the patient finished their history,

92   students then completed an online assignment, which asked for their top three diagnoses (beginning

93   with the most likely), an explanation of the aspects of the case that led to their most likely diagnosis,

94   and additional questions or information that would help to confirm their differential (Figure 1). The

95   goal with the questions was not for the students to obtain the exact, true diagnosis, but for them to use

96   their clinical reasoning skills to narrow down a reasonable differential diagnosis list based on the

97   patient's history. We wanted the students to justify the rationale for their differential list and to

98   formulate additional questions or tests that they would like to use to narrow down the differential list.

99   Following submission of the online assignment, students were then permitted to ask the patients

100   additional questions to determine the true diagnosis as a class. They were also given time to ask

101   questions regarding the social, behavioral, economic, and other impacts of the disease on the patients'

102   lives.

103   As the patient cases were not straightforward, simple, first-year cases, it was stressed to both

104   the students and the teaching assistants that the goal of the assignments was not to obtain the exact,

105   correct diagnosis, but to formulate a reasonable differential diagnosis list based on the patient's history.

106   We specifically sought out patients with more complicated or multi-system diagnoses to expand the

107   differential diagnoses that students could assemble for a given patient history. Consequently, the cases

108   and the grading rubric allowed for a wider variability in the differential diagnoses compared with

109   simpler medical case presentations. Teaching assistants utilized an established grading rubric and

110   grading methodology used in other differential diagnosis assignments in the course to grade the

111   assignments on an 18-point scale (Figure 1)(Martin et al., 2014). Student scores on the assignments

112   were compared using ANOVA with Tukey–Kramer post-processing at the 0.05 α level.

113   At the conclusion of the course a survey was conducted among the students to determine the

114   impact of patient encounters on their understanding of pathology, differential diagnosis formation,

115   clinical reasoning, and patient empathy. The survey results were tallied on the basis of a five-point

116   Likert scale. For simplicity in the summary table, strong and very strong agreement ratings were

117   grouped into the agreement column and strong and very strong disagreement ratings were grouped into

118   the disagreement column.

119

120   **Results**

121   We piloted bringing volunteer patients with actual disease into a first-year pathology course to help

122   students develop their differential diagnosis, history-taking, and basic clinical decision-making skills.

123   The students' previous first-year courses included genetics, anatomy, and histology. The first volunteer

124   patient presented his history of liver cirrhosis secondary to alpha-1 antitrypsin deficiency during the

125   first week of the course. The differential assignments were graded by teaching assistants using the

126   grading rubric shown in Figure 1 and using a previously described grading methodology (Martin et al.,

127   2014). The first assignment resulted in an average score of 8.8 ± 3.1 out of 18 (Figure 2). During the

128   pathology course, lectures, assignments, and teaching assistant feedback was devoted to helping

129   students learn how to develop differential diagnoses, including the VITAMIN CDE methodology

130   (Martin et al., 2014), how to ask appropriate questions of patients, and how to make basic diagnostic

131   decisions.

132   The second volunteer patient was a pediatric patient who experienced a biliary leak and

133   infection secondary to liver transplantation. The mother and patient presented the patient's history to

134   the class approximately 3 weeks after the first patient. The second assignment resulted in an average

135   score of 9.7 ± 2.7 (Figure 2), which was higher than the first assignment, but not significantly higher.

136   Due to scheduling conflicts, the third patient presented his case of heart failure secondary to

137   hypertrophic obstructive cardiomyopathy approximately one week after the second patient. The

138   average score on this third assignment was 11.6 ± 2.7, which was significantly higher than both the

139   first and second assignments, p<0.0001 and p=0.0043, respectively (Figure 2). We found that the

140   students' grades on the patient encounter differential diagnosis assignments improved significantly by

141   32% over the course of the block (Figure 2).

142   At the end of the pathology block, students were asked to fill out a survey regarding their

143   experiences with the patient encounter differential diagnosis assignments (Table 1). Overall, the

144   students felt that the patient encounter experiences should be a continuing part of the pathology block

145   and other first-year medical school courses (72.3% and 66.0%, respectively). Importantly, students

146   strongly felt that the patient encounter experiences helped them develop clinical decision-making

147   skills, know what questions to ask patients, and understand social and emotional challenges that

148   patients face during disease (74.5%, 74.5%, and 87.2%, respectively). Interestingly, the students still

149   indicated that they did not feel more comfortable facing patient encounters in the clinic after these

150   experiences (27.7%). Students also indicated that they would have liked to have had patients with

151   simpler, more common pathologies than those presented (data not shown).

152

153   **Discussion**

154   In this study, we have demonstrated that real patient encounters in the basic science classroom coupled

155   with assignments aimed at clinical decision-making may improve clinical skills and help to provide

156   clinical context to the basic sciences they are learning. We have shown that actual, volunteer patients

157   can be brought into a first-year, basic science classroom to serve as patient educators, helping students

158   learn to ask the right questions, formulate differential diagnoses, and understand the nonmedical

159   challenges that patients endure. We believe that this coupling of the basic and clinical sciences in the

160   early years of medical school is important to help students more readily and confidently transition from

161   the classroom to the clinical setting.

162   Other institutions have provided beginning medical students with early clinical exposure,

163   through the use of clinical case scenarios and simulated patients (Fulop, 1985; Duque, Gold &

164   Bergman, 2003; Gesundheit et al., 2009; Jacobson et al., 2010; Gunning & Fors, 2012). The challenge

165   with these simulated experiences lies in their very nature, namely, they are simulated or artificial

166   experiences (Tamblyn et al., 1991; Williams, 2004). Actual patient encounters provide realistic

167   exposure to clinical scenarios. They can provide clinical context and psychosocial factors that cannot

168   be considered in typical standardized patient scenarios. We did not focus on the students coming up

169   with the exact, correct diagnosis at this early stage, because we felt that the process involved in

170   formulating and justifying a reasonable differential diagnosis list is more important in early medical

171   education. In particular, we wanted students to broaden their differential in the context of the pathology

172   that they were learning about in the course.

173   Another benefit of real patient exposure in the early medical school years lies in the

174   development of empathy or emotional IQ. While not directly assessed in this study, an overwhelming

175   percentage of students did report a greater appreciation for the social and emotional challenges that

176   patients endure. It is not clear that the same increase in empathy could be obtained from simulated

177   patient experiences (Colliver et al., 1998). Empathy or emotional IQ is an important attribute of

178   professional physicians, particularly, with many studies showing a decline in empathy over the course

179   of medical education (Neumann et al., 2011).

180   We understand that our study is limited in that it was a pilot study for bringing actual patients

181   into the basic science classroom. We only were able to recruit the three patient volunteers during the

182   first round of recruiting. While we felt that each patient scenario was appropriate for allowing students

183   to create a reasonable differential diagnosis list, we were not able to choose from among a wide variety

184   of patient scenarios. We also encountered some of the challenges in dealing with actual patients rather

185   than simulated patients, in that we were not able to decide when students would encounter patient

186   scenarios due to patient schedules. We also did not have fine control over how much or how little the

187   patients would discuss about their cases. The patients were instructed to give as much pertinent history

188   as they could without revealing the actual diagnoses being assessed. In the future, we hope to have a

189   larger pool of volunteer patients from which to decide the most appropriate patient encounters at

190   regular intervals during the course.

191   Interestingly, although students felt that the patient encounters increased their clinical decision-

192   making skills and helped them to know what types of questions to ask patients, many students still did

193   not feel an increase in confidence in dealing with patients (Table 1). Understanding that these students

194   are still first-year students, it would be interesting to know what knowledge, skills, and experiences

195   students require to feel confident going into clinical patient scenarios. It would also be interesting to

196   see how the patient educators would rate students with regards to empathy or emotional IQ during

197   these sessions to work on improving this professional characteristic. Unfortunately, in this study, we

198   did not collect a grade breakdown for the different grading rubric criteria from the teaching assistants,

199   only a total grade for the assignment. In the future, we would like to understand what specific areas

200   showed the most improvement during the course, i.e. differential formation, differential justification, or

201   clinical decision-making. Lastly, we would like to develop objective means to determine if the skills

202   taught in this course are being implemented in the clinical setting.

203

Conclusions

204

205   Introducing actual patients into a first-year, basic science pathology classroom helped students to

206   develop differential diagnosis formation, history-taking, and basic clinical decision-making skills at an

207   early stage of undergraduate medical education. Students also reported that they were better able to

208   understand and appreciate the challenges that patients face during the course of their disease.

210 **Disclaimer**

211 The view(s) expressed herein are those of the author(s) and do not reflect the official policy or position

212 of Brooke Army Medical Center, the U.S. Army Medical Department, the U.S. Army Office of the

213 Surgeon General, the Department of the Army, the Department of the Air Force and Department of

214 Defense or the U.S. Government.

215

216 **Declaration of Interest**

217 The authors do not have any conflicts of interest.

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255 **Figures**

256 **Figure 1. Questions and grading rubric for patient encounters.**

257 The patient encounter questions given to the students are seen in black type, while the grading rubric is

258 seen in red type.

259

260 **Figure 2. Box plot of student scores for patient encounter assignments.**

261 Box plot with 25% quartiles and median for the grades of students during the first, second, and third

262 patient encounters. One-factor ANOVA with repeated measures indicated a significant difference in

263 the grades between the 3rd patient scores compared with the 1st and 2nd patient scores [F Ratio =

264 12.1244, P <0.0001]. *P < 0.05, by post hoc Tukey-Kramer HSD. Significant pairings are designated

265 by a bracket connecting the pairings with an * above the bracket.

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271 **Tables**

272 **Table 1. Survey summary for student survey regarding patient encounter experiences.**

273 Survey statistics are listed as percentages of the total class responses (N = 47). Likert scores of

274 strong/very strong agree (4/5) are grouped together in agreement column, Likert scores of strong/very

275 strong disagree (1/2) are grouped together in disagreement column, and the rest (Likert score 3) are in

276 the neutral column.

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1

Figure 1

Figure 1. Questions and grading rubric for patient encounters.

The patient encounter questions given to the students are seen in black type, while the grading rubric is seen in red type.

Patient Encounter Grading Rubric (18 points possible)

Given the clinical presentation you have just heard:

1) What are your top three diagnoses, in order, beginning with the most likely? (8 pts. possible)

1. 0-2 points (2 = excellent likelihood, 1 = good/likely, 0 = unlikely/blank)

2. 0-2 points (2 = excellent likelihood, 1 = good/likely, 0 = unlikely/blank)

3. 0-2 points (2 = excellent likelihood, 1 = good/likely, 0 = unlikely/blank)

For #1, most likely diagnosis, if it truly is the most likely diagnosis out of the three possible diagnoses give 1 point.

If #1 is the correct diagnosis give 1 more point

2) What aspects of the case lead you to your most likely diagnosis? (1-2 sentences) (4 points possible)

For each aspect of the history that corroborates with their most likely (#1 above) diagnosis, give 1 point. up to a maximum of 4 points. For each incorrect aspect cited, subtract 1 point.

3) What other questions/information do you believe would help you confirm/justify your differential? (3-4 questions) (6 points possible)

0-2 points (2 = excellent question/info to confirm diagnosis, 1 = good ques/info, 0 = poor/blank ques/info)

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Figure 2

Figure 2. Box plot of student scores for patient encounter assignments.

Box plot with 25% quartiles and median for the grades of students during the first, second, and third patient encounters. One-factor ANOVA with repeated measures indicated a significant difference in the grades between the 3rd patient scores compared with the 1st and 2nd patient scores [F Ratio = 12.1244, $P < 0.0001$]. *$P < 0.05$, by post hoc Tukey-Kramer HSD. Significant pairings are designated by a bracket connecting the pairings with an * above the bracket.
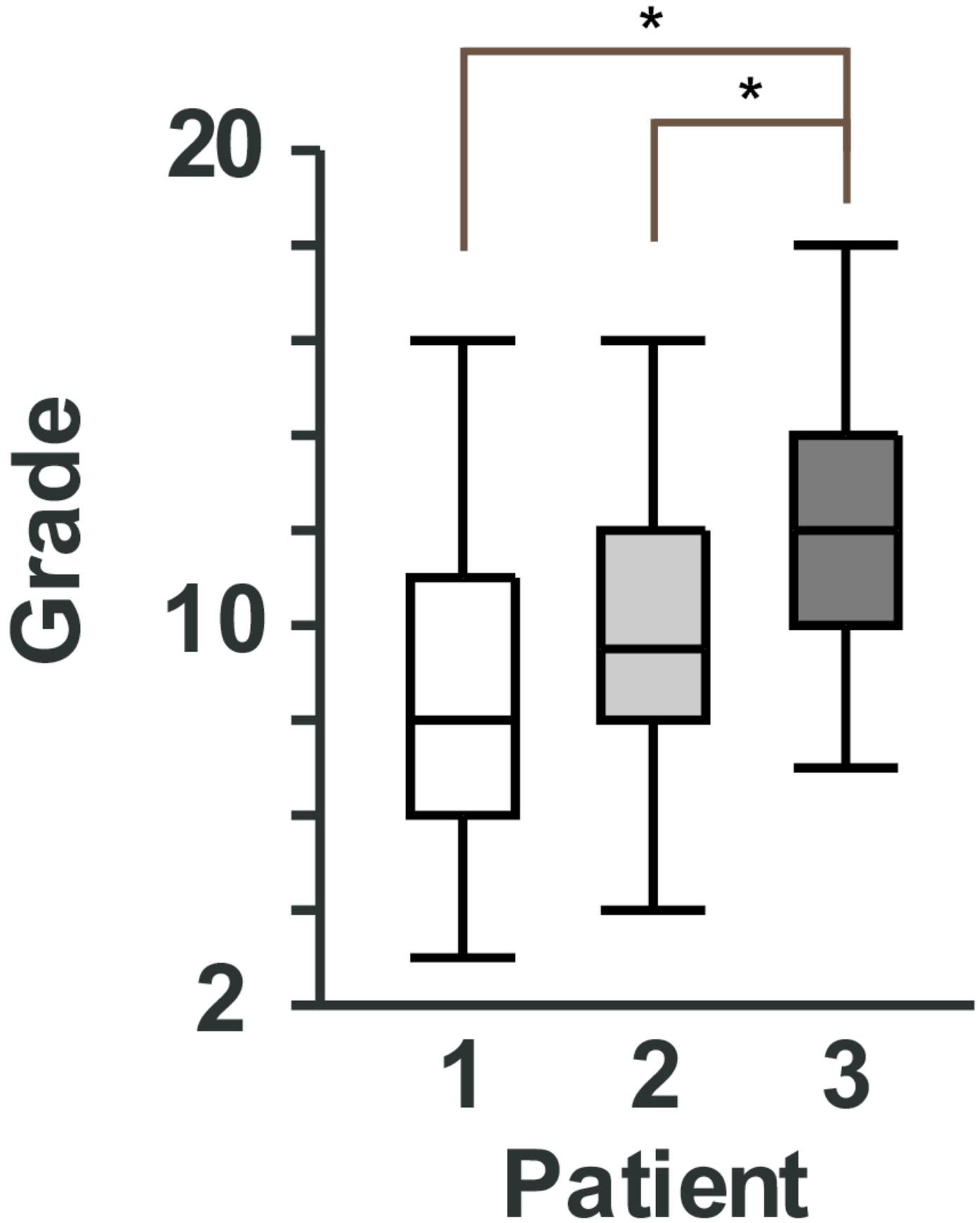
Table 1

Table 1. Survey summary for student survey regarding patient encounter experiences.

Survey statistics are listed as percentages of the total class responses (N = 47). Likert scores of strong/very strong agree (4/5) are grouped together in agreement column, Likert scores of strong/very strong disagree (1/2) are grouped together in disagreement column, and the rest (Likert score 3) are in the neutral column.

Survey Statement	Agreement	Neutral	Disagreement
Patient encounters should be incorporated into the Pathology block next year.	72.3	12.8	14.9
More patient encounters should be included in the first-year courses.	66.0	17.0	17.0
The DDX assignments associated with the patient encounters help me develop differential diagnosis formation skills.	57.4	17.0	23.4
The DDX assignments associated with the patient encounters helped me develop clinical decision-making skills.	74.5	10.6	14.9
I have a better understanding of pathology through the patient encounter experiences.	53.2	21.3	25.5
The patient encounters helped me to better link a patient's pathology with the patient's clinical presentation.	68.1	14.9	14.9
The patient encounters helped me to better recognize key elements of clinical history and exam in a patient.	66.0	23.4	10.6
The patient encounters improved my confidence to interact with patients.	27.7	31.9	40.4
The patient encounters gave me a better sense of what questions would be important to ask patients.	74.5	12.8	12.8
The patient encounters gave me a better sense of what diagnostic procedures or test to order for patients.	63.8	6.4	29.8
The patient encounters gave me a better appreciation of the social and emotional challenges that patients go through.	87.2	8.5	4.3
The patient encounters helped to give you insight into what your clinical experience might be like.	68.1	19.1	10.6