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The Close Exposure to Radiology Program: Educational Benefits to Medical Students

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Background: Radiology clerkships during medical school provide a suboptimal training experience in the Chinese medical doctor training program. Staff radiologists are heavily occupied with clinic tasks which decreases teaching quality. The close exposure to radiology program (CERP) is a novel pathway designed to improve teaching quality, yet students' expectations of the potential benefits of such a program and their willingness to join CERP still have not been investigated among Chinese medical students.

Methods: A survey was conducted among medical students of both sexes with various majors and at different levels of training. The students were asked to identify the potential benefits of CERP as well as to indicate if they were willing to join CERP.

Results: Of the 1,600 surveys distributed to medical students, 1,394 were returned and analyzed. Most of the returned surveys were from males (1,268, 91%), and most respondents had not had a radiology clerkship experience (1,376, 99%). Most responding students were in a 5-year training program (94%) and in their third grade of training (41%). More than 60% of the surveyed students acknowledged each of the 5 benefits listed on the survey, although no statistically significant differences were seen between sexes, training grades, those with and without prior radiology experience, program length, or majors in how the questions were answered. Students most willing to participate in CERP were those enrolled in a 5-year training program (71%) and those who had previous radiology clerkship experience (89%). Students least willing to join CERP were majoring in somatology medicine (54%) and medical psychology (55%), and only 45% of students in 8-year programs indicated a willingness to join CERP. Chi-square tests indicated that the willingness to join CERP was not associated with sex ($\chi^2_{(df = 1393)} = 128.6$, P=1.00), training program ($\chi^2_{(df = 1393)} = 111.3$, P=1.00), training grade ($\chi^2_{(df = 1393)} = 266.1$, P=1.00), major ($\chi^2_{(df = 1393)} = 456.1$, P=1.00), or previous experience with radiology ($\chi^2_{(df = 1393)} = 142.2$, P=1.00).

Conclusion: Medical students enrolled at Fourth Military Medical University developed an awareness of the potential benefits of CERP; however, this awareness did not correlate with their willingness to join CERP.

Keywords: *Clinical clerkship, education–medical–undergraduate, radiology, schools–medical, students–medical*

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INTRODUCTION

Obtaining the knowledge and experience to become an excellent physician is challenging; it requires hard work and exposure to many fields of medicine. One important bridging field for medical students is radiology. Sixty-seven percent of medical students in the United States believe that having a basic knowledge of radiology is important to become a competent doctor.[1] However, little emphasis is placed on radiology during their core rotations. Chinese medical students also have limited time to learn radiology with only a 1-week radiology clerkship available in most medical schools throughout the country. Staff radiologists are heavily occupied with clinic tasks which decreases teaching quality. The close exposure to radiology program (CERP) is a novel pathway for improving teaching quality in radiology.[2] CERP and other similar programs have been used at the Dartmouth-Hitchcock Medical Center, Yale-New Haven Hospital, and the University of Iowa Hospitals and Clinics and are suggested as models that can improve teaching quality.[2-4]

CERP is an alternative to the current educational curriculum and has the potential to help increase students' understanding of radiology, in particular emergency studies and radiology workflow patterns. CERP not only gives

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Table 1. Survey Questions (Q) to Assess Perceived Benefits of a Close Exposure to Radiology Program (CERP) and Willingness to Join the Program

Q1	Obtain an early, in-depth, and hands-on exposure to radiology
Q2	Develop consultant skills for working with clinicians from different backgrounds
Q3	Develop knowledge of the appropriate indications for various imaging studies
Q4	Foster multitasking and communication skills
Q5	Extracurricular activity that serves as an asset on curriculum vitae
CERP	Are you willing to join CERP during your fourth year of training?

medical students in-depth exposure to radiology studies but also to members of the hospital staff, including staff physicians, residents, and technicians. Active interactions with other members of the healthcare team give students the opportunity to develop and hone their communication skills. Medical students often wish to be actively involved in patient and study management.[5] Through CERP, medical students triage the radiology studies and contribute to system efficiency by reducing resident workload, thereby allowing the residents more time for teaching. All of these activities are beneficial to medical students regardless of their future residency choice.

A CERP was developed by members of the Department of Radiology at Tangdu Hospital (affiliated with the Fourth Military Medical University) located in the city of Xi'an in Shaanxi Province in central China. The Fourth Military Medical University offers systematic medical training to students in 5- and 8-year programs. Medical students obtain either bachelor's degrees or medical doctor degrees. Students can major in clinical medicine (5- or 8-year program to receive a bachelor's or medical doctor degree), aerospace medicine (5-year program to receive a bachelor's degree), general medicine (5-year program to receive a bachelor's degree), medical psychology (5-year program to receive a bachelor's degree), somatology medicine (5- or 8-year program to receive a bachelor's or medical doctor degree), preventive medicine (5-year program to receive a bachelor's degree), and biomedical engineering (5- or 8-year program to receive a bachelor's or doctoral degree).

The CERP at Tangdu Hospital was implemented in September 2014, and is still under development. When the CERP is fully implemented, participants will be fourth-year medical students who work with a radiology resident either Friday or Saturday from 2:00 pm to 9:00 pm. These hours were selected because these are the hours the residents most need assistance. The CERP rotation will ideally last 6 months.

The CERP was approved by the university ethics research committee. Initially, medical students from various grades, not just the fourth grade, were recruited via face-to-face invitation to be on duty for the radiology resident; students of various grades were selected for the purpose of fine-tuning CERP according to participant feedback. CERP faculty directors and resident volunteers

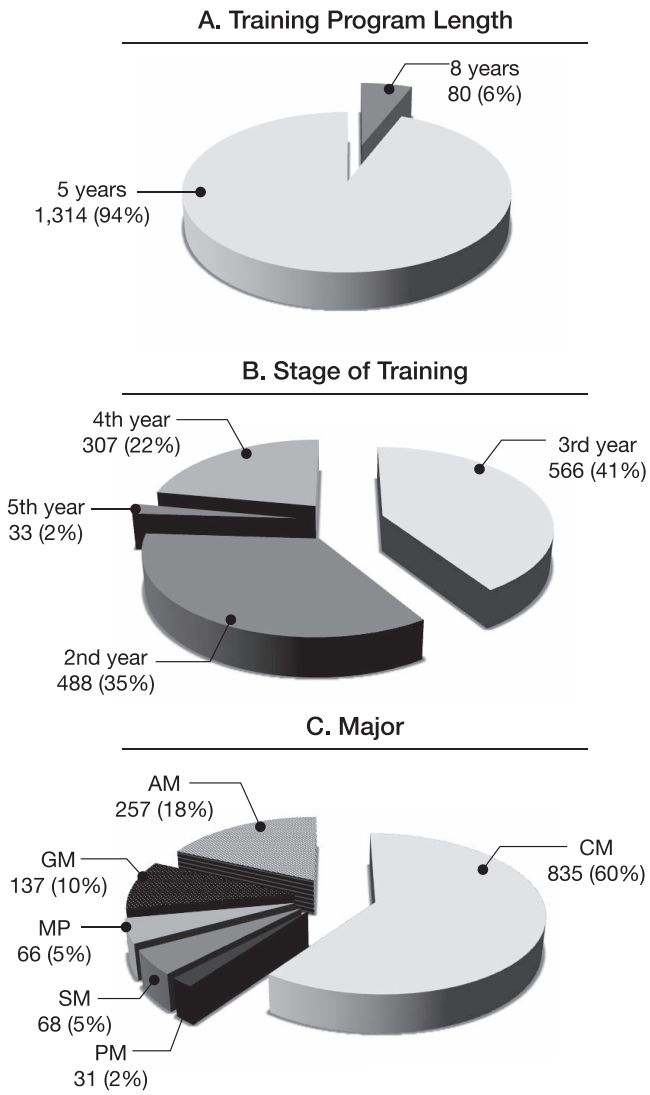

Figure 1. Demographics of student respondents by (A) training program length, (B) stage of training, and (C) major. AM, aerospace medicine; CM, clinical medicine; GM, general medicine; MP, medical psychology; PM, preventive medicine; SM, somatology medicine.

organized an orientation session to introduce the program goals, student responsibilities, and workflow scenarios. The recruiting and training of new members was organized by the student director who was also responsible for creating and updating manuals and policy documents; maintaining work schedules; updating the program according to faculty, resident, and student feedback; and acting as a correspondent among all involved. To simplify the training process, the student director created a step-by-step Microsoft PowerPoint manual that highlighted the most common situations medical students face during a shift. The manual and documents related to the program were shared in an online QQ (a free Chinese social software commonly used by students and hospital staff) group. The student director sent the manual to the participants at least 1 week ahead of starting CERP, and the trainees were asked to review it before training. The student director

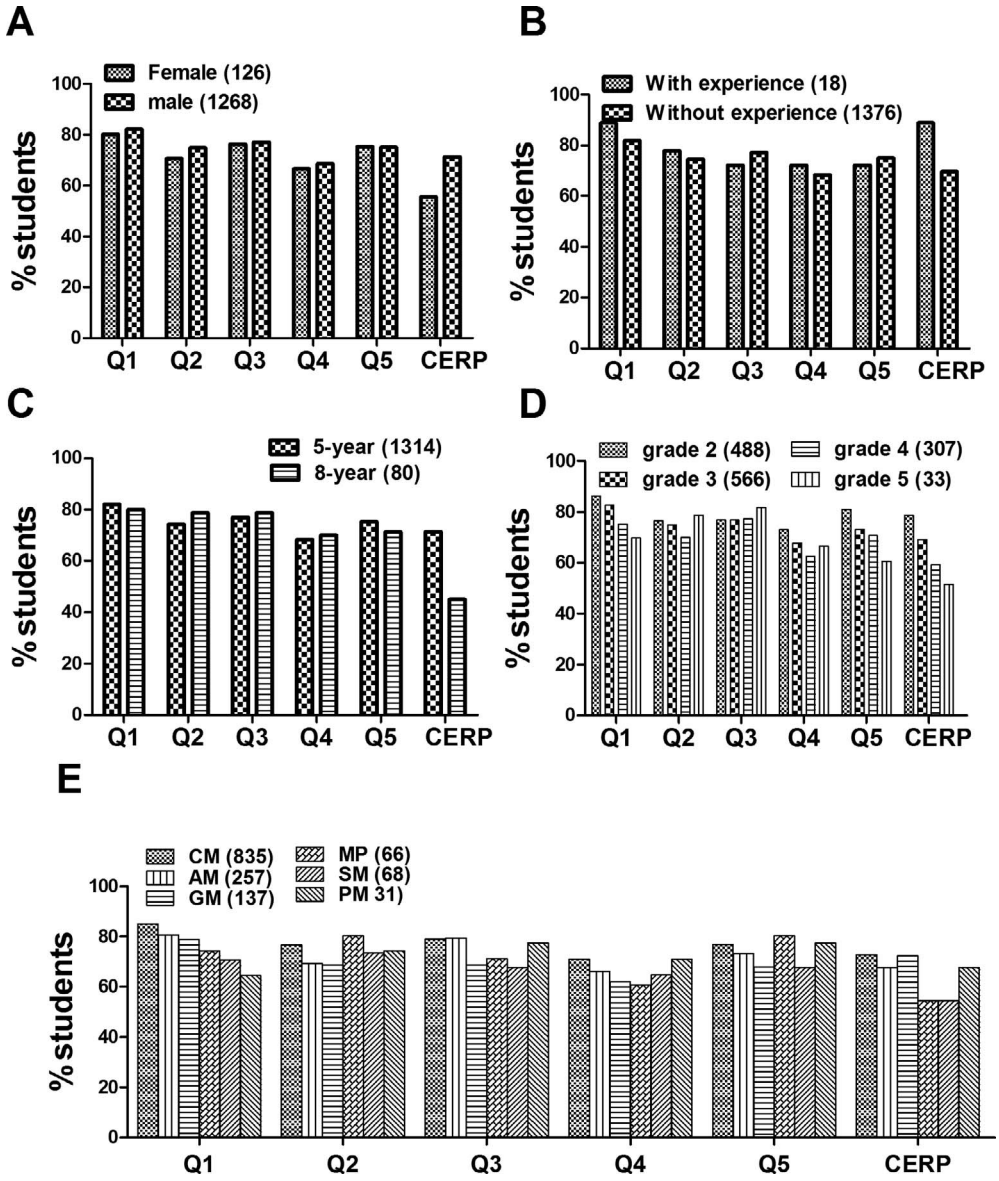

Figure 2. Analysis of student responses to questions 1-5 (Q1-Q5) and to the willingness to join a Close Exposure to Radiology Program (CERP) question on the survey by (A) sex, (B) radiology clerkship experience, (C) length of training program, (D) stage (grade) of training, and (E) major. AM, aerospace medicine; CM, clinical medicine; GM, general medicine; MP, medical psychology; PM, preventive medicine; SM, somatology medicine.

reviewed the manual again with the trainee to clarify any unclear points. Participants trained with the student director for 4 hours before starting their first shift. Medical students signed up for shifts on a first come, first served basis.

Students had their own Picture Archiving and Communications System (PACS) logins that gave them limited access to the PACS. They could see the images but could not annotate the studies. At the beginning of the shift, students signed on to a PACS station with a radiology resident. Students were in charge of answering calls from clinicians, radiology technicians, and other hospital personnel. When they answered calls and before the caller could make an imaging request or ask a question, students clearly stated their role as "radiology triage" to avoid confusion. In emergent situations (ie, cord compression, aortic dissection, or abdominal aortic aneurysm rupture) or situations that required radiology resident expertise, the call was promptly transferred to a radiology resident. Students

Table 2. Perception of Question 1-5 (Q1-Q5) Benefits Among Male vs Female Students

Question	Male	Female	χ^2	*P* Value
Q1	82%	80%	$\chi^2_{(df\ =\ 1142)} = 92.71$	P=1.00
Q2	75%	70%	$\chi^2_{(df\ =\ 1037)} = 84.01$	
Q3	77%	76%	$\chi^2_{(df\ =\ 1073)} = 90.14$	
Q4	69%	67%	$\chi^2_{(df\ =\ 1045)} = 90.67$	
Q5	75%	75%	$\chi^2_{(df\ =\ 1045)} = 90.67$	

Table 3. Perception of Question 1-5 (Q1-Q5) Benefits Among Students With Radiology Experience vs Students Without Radiology Experience

Question	With Radiology Experience	Without Radiology Experience	χ^2	*P* Value
Q1	82%	80%	$\chi^2_{(df = 1142)} = 102$	P=1.00
Q2	74%	73%	$\chi^2_{(df = 1037)} = 91.84$	
Q3	76%	77%	$\chi^2_{(df = 1073)} = 97.97$	
Q4	69%	63%	$\chi^2_{(df = 1045)} = 97.85$	
Q5	69%	75%	$\chi^2_{(df = 1045)} = 97.85$	

generally gathered pertinent information (patient name, medical record number, location, study type, indication, pertinent laboratory results, referrer name, and cell number) on a log sheet. If the request was nonemergent, the medical student notified the resident of the requests between studies. The resident processed the requests in chronological order. The students communicated the results to the inquiring clinicians by phone. Assistance from the student director was always available when issues arose.

Student expectations of CERP and their willingness to join CERP are 2 primary determinants of the success of the program. The purpose of this study was to evaluate student expectations and willingness by administration of a survey related to various aspects of CERP.

METHODS

An anonymous survey was given to 1,600 male and female students enrolled in the different majors (except biomedical engineering) who had different program lengths and were in various grades. Because students majoring in biomedical engineering are not required to perform medical practice, these students were not included in the survey cohort. The survey included 5 questions designed to gauge the benefits students perceived they would receive from participating in CERP, as well as a question asking if they were willing to join CERP during their fourth year of training (Table 1). The survey was distributed as a printed handout during a weekend when all the participating students were together. The results were tabulated via Microsoft Excel.

RESULTS

Student Demographics

Of the 1,600 surveys distributed to medical students, 1,394 were returned. Most of the students who responded to the survey were enrolled in a 5-year training program (1,314, 94%) (Figure 1A). The majority of respondents were in their third (566, 41%) and second grades (488, 35%) of training (Figure 1B) and were majoring in clinical medicine (835, 60%) (Figure 1C). Most students were male (1,268, 91%) and had never had a radiology clerkship (1,376, 99% (Figures 2A and 2B).

Potential Benefits of CERP

The majority of the student respondents (>60%) perceived that there would be a benefit to participating in CERP. For questions 1-5 in each analyzed group, >60% of the students acknowledged the specific benefit identified in each question. However, no significant difference was demonstrated between sexes, level of radiology experience, type of program (5 years vs 8 years), or major for each of the questions answered.

No significant difference was noted between males and females with regard to acknowledging the 5 benefits of CERP (Table 2 and Figure 2A). Students with radiology experience acknowledged 3 of the 5 benefits of CERP (Q1, Q2, and Q4) more than the students without radiology experience (Table 3 and Figure 2B). Students in 5-year programs acknowledged 2 of the 5 benefits of CERP (Q1 and Q5) more often than students in 8-year programs (Table 4 and Figure 2C). Students in grade 2 acknowledged 3 of the 5 benefits of CERP (Q1, Q4, and Q5) more often than students in the other 3 grades; students in grade 5 acknowledged 2 of the 5 benefits (Q2 and Q3) more often than students in the other 3 grades (Table 5 and Figure 2D). Regarding the influence of major, students with a clinical medicine major responded the most favorably to Q1, students with a medical psychology major responded the most favorably to Q2, students with aerospace medicine and clinical medicine majors responded equally favorably to Q3, students with majors in clinical medicine and preventive medicine agreed equally on the benefit described in Q4, and students with a general medicine major were most likely to respond favorably to Q5 (Table 6 and Figure 2E).

Willingness to Join CERP

The students who had the highest willingness to join CERP were male (71% vs 56% females, Figure 2A), in a 5-year training program (71% vs 45% in an 8-year training program, Figure 2C), in grade 2 (79% vs 69% in grade 3, 59% in grade 4, and 52% in grade 5, Figure 2D), and with radiology clerkship experience (89% vs 70% of students without radiology experience, Figure 2B). However, our sample was heavily skewed in favor of males (1,268 males vs 126 females), so no conclusions can be drawn from this

Table 4. Perception of Question 1-5 (Q1-Q5) Benefits Among Students in 5-Year Programs vs Students in 8-Year Programs

Question	5-Year Program	8-Year Program	χ^2	*P* Value
Q1	82%	80%	$\chi^2_{(df = 1142)} = 77.55$	P=1.00
Q2	74%	79%	$\chi^2_{(df = 1037)} = 71.91$	
Q3	77%	79%	$\chi^2_{(df = 1073)} = 74.61$	
Q4	68%	70%	$\chi^2_{(df = 1045)} = 78.3$	
Q5	75%	71%	$\chi^2_{(df = 1045)} = 78.3$	

Table 5. Perception of Question 1-5 (Q1-Q5) Benefits Among Students at Various Grade Levels

Question	Grade 2	Grade 3	Grade 4	Grade 5	χ^2	*P* Value
Q1	86%	82%	75%	70%	$\chi^2_{(df = 1142)} = 203.8$	P=1.00
Q2	76%	75%	70%	79%	$\chi^2_{(df = 1037)} = 180.2$	
Q3	77%	77%	77%	81%	$\chi^2_{(df = 1073)} = 189.4$	
Q4	73%	68%	63%	67%	$\chi^2_{(df = 1045)} = 187.9$	
Q5	81%	73%	71%	61%	$\chi^2_{(df = 1045)} = 187.9$	

data set as to whether there is a gender difference in the students' willingness to join CERP.

Majors associated with the highest willingness to join CERP were clinical medicine (73%) and general medicine (72%), while majors associated with the lowest willingness to join CERP were somatology medicine (54%) and medical psychology (55%). Student willingness to join CERP was similar in the majors of aerospace medicine (68%) and preventive medicine (68%) (Figure 2E).

Chi-square tests indicated that the willingness to join CERP was not associated with sex ($\chi^2_{(df = 1393)} = 128.6$, P=1.00), training program ($\chi^2_{(df = 1393)} = 111.3$, P=1.00), training grade ($\chi^2_{(df = 1393)} = 266.1$, P=1.00), major ($\chi^2_{(df = 1393)} = 456.1$, P=1.00), or previous experience with radiology ($\chi^2_{(df = 1393)} = 142.2$, P=).

DISCUSSION

We expected that most students would feel CERP would be beneficial for their future career, and such a response would have been consistent with previous studies.[2-4] The majority of students, regardless of their sex, radiology clerk experience, training program, training grade, and major, accepted each of the proposed 5 benefits of CERP (>60% for each question). This finding encouraged us to provide CERP in the future with the goal of making it routine for our overall medical doctor training system. However, the percentage of students in each analyzed category who indicated a willingness to join CERP was <60% in some cases, showing a discrepancy between acknowledgement of benefit and willingness to participate. This unwillingness was noted in students majoring in medical psychology and somatology medicine and in students enrolled in 8-year programs. This lack of willingness among students majoring in medical psychology and somatology medicine may be motivated by the knowledge that in China, physicians in these fields do not directly treat patients. Students in 8-year programs require knowledge of radiology, but these students may believe that they have enough time to obtain in-depth knowledge of radiology during their extended medical training without having to learn radiology in what is perceived as their spare time.

An area for future research could be the determination of what belief systems dissuade or encourage medical students from participating in CERP; the answers to this question may also tell us why students want or do not want to pursue a career in radiology. Follow-up of CERP students as they go through residency training and after they enter clinical practice would be useful to see the true effect of CERP on a future doctor's interest in and knowledge of radiology, as well as the effect that CERP had on the student's mastery of communication and multitasking.

CONCLUSION

Our investigation shows that while students perceive a benefit of CERP, the percentage of students willing to join the program is lower than the percentage of those who acknowledge a benefit and varies nonsignificantly among program lengths, training grades, and majors. Students in their second grade and in 5-year training programs were most likely to join the program as were students majoring in clinical medicine and general medicine. CERP has both research and implementation potential.

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Table 6. Perception of Question 1-5 (Q1-Q5) Benefits Among Students With Various Majors

Question	CM	AM	GM	MP	SM	PM	χ^2	*P* Value
Q1	85%	80%	79%	74%	71%	65%	$\chi^2_{(df = 1142)} = 346$	P=1.00
Q2	77%	69%	69%	80%	74%	74%	$\chi^2_{(df = 1037)} = 330.3$	
Q3	79%	79%	69%	71%	68%	77%	$\chi^2_{(df = 1073)} = 331.7$	
Q4	71%	66%	62%	61%	65%	71%	$\chi^2_{(df = 953)} = 300.3$	
Q5	77%	73%	79%	61%	71%	65%	$\chi^2_{(df = 1045)} = 329.8$	

AM, aerospace medicine; CM, clinical medicine; GM, general medicine; MP, medical psychology; PM, preventive medicine; SM, somatology medicine.

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