Bedside Cardiology Skills Training for the Osteopathic Internist Using Simulation Technology

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Medical practice changes that limit patient availability, instructor time, and advances in technology have led to a greater use of simulators and multimedia computers in medical education. These systems address the problem of inadequate bedside skills training and poor proficiency among all health care providers. While studies have shown their effectiveness among medical students, residents, and practicing physicians, none has focused on the osteopathic internist population—one that is becoming more responsible for conducting initial and follow-up physical examinations.

This report describes the use of “Harvey,” the cardiology patient simulator, and the UMedic Multimedia Computer System at a workshop conducted at the American College of Osteopathic Internists’ 61st Annual Convention and Scientific Sessions. Participants in this study significantly improved their ability to identify common cardiac auscultatory events, as indicated by pretest-to-posttest scores. Workshop participants were nearly unanimous in their belief that they would like to use these tools for learning and assessment.

Approximately 60% of the more than 45,000 osteopathic physicians licensed in the United States practice in primary care settings. Those who practice in the primary care disciplines of family practice, general internal medicine, and pediatrics handle approximately 10% of all primary care visits in this country. Because managed care has demanded expertise in pertinent bedside skills to provide more cost-effective patient evaluations, and government and patient advocacy groups have demanded more accountability in clinical practice, osteopathic physicians must be equipped with the ability to conduct a thorough cardiovascular bedside examination.

Despite evidence that accurate clinical examination of patients with cardiac signs and symptoms is a cost-effective modality, direct teaching of these skills among allopathic medical students and physicians is occurring with decreasing frequency. The result has been a decline in allopathic students’ and physicians’ ability to detect and identify common cardiac findings. While recent reports cite effective solutions, including the use of simulators and multimedia computer systems for training, no formal study has focused on the osteopathic population. The purpose of this report is to describe the use of simulation technology to teach cardiac bedside skills to individuals responsible for providing care to patients with cardiac conditions.

A workshop, “Essential Bedside Cardiology Skills for the Generalist,” was conducted at the American College of Osteopathic Internists’ 61st Annual Convention and Scientific Sessions. The mission of the workshop was to provide a mixture of didactic and interactive learning sessions to assist participants in refining their skills and to bring them up-to-date on the most current research and findings. The 64 participants in the workshop included practicing clinicians (most of whom have direct teaching responsibilities), house officers, and medical students. The objective of the workshop was for participants to be able to recognize the most important cardiac auscultatory findings and to be able to outline their underlying pathophysiology using simulation technology.

Methods
For nearly 35 years, the University of Miami Center for Research in Medical Education has developed and used teaching and assessment systems that wed simulation and technology to medical education. The Center houses full facilities for simulation and computer-design engineering, production, and manufacturing; a high-technology auditorium; a self-learning laboratory; and skills training areas. A national consortium of clinicians and medical educators from 14 med-
Figure 1. “Harvey,” the cardiology patient simulator.

Figure 2. The UMedic Multimedia Computer System.

Harvey, the Cardiology Patient Simulator
Harvey is a proven teaching device that provides a comprehensive cardiology curriculum by realistically simulating 27 common and rare cardiac conditions. The physical findings programmed in Harvey for each disease include blood pressure, bilateral jugular venous pulses, bilateral carotid and peripheral arterial pulses, precordial impulses in 6 different areas, and auscultatory events. The latter are heard in the four classic auscultatory areas, are synchronized with the pulses, and vary with respiration when appropriate. More than one example of a particular disease state may be represented, simulating the marked difference in the clinical presentation of a particular disease with regard to chronicity and severity.

Harvey has been subjected to rigorous testing to establish its educational efficacy. In a multicenter study involving 208 senior medical students at five medical schools, fourth-year medical students who used the CPS during their cardiology elective performed significantly better than the non–CPS-trained group that learned in the traditional manner (real patients). This was true not only on the CPS skills posttest ($P < .001$), but also on the live patient skills posttest ($P < .03$). In addition, there was no statistically significant difference in the way patients perceived the professional behavior of CPS-trained and non–CPS-trained students. The latter data address the concern that simulators may negatively affect physician behavior. In another study involving more than 200 second-
year medical students at the University of Michigan, incorporation of Harvey into a required physical skills course significantly improved overall cardiac examination skills as measured by pretests and posttests of unknown findings on the simulator \((P < .001)\). Additional observations were that the use of Harvey saved both faculty and students time locating patients and permitting them to examine a wide variety of cardiac problems.

**UMedic Multimedia Computer System**
The UMedic Multimedia Computer System has been developed over the past 15 years with multimedia features that include computer and video graphics and real-time digitized video and audio. Fifteen patient-centered, case-based programs comprise a comprehensive generalist curriculum in cardiology and have been described in detail elsewhere. All programs share a similar structure:

- History;
- Bedside findings—includes appearance, blood pressure, arterial and venous pulses, precordial movements, and auscultation, presented by an instructor on videos of Harvey;
- Diagnosis;
- Laboratory data—includes blood chemistries, electrocardiograms, x-rays, scintigraphy, and real-time echo-Dopplers and angiograms;
- Treatment—includes videos of interventional therapy and surgery;
- Pathology; and
- Discussions—includes case reviews by authoritative cardiologists.

Learners can choose to study an entire program that includes all of the above sections or choose to study only the bedside evaluation (as would be the case with first- and second-year medical students) in which the laboratory data and treatment sections are omitted. The programs operate in two modes: a self-learning mode for one to five learners and an instructor mode for teaching large numbers in a classroom or auditorium with a video projector or multiple monitors.

A recent multicenter study demonstrated that this system could be integrated into the entire 4-year medical school curriculum. A total of 1,586 students at six medical schools completed 6,131 programs and favorably rated the educational value of the system compared to other learning materials. The study resulted in a recommended 4-year curriculum plan for the UMedic system. Valid pretests and posttests were then created to measure outcomes in bedside skills and were used.

*Figure 3. Pretest and posttest performances by workshop participants in 10 common auscultatory findings. Cont indicates continuous murmur; AS, aortic stenosis; Rub, pericardial friction rub; MS, mitral stenosis; S4, fourth heart sound; AR, aortic regurgitation; S3, third heart sound; S2 Split, second heart sound splitting; TR, tricuspid regurgitation; MR, mitral regurgitation; Total, total correct. Accuracy is reported as a percentage of correct answers. There was significant improvement in each of the 10 auscultatory findings \((P < .001)\). Total pretest = 37%; total posttest = 81%.*
in an additional multicenter cohort study that compared the UMedic system with traditional methods for teaching bedside skills in cardiology. The study involved senior medical students at five institutions. In the intervention group, UMedic modules replaced instruction in bedside skills that occurred during teaching rounds and individual patient workups. There was a statistically significant improvement in the pretest-to-posttest scores of the UMedic-trained students compared to non-UMedic-trained students ($P < .001$).

**Workshop Description**

Two 2-hour workshops were carried out in an interactive, patient-centered format with full audience participation. Of the 64 participants, 29 were practicing clinicians with teaching responsibilities, 14 were practicing clinicians without teaching responsibilities, 14 were house officers, and 7 were medical students. Forty of the participants had direct teaching responsibilities in osteopathic educational programs. Although the size of the audience prevented direct contact with the CPS and UMedic, the use of individual infrared stethoscopes for cardiac auscultation and projection of digital videos showing Harvey’s pulses and breathing allowed each member of the workshop to participate in the evaluation of most of the nonauscultatory as well as auscultatory physical findings.

At the beginning of the workshop, all participants were administered a pretest on the identification of 10 cardiac auscultatory findings, including normal second heart sound splitting, third heart sound, fourth heart sound, mitral regurgitation, aortic stenosis, aortic regurgitation, mitral stenosis, tricuspid regurgitation, pericardial friction rub, and continuous murmur. These findings also represent those judged by program directors of internal medicine and family medicine residencies to be most important and therefore to be mastered by practicing physicians. Each auscultatory finding was presented through digital video clips of Harvey, and participants were given 2 minutes to choose the best description from a list of 14 auscultatory sounds and murmurs.

In the instruction session that followed the pretest, many of the cardiovascular problems encountered by physician assistants were reviewed, including the auscultatory findings assessed in the pretest. A two-member panel of clinical physicians who had experience with these systems discussed the significance of each physical finding, as well as the pathophysiology, natural history, and management of each disease. Questions were posed intermittently throughout the teaching session to encourage participant interaction. Following the instruction period, an analogous posttest of the same 10 auscultatory findings was administered. Participants were also asked to complete an evaluation form designed to elicit the participants’ reaction to the instruction and overall presentation of the workshop. Each attendee was also asked to list his or her teaching responsibilities, if any, and to provide additional comments in an open-answer format. Pretest-to-posttest changes were analyzed with a paired t test. Responses to the evaluation form items were analyzed with the chi-square test for the ordinal data. A .05 level of significance was accepted for all statistical tests.

**Results**

A total of 64 individuals completed pretests, participated in the teaching session, and completed posttests and evaluation forms. Paired t tests indicated a significant difference between the pretest and posttest results. The participants’ scores increased from 37% to 81%. Figure 3 summarizes the accuracy rates for each of the auscultatory findings for both the pretest and posttest. Table 1 summarizes the evaluation of the workshop by the participants. All aspects of the workshop were highly rated, and many participants also expressed the desire to work with these simulation systems in an individual, hands-on learning experience. Open-ended comments provided by participants included the following:

- “The workshop was very helpful.”
- “Excellent workshop/presentation.” (25 evaluations)
- “This is the type of learning method I like most!”
- “I learned so much more in this 2-hour session than I did all semester in cardiology. You explained everything very well.”
- “This is the best cardiac review I have ever had!”
- “This should be part of medical schools for second-year students prior to rotations.”
- “I wish we had this at our medical school when we learned cardiology.”
- “A great program, educational, clear, great trainers—I learned a lot in 2 hours.”

**Discussion**

Accurate clinical examination of patients with cardiac disease is cost-effective, yet, even among osteopathic interns, there is
a need for teaching these skills—the average pretest score at our workshop was 37%. This low score is consistent with performances by physicians-in-training and practicing clinicians.\(^4\)\(^6\)\(^7\) Our results indicate that a 2-hour workshop using simulation instruments such as Harvey and UMedic can result in a significant improvement in cardiovascular auscultation skills—the average posttest score at our workshop was 81%. Integration of simulation techniques such as Harvey and UMedic into undergraduate, graduate, and postgraduate osteopathic curricula is likely to result in even greater improvement in cardiac bedside skills. This has already begun at osteopathic programs at Des Moines University Osteopathic Medical Center\(^16\) and Nova Southeastern University College of Osteopathic Medicine.\(^17\) The latter program has had an undergraduate, second-year curriculum in cardiac auscultation skills using Harvey since 1993.

While simulation instruments are not meant to replace actual patients, they do solve some of the problems associated with modern medical education. This includes the pressures of managed care that have permanently changed the nature of hospitalizations, with higher percentages of acutely ill patients and shorter inpatient stays. The result is less opportunity for trainees to assess patients adequately with a wide variety of diseases and physical findings. Expertise in any skill such as bedside cardiology results from deliberate practice that includes “informative feedback and opportunities for repetition and correction of errors.”\(^18\)

Because cardiovascular disorders constitute a major portion of health problems in the United States and most patients are seen and managed by primary care providers, including osteopathic physicians, an emphasis on skills training for this group is necessary. Simulation systems such as Harvey and UMedic provide a mechanism for repeated practice, feedback, and reassessment to ensure that physicians master and maintain core cardiac examination skills. The regular use of simulation incorporated into self-assessment and self-directed remediation programs, as well as structured continuing medical education programs, offers great promise for lifelong professional development to all health care providers.

References