Harvey® Instructor Guide

The Cardiopulmonary Patient Simulator

UHealth UNIVERSITY OF MIAMI HEALTH SYSTEM | UNIVERSITY OF MIAMI MILLER SCHOOL of MEDICINE

Michael S. Gordon Center for Research in Medical Education

The Gordon Center Health • Education • Innovation

Harvey®
Instructor Guide

The Cardiopulmonary Patient Simulator

Michael S. Gordon Center for Research in Medical Education

UHealth University of Miami Health System | University of Miami Miller School of Medicine

The Gordon Center · Health · Education · Innovation

Harvey® Instructor Guide

The M.I.A.M.I. Group

The **M**iami **I**nternational **A**lliance for **M**edical-Education **I**nnovation

University of Miami
Joseph P. Esterson, M.D.
Michael S. Gordon, M.D., Ph.D.
S. Barry Issenberg, M.D.
Hector F. Rivera, M.D.
Ross J. Scalese, M.D.

Donald D. Brown, M.D.
University of Iowa

Gordon A. Ewy, M.D.
University of Arizona

Luke Devine, M.D., MHPE
University of Toronto

Ira H. Gessner, M.D.
University of Florida

Ronald M. Harden, M.D.
University of Dundee

William C. McGaghie, Ph.D.
Northwestern University

Robert E. Safford, M.D., Ph.D.
Mayo Clinic, Jacksonville

Robert A. Waugh, M.D.
Duke University

Keith R. Oken, M.D.
Mayo Clinic, Jacksonville

The contributions of the above authors reflect their personal experience and opinions, and not the opinions or endorsements of their institutions.

Table of Contents **Page**

Overview

This Instructor Guide has been updated to continue sharing our long experience with our colleagues who use Harvey, the Cardiopulmonary Patient Simulator (CPS) for teaching and testing. We trust this guidance will assist you and, most importantly, will result in the optimal use of the simulator for the benefit of your learners.

Harvey has been used for teaching and assessing bedside cardiac skills for almost 50 years. The simulator and all the accompanying learning materials were created at the University of Miami Gordon Center for Research in Medical Education (GCRME). They are continuously updated by the GCRME's consortium of physicians, nurses, physician assistants, educators and engineers representing medical institutions worldwide. The consortium is known as the MIAMI (**M**iami **I**nternational **A**lliance for **M**edical-Education **I**nnovation) Group.

The Harvey training system consists of the following components that are provided to the user institution:

- Harvey, the Cardiopulmonary Patient Simulator
- Manuals and guides:
  - Harvey Instructor Guide
  - Harvey Learner Manual
  - Harvey Nurses Instructor Guide
  - Harvey Nurses Learner Manual
  - Harvey Technical Manual
- Standardized patient cases for teaching and/or assessment
- Laptop PC with pre-loaded curricula and software
- Software:
  - Harvey curriculum program
  - Harvey nurses introductory program
  - Harvey technical support files
- One USB connector cable
- Cleaning kit:
  - Baby powder (corn starch)
  - White cleaning cloths
  - Box of alcohol cleaning pads
  - Cotton swabs

- Optional accessories:
  - Infrared sound emitter & infrared headphones
  - UMedic Multimedia Computer Curriculum in Cardiology
  - UMedic Essential Cardiac Auscultation
  - UMedic Essential Electrocardiography and Arrhythmia
  - Laminated poster, Master Key of all Harvey patient scenarios

Harvey

Harvey Overview

Harvey, the Cardiopulmonary Patient Simulator provides a comprehensive cardiology curriculum by realistically simulating 50 cardiac conditions. Unlike a real patient, it is always available and is never tired, or at risk of harm. Interesting, instructive, or rare cases may be immediately presented. The user may learn at his/her own rate and become personally involved in the evaluation, acquiring skills as well as cognitive information. The learner may control the number of findings being presented, thus reducing the complexity that often overwhelms a novice when working with real patients for the first time [1].

There are two requirements for mastery of the bedside examination used in patient diagnosis and care. First, skills must be practiced repetitively, and second, trainees must have an orderly examination technique together with knowledge of the hemodynamic correlations with bedside findings. Traditionally, this had required a pool of "teaching" patients with diverse diseases at different stages of severity, and treatment combined with instruction by experienced physicians who are motivated to teach. These requirements have become difficult and often impossible to meet, rendering challenges in healthcare education, as follows:

Reduced numbers of patients as resources for clinical teaching
Changes in the delivery of healthcare have resulted in a major shift in the approach to medical education. The pressures of patient care have permanently changed the nature of hospitalizations, with higher percentages of acutely ill patients and shorter inpatient stays. The result is less opportunity for learners to adequately assess patients with a wide variety of diseases and physical findings.

Increased demands of clinician-educators
Outpatient care has become more cost-efficient, but reductions in physician reimbursement and shrinking financial resources have placed greater constraints on the time that experienced clinician-educators devote to medical education in this environment.

Increased demand for vertical integration of the curriculum
Curricular reform typically demands increased patient contact in the early years of the curriculum to provide a clinical context for the basic sciences. As a result, students in all phases of the curriculum are competing for meaningful patient contact at a time when fewer patients are available.

Increased need for time-effective training
Under the present system of medical education, students find it increasingly difficult to keep abreast of those topics already included in the curriculum, which is itself overcrowded. Opportunities for student learning need to be readily available in order to maximize the time-effectiveness of their training. However, student logs show students spend less than 5% of ward rounds demonstrating their physical examination skills, as patients are often unavailable.

Result: Poor clinical skills training
These problems are having a direct effect on clinical skills training, including bedside cardiology. Despite evidence that accurate clinical examination of patients with cardiac signs and symptoms is a cost-effective diagnostic modality, [2,3] direct bedside teaching of these skills is occurring with decreasing frequency.[4] We believe the inevitable result is a decline in the

quality of practitioners' bedside skills and a reduction in the ability to provide high-quality and cost-effective medical care. The loss of clinical acumen was documented in a study that demonstrated house officers have difficulty identifying common cardiac findings.[5] This study also stressed the need for structured, supplemental strategies to improve clinical education.

As a response to these challenges, the MIAMI Group began work more than 45 years ago to develop Harvey, a simulator capable of reproducing the bedside findings of almost all cardiac diseases instantly and with high fidelity [6-13].

High fidelity simulations such as Harvey are often seen only as a tool for students to gain experience in psychomotor clinical skills in a non-threatening environment. Experience with Harvey has shown that it can be used for a much wider range of educational outcomes. Once the psychomotor skills are developed and a given bedside finding is identified, the trainee may also learn to integrate the pathophysiology, define a differential diagnosis, estimate severity and make management decisions.

Simulators as an answer

Patient simulations can reproduce a wide variety of medical conditions. Simulators are not intended to replace real patients. However, they can address the disadvantages inherent in a totally patient-dependent curriculum. The disadvantages include: [14]

- unavailability of patients demonstrating known diseases at a specific time in the curriculum schedule
- embarrassment and stress to patients and beginning students
- reluctance among patients to participate in an examination where they are exposed to a large number of learners
- unpredictable patient behavior because their physical signs of disease may change and their overall condition may deteriorate
- lack of standardization of patients with unstable disease, resulting in students' assessment on one patient being a very different experience than on others

Learning Guide

Harvey, the Cardiopulmonary Patient Simulator (CPS), is capable of simulating the bedside findings of almost any cardiac condition. The approach to examining the CPS is the same as for a real patient. When used with the accompanying PowerPoint programs or the UMedic Multimedia Computer Curriculum, all of the data available from a patient are presented. This is embodied in the "The Five Fingers of Clinical Diagnosis" (Figure 1).

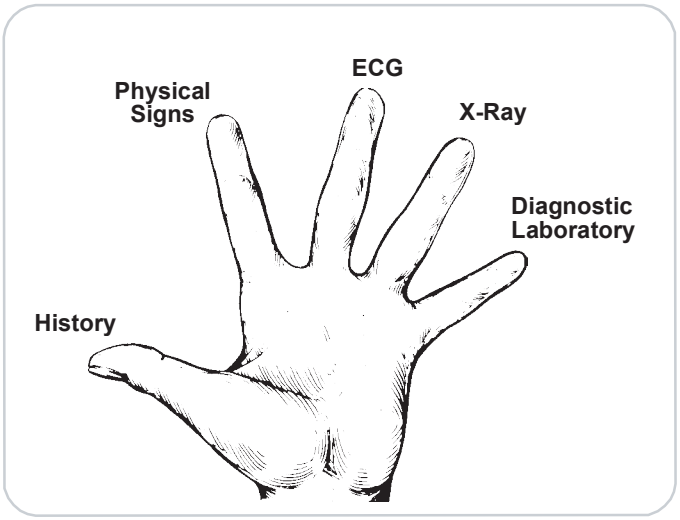

Figure 1 - The Five Fingers of Clinical Diagnosis

Harvey presents the cardiac physical signs of each patient scenario according to the outline indicated in "The Five Fingers of Physical Signs" (Figure 2). The pulmonary exam should include careful auscultation of all lung fields. These outlines are carefully followed for each patient case simulated by Harvey. They are excellent guidelines for a thorough cardiopulmonary physical examination. They also embody the essence of clinical medicine, as the history and physical examination are the cornerstone of patient management. In addition, noninvasive and invasive procedures are best interpreted in the context of a complete bedside patient evaluation.

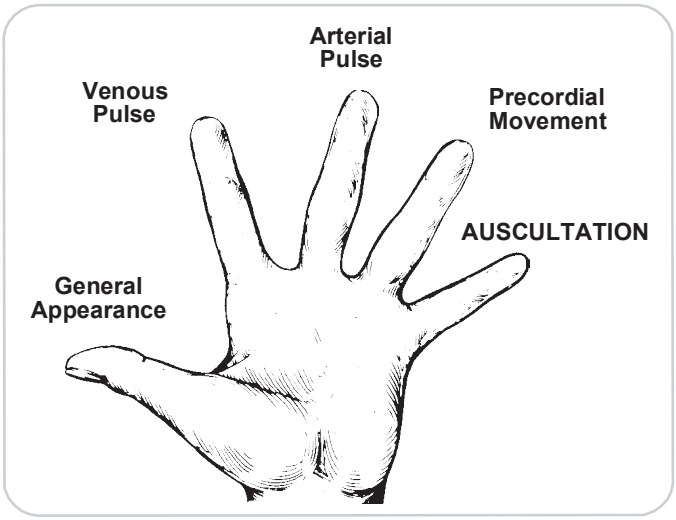

Figure 2 - The Five Fingers of Physical Signs

The self-assessment PowerPoint programs that have been developed for each patient scenario provide the history, physical findings, electrocardiograms, x-rays, echocardiograms, and hemodynamic, therapeutic, pathologic and epidemiologic information. The slides sequentially guide the learner through each case and conclude with a summary of the disease and a review of the case presented.

Harvey may also be used with UMedic, allowing access to an advanced, interactive multimedia computer curriculum. The entire patient evaluation is then presented in real time without the need for an on-site instructor. Learner performance may also be documented. UMedic programs are available for the majority of conditions programmed in Harvey, especially the most common and instructive disorders.

Important Safeguards

Before operating Harvey, advise the users to follow these important safeguards:

1. Please treat Harvey with the same respect you would a live patient – gently! DO NOT PERFORM CPR!

2. **Do not** put pressure on the abdomen or place heavy objects on it.

3. Keep ink, marking materials, power cords, printed materials, and stethoscope tubing away from Harvey's skin, as marks cannot be removed. Wash your hands before using Harvey and/or use examination gloves.

4. **Do not** attempt to move the hands or remove/reposition the blood pressure cuff.

5. Although Harvey is portable, exercise care when moving to protect internal circuitry and mechanics. Keep Harvey horizontal at all times.

6. If you have any technical problems or questions, please make a record of the problem and contact the person in charge.

Harvey skin

Harvey's skin is latex-free.

Controls and Indicators

Harvey's controls and indicators are found on the keypad next to the head (Figure 3). Their functions are described in the instructions next to the keypad. The volume keys control the volume of both the stethoscope and any device connected to the "audio out" located on the left side of Harvey's cabinet door, to transmit sounds to an individual or multiple leaners.

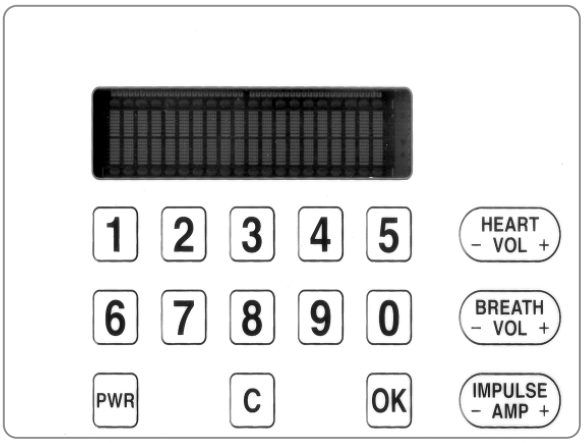

Figure 3 - Keypad

Harvey is simple to operate. It requires the integration of two primary sources of control:

1. Selecting the appropriate patient scenario code number on the keypad control.

2. Displaying the PowerPoint program or using the UMedic program for the same patient scenario.

Examination of the "patient" should proceed according to the standard medical procedure outlined in the "Five Fingers Approach."

Avoid excessive pressure when palpating the simulator, or, as in the case of a real patient, the movement may be occluded or trauma may result. The examination procedure should be systematic and identical to that used when examining a live patient. The bedside examination technique is described at the end of this chapter.

Directions for operating Harvey

1. Power on: press **PWR** – The unit initializes by displaying, "*Please Wait While Loading Sounds."* Patient scenario code 46 (Normal) will appear with instructions to "*Examine Patient Now*."

2. Change patient scenario: enter code number and press **OK**.

3. Cancel entry: press **C**.

4. Change volume or impulse amplitude: press **VOL** or **AMP** "-" or "+" as required. When changing to a new patient scenario, the settings will automatically return to the preset level. You may also return to preset levels by pressing **C** twice consecutively.

5. Remove patient scenario code from screen: Once the appropriate code is set and necessary adjustments are made to the case (volume and impulse amplitude as described in step 4), press **C** once and the number will disappear from the screen. To restore to preset values, press **C** twice consecutively.

6. Power off: press **PWR**.

Note: Harvey will turn off approximately 30 minutes after the last keypad entry or stethoscope sound activation. To turn on, press **PWR**.

Testing Mode: Use step # 5 described above to remove the patient scenario code from the screen.

Capabilities

Identify the locations of Harvey's findings in the figures below.

Arterial and Venous Pulses

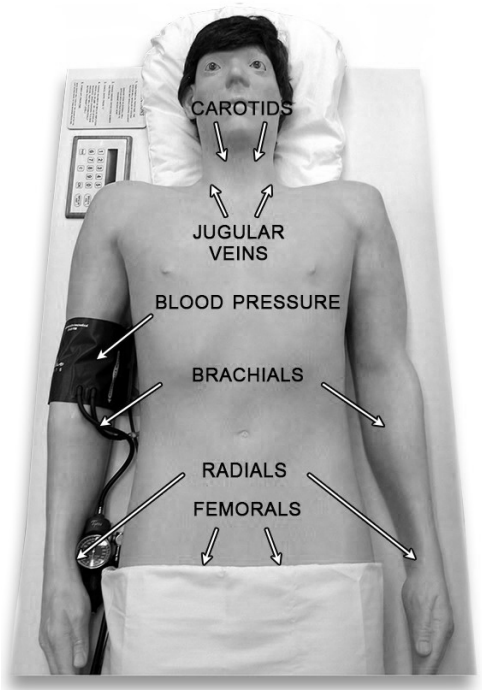

Figure 4

Precordial Movements

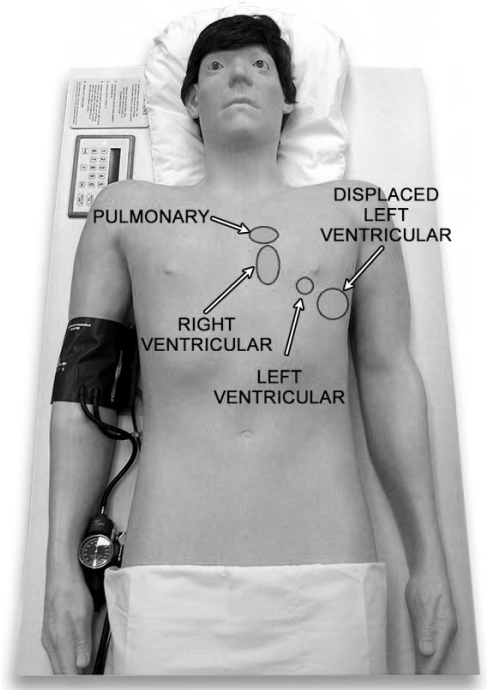

Figure 5

Cardiac Auscultation

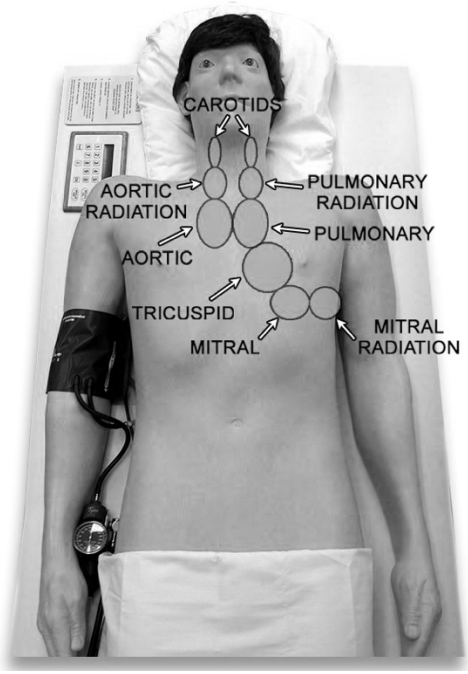

Figure 6

Pulmonary Auscultation

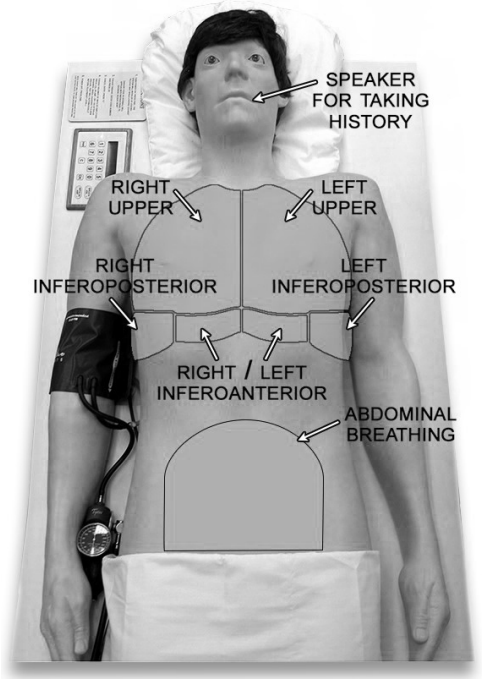

Figure 7

Talking feature

Harvey has a speaker located at the base of the head. Through the use of the wireless microphone and receiver installed in Harvey, a person may speak for Harvey, thus allowing individuals to obtain a history from the simulator (Figure 8).

In addition to the 10 standardized patient (SP = person trained to portray a real patient) cases provided with Harvey, the Harvey PowerPoint curriculum and UMedic programs provide a basis for an SP to portray a real patient. Materials from an established SP program may also be used.

Figure 8 - Instructor responds to learner questions through the use of a wireless microphone

Examination Technique

The technique of examining Harvey is identical to that used when examining a live patient. “The Five Fingers of Physical Signs” should be used as an outline.

General appearance

The general appearance of each patient simulated by Harvey is described or graphically demonstrated in the PowerPoint programs, in the UMedic system, and in the patient scenarios.

Venous pulses

The venous pulses are evaluated by inspection of the jugular veins that directly reflect right atrial hemodynamics. They are observed (not palpated) as they undulate at the inferolateral aspect of the sternocleidomastoid muscle. There are two types of information that can be obtained from the venous pulse: mean central venous pressure and waveform.

The mean central venous pressure varies only slightly in Harvey. The exact level is given for each patient scenario in the accompanying slide program and in the corresponding UMedic program. The venous waveform is exactly simulated. A tangential light source may be cast across the jugular venous pulse to better visualize the waveform (Figure 9), which is best assessed by observing one jugular venous impulse and timing its movement with the contralateral carotid pulse (which lies higher in the neck, just medial to the sternocleidomastoid muscle) or with the heart sounds (Figure 10).

Figure 9

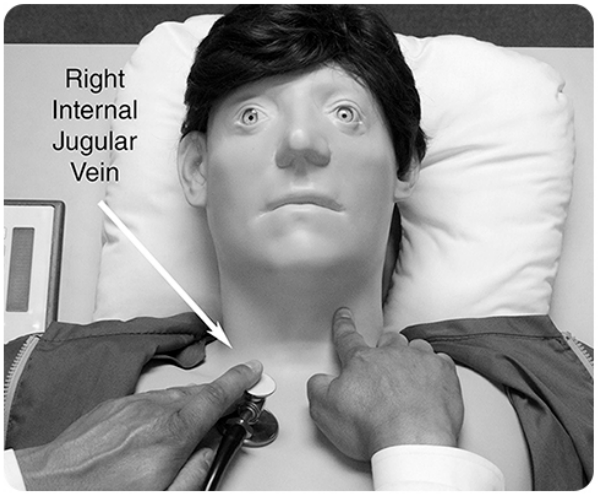

Figure 10

Arterial pulses

Assessment of the arterial pulses includes taking the blood pressure and palpating the pulses. As with a patient, the blood pressure is taken by first palpating the right brachial artery at the medial aspect of the antecubital fossa. The stethoscope diaphragm is then placed over the artery and the cuff inflated (Figure 11). While slowly deflating the cuff and simultaneously listening through the stethoscope, the sphygmomanometer is observed to determine when the Korotkoff sounds begin and end (Figure 12).

Figure 11

Figure 12

The carotid arterial pulse should be lightly palpated high in the neck, just medial to the sternocleidomastoid, assessing its upstroke, peak, and downstroke (Figure 10). The bilateral brachial, radial and femoral arterial pulses should be examined subsequently and assessed for symmetry. The brachial pulse should be palpated simultaneously with the femoral pulse to detect diminution or delay in the latter, as a clue to coarctation of the aorta (Figure 13).

Figure 13

Precordial movements

The locations of some possible precordial movements have been illustrated earlier (Figure 5). The observer should GENTLY palpate the chest wall in each of these areas. Multiple movements may occur, both in systole and diastole. It is necessary to simultaneously palpate the carotid and/or listen to the heart sounds to time any palpable precordial movements (Figure 14).

Figure 14

Cardiac auscultation

After having assessed the venous, arterial and precordial pulsations, the acoustic events may be analyzed. The auscultatory examination is commonly begun at the aortic area and the stethoscope inched to the pulmonary area, tricuspid area and mitral area. Also listen for posterolateral radiation of mitral murmurs, superior radiation of aortic and pulmonary murmurs, and for carotid bruits. It is helpful to simultaneously palpate the carotid to time the acoustic events (Figure 15). Great care should be used to exactly time all of the sounds and murmurs and to assess their intensity, frequency, contour, duration, radiation, and variation (if any) with respiration.

Figure 15

Pulmonary auscultation

Auscultation of the lungs should also be carried out in an orderly manner. Different findings may be present on the left and right sides, and in the upper, lower anterior and lower posterior lung fields. In addition to listening to the breath sounds, the rise and fall of Harvey's abdomen can be observed as a visual means of timing respirations.

Overview of Instructional Materials

Learner Manual

This manual covers all of the bedside findings for each of the 50 patient scenarios provided with Harvey (see listing on p. 21). They include graphics of the heart sounds and murmurs, with explanations of their pathophysiology. The first section of the manual describes the capabilities of Harvey, how to operate the simulator, and the examination technique. The second section, ”Curriculum Guide”, describes the exact findings for each patient scenario, explains the underlying pathophysiology, and presents a graphic representation for each finding.

Instructor Guide

This guide provides practical information about the most effective uses of Harvey for teaching and testing. It provides advice to administrators and instructors on logistical, educational and technical issues in the use of the simulator, and it provides suggestions for research projects. It is based on the University of Miami Gordon Center for Research in Medical Education’s 50-year experience in developing and using Harvey, as well as the results from a worldwide survey of Harvey users.

Nurses Learner Manual

This manual provides focused and guided instructions to teach nursing students and practicing nurses to: 1) identify key assessments when caring for a cardiopulmonary patient; and 2) discuss the basic underlying pathophysiology associated with the assessment findings. It includes all of the findings in the Harvey Nurses Curriculum.

Nurses Instructor Guide

This guide outlines the optimal use of Harvey for those who teach learners in nursing. The information in this guide is based on our consortium’s 50-year experience in developing and using Harvey, the results of a worldwide survey of Harvey users, and the contributions of nurse-educators with experience in simulation-based training.

Harvey Standardized Patient cases

A total of 10 cases are provided with Harvey. A standardized patient (SP) may provide a full history. Each SP case is composed of:

- SP history script
- Rater checklist
- SP checklist

Harvey slide curriculum

The Harvey slide curriculum consists of menu-driven PowerPoint slide presentations for use in self-directed learning and assessment. There is a presentation for each of Harvey's patient scenarios. The slides discuss the history, physical findings, electrocardiograms, echocardiograms, hemodynamics, therapy, pathology and epidemiology of each case. They guide the learner through each case and conclude with a summary for the condition.

Nurses Introductory Program

This program is an excellent resource for nursing students to learn the basics of cardiopulmonary assessment. It is accessible after all of the PowerPoint slide programs have been installed on a computer.

UMedic programs

The UMedic programs provide an interactive, multimedia-rich, teaching and testing resource. Because of the instructor time saved, UMedic is the preferred method of self-learning when used in conjunction with Harvey. UMedic should be used in close proximity to Harvey as shown in Figure 16. The instructions for the use of UMedic linked to Harvey are the same as those when UMedic is used alone and are detailed in the UMedic User Manual. Important exceptions include:

- Be sure to enter the patient scenario code in Harvey that matches the UMedic program.
- Use Harvey's stethoscope or headphones when you are instructed to listen to Harvey's heart sounds and murmurs.
- Either speakers or headphones can be used for the audio portion of the UMedic system. Speakers are convenient, since Harvey's stethoscope or headphones will also be used. However, the fidelity of the heart sounds and murmurs in the UMedic system will be enhanced if headphones are used.

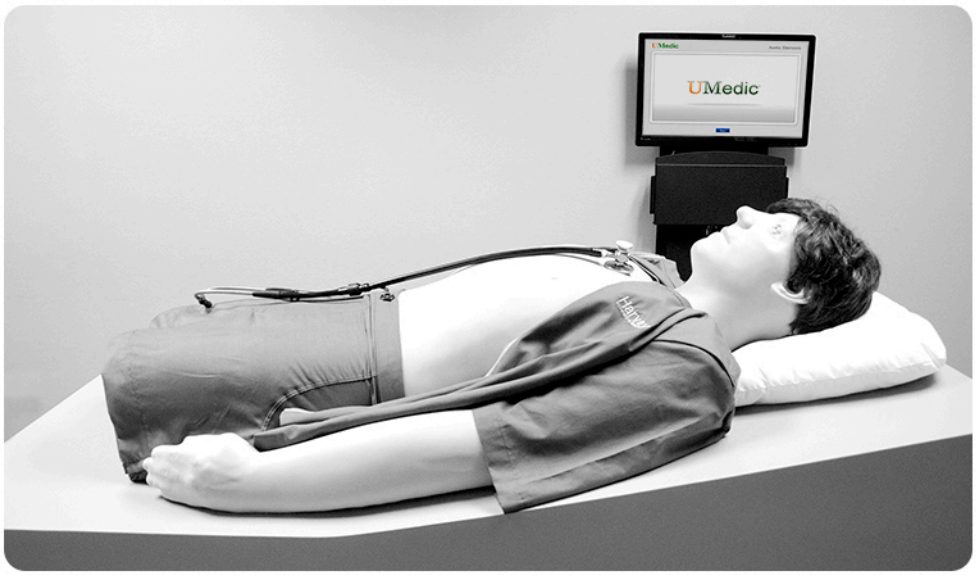

Figure 16 – Harvey and UMedic in small learning room

Patient Scenarios Available

Patient Scenario	Code	HR	RR
Introductory Program	44	60	12
Normal (60 bpm)	46	60	12
Normal (90 bpm)	246	90	15
Innocent Murmur (60 bpm)	22	60	12
Innocent Murmur (90 bpm)	222	90	15
Aortic Valve Sclerosis	49	60	12
Hypertension (60 bpm)	36	60	12
Hypertension (90 bpm)	236	90	15
Angina Pectoris	39	60	12
Acute Inferior Myocardial Infarction	43	60	12
Acute Anterior Myocardial Infarction	40	60	12
Ventricular Aneurysm	48	60	12
Mitral Valve Prolapse (60 bpm)	9	60	12
Mitral Valve Prolapse (90 bpm)	209	90	15
Mitral Valve Prolapse, isolated click and murmur	10	60	12
Mitral Regurgitation, chronic	7	60	12
Mitral Regurgitation, moderate	70	60	12
Mitral Regurgitation, mild (60 bpm)	8	60	12
Mitral Regurgitation, mild (90 bpm)	208	90	15
Mitral Regurgitation, acute	6	60	12
Tricuspid Regurgitation, mild (60 bpm)	50	60	12
Tricuspid Regurgitation, mild (90 bpm)	250	90	15
Mitral Stenosis with Severe Tricuspid Regurgitation	4	60	12
Mitral Stenosis with Mild Tricuspid Regurgitation	5	60	12
Mitral Stenosis and Regurgitation	3	60	12
Aortic Regurgitation, chronic (60 bpm)	17	60	12
Aortic Regurgitation, chronic (90 bpm)	217	90	15
Aortic Regurgitation, mild	38	60	12
Aortic Regurgitation, acute	37	60	12
Aortic Stenosis (60 bpm)	13	60	12
Aortic Stenosis (90 bpm)	213	90	15
Aortic Stenosis, moderate	14	60	12
Severe Aortic Stenosis and Mild Aortic Regurgitation	15	60	12
Hypertrophic Obstructive Cardiomyopathy	1	60	12
Cardiomyopathy (60 bpm)	42	60	12
Cardiomyopathy (90 bpm)	242	90	15
Ischemic Cardiomyopathy	41	60	12
Heart Failure, mild systolic	45	60	12
Heart Failure, mild diastolic	47	60	12
Acute Pericarditis (60 bpm)	30	60	12
Acute Pericarditis (90 bpm)	230	90	15
Primary Pulmonary Hypertension	11	60	12
Cor Pulmonale	64	90	15
Pulmonary Embolism	62	90	15
Atrial Septal Defect	23	60	12
Ventricular Septal Defect	25	60	12
Patent Ductus Arteriosus	28	60	12
Pulmonary Stenosis	20	60	12
Coarctation of the Aorta	33	60	12
Tetralogy of Fallot	27	60	12

Location & Allocating Responsibilities

Physical Location

One of the most important conclusions of our user survey was that the location of Harvey directly correlated with its use throughout the curriculum. The location should be convenient for both students and the faculty person-in-charge. Even though Harvey functions as a self-learning device, the nearby presence and availability of knowledgeable faculty and staff ensure a successful program.

Locations that contribute to Harvey's success:
- Clinical skills center
- Dedicated small classroom in medical education center
- Dedicated small classroom in main teaching hospital
- Standardized patient center, especially using Harvey's "talking" feature

Locations that contribute to Harvey's lack of use:
- Library setting
- Off-site clinic location remote from other learning activities
- Non-dedicated small classroom in which other other educational activities are scheduled

Access to Harvey

In our user survey, the majority of institutions reported having restricted hours for the use of Harvey. About one-fourth of the schools have unrestricted hours. There are advantages and disadvantages to both of these methods.

Issues related to restricted access to Harvey
- Limits the potential off-peak hours for practice with Harvey (e.g., evenings and weekends).
- Allows for greater degree of surveillance of Harvey - damage is less likely to occur when others are present.
- Conflicts in scheduling Harvey's use for multiple groups of learners are more likely to occur.
- Many schools have found it helpful to implement a "sign up" schedule for access time when Harvey is not being used as part of a core learning activity.

Issues related to unrestricted access to Harvey
- Increases the potential off-peak hours for practice with Harvey (e.g., evenings/weekends).
- Allows for less surveillance of Harvey - damage more likely to occur when others not present.
- Conflicts in scheduling Harvey's use for multiple groups of learners are less likely to occur.
- Schools have found it helpful to install electronic access card systems to allow room entry.

Note: With either system, the key factor is a person designated to control the schedule and briefly orient learners.

Learning Environment

Harvey may be used for teaching in any environment in which a patient might be examined. Individuals, or small groups using headphones, may learn without an instructor by using the Harvey curriculum slide programs or the UMedic system (Figure 25). Larger groups may learn in a lecture hall setting by using headphones for auscultation and video cameras and monitors (or a projector) for observing other physical findings.

Harvey may be permanently housed in a variety of settings. If the area is only for Harvey, it should be about the size of a small hospital room, so that space is available for small group “bedside rounds.” Harvey may also be used in clinical skills or simulation training centers that house other skills/simulation training systems. While special facilities are not required to use Harvey for history taking, Standardized Patient (SP) training areas facilitate such use. Again, what’s most important is that the location should be convenient for both students and the faculty person-in-charge. Even though Harvey functions as a self-learning device, the nearby presence and availability of knowledgeable faculty and staff will ensure a successful program. The simulator is portable and may be moved to a lecture hall or other sites as needed.

Allocating Responsibilities

Academic

Appoint one faculty member who is responsible not just for the use of Harvey in one specific course, but for integrating Harvey into the curriculum. Schools that have been most successful at fully integrating Harvey throughout the entire curriculum have such a “Harvey champion”. This person is typically a clinician who believes in the value of the bedside examination, enjoys the teaching of bedside skills, and often directs a related component of the curriculum.

Administrative

Appoint an administrator of Harvey (someone who works closely with the academic Harvey champion). Administrative responsibilities relating to Harvey include:

- briefly orienting students and providing them with appropriate instructions
- scheduling the use of Harvey
- liaising with faculty to facilitate teaching and assessment sessions
- working with the technician to keep records related to the maintenance of Harvey

Technical

There are no maintenance requirements other than cleaning the skin with rubbing alcohol and lightly powdering the skin each day that Harvey is used. Users should be advised to wash their hands prior to use, and to refrain from bringing pens, food or drinks into the area. In the event of a malfunction or need to adjust the unit, a person with basic computer skills may be needed to obtain technical support from the University of Miami Gordon Center for Research in Medical Education.

Accessory Technologies in the Use of Harvey

Infrared sound transmission systems

We strongly encourage user institutions to obtain a sound transmission system consisting of a classroom emitter and a minimum of 10 headphones. Because this will enable multiple users to all hear the auscultatory findings at the same time, it enhances teacher-student interaction, and is necessary for group instruction. Depending on the audio system and the number of headphones obtained, any number of users, from a small group to a large auditorium of over 200 people, may auscultate simultaneously.

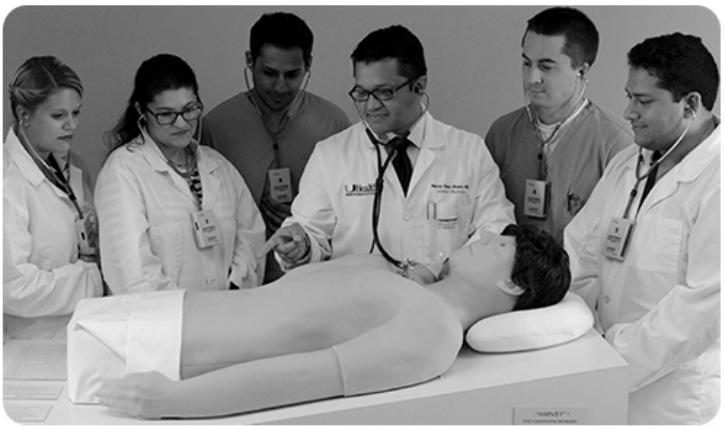

Figure 17 - Teaching a small group using infrared headphones for simultaneous auscultation

We suggest the following infrared systems from Cardionics:

Classroom emitter

Up to 30 individuals, each wearing a HeartMan infrared headphone, may interact with Harvey through the classroom infrared emitter. The sound clarity is very similar to a standard stethoscope.

Auditorium emitter

The auditorium infrared sound system transmits sounds to a small or large audience, with each individual wearing a HeartMan infrared headphone. A single three-panel infrared array accommodates small classrooms or auditoriums seating up to 175 people, while a dual three-panel infrared array system will likely be needed for larger auditoriums seating up to 500 people.

HeartMan infrared headphones

HeartMan infrared headphones works with these classroom and auditorium systems to allow simultaneous listening in both educational and clinical settings.

Speaker sound transmission systems

An institution may choose to use a 2:1 speaker system (2 small, medium/higher frequency speakers and 1 subwoofer or lower frequency speaker) that may be connected to Harvey's audio output. One may also connect Harvey to an existing room's audio system (classroom, simulation room, auditorium, etc.). To connect a sound system to Harvey's audio output requires a cable with a male mono ¼-inch plug (or mono to stereo adapter).

Multiple systems exist, and it is important to test these in advance to guarantee that all sound frequencies are transmitted accurately. This may not work with all audio systems, as some may not be able to support low frequency sounds.

Video capture systems

When utilizing Harvey in a classroom setting, use one of the modalities described above for audio transmission. In addition, having learners visualize findings will aid in their understanding and learning of the cardiopulmonary conditions presented by Harvey. Options to consider include single- or multiple-camera systems. If only a single camera is available the view should be adjusted to include the neck, precordial and abdominal respiratory movements (Figure 18). If additional cameras are available a close-up view of the neck area is recommended to better demonstrate carotid arterial and jugular venous pulsations (Figure 19). The cameras may be fixed to the ceiling or other structures, and should be of the Pan-Tilt-Zoom (PTZ) type for added flexibility. In addition to having a clear and sharp image, ensure that cameras are well mounted to avoid vibration. Video lag may be an issue in some systems. Therefore, it is important to test these in advance.

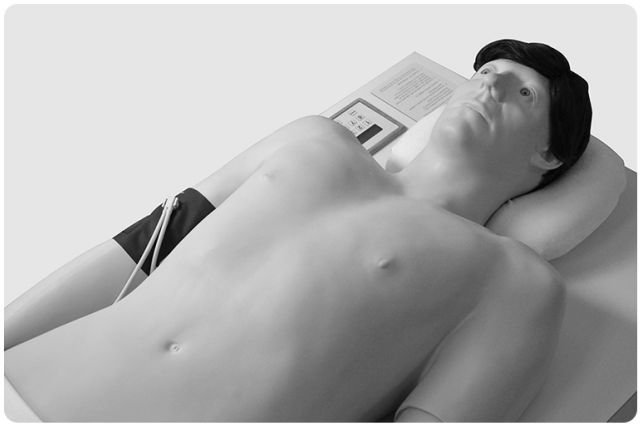

Figure 18

Figure 19

When using video cameras to demonstrate Harvey's findings, one may place a (coin or similar) very light object on Harvey's abdomen to enhance visibility of the respiratory movement. In addition, one may use a cotton swab to show the waveform of venous, arterial and precordial impulses. To do so, follow these steps (Figure 20):

1. Palpate to determine the location of the impulse you wish to demonstrate. (This will be the fulcrum of the cotton swab lever, as indicated by the triangle in the figure below.)
2. Place one finger on the tip of the swab approximately ½ inch behind the impulse, as illustrated below.

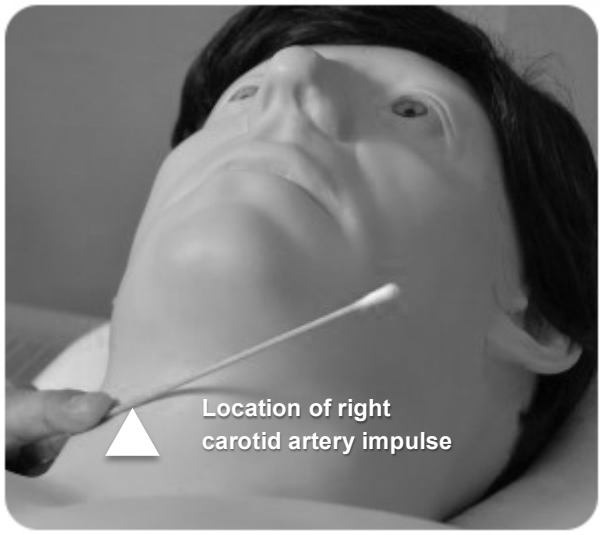

Figure 20

Target Audience

Learner Populations

Harvey may be used to emphasize vertical integration in the curriculum and the continuum of students' learning. Students are introduced to basic skills in the early years and, as they progress through their training, they:

- increase the breadth of their competence by learning new skills (e.g., relating to congenital heart disease)
- increase the level of difficulty through exposure to more complex situations (such as multiple valvular lesions, or less obvious or typical auscultatory findings)
- increase their proficiency (with fewer errors expected, and examination of the patient completed in less time)

Medical students and physicians

All medical schools that have Harvey use the simulator for training medical students. Seventy-five percent also use Harvey for training residents and 50% use it for continuing medical education.

Physician Assistants (PA) / Nurse Practitioners (NP)

More than half of these healthcare providers practice in a primary care setting. Increasingly, PAs and NPs are called upon to conduct initial and follow-up physical examinations. Half of the institutions that have Harvey use it to teach these populations.

Nursing

Harvey is also used at half of the user institutions for basic and specialist training of nurses. The simulator has been used successfully to introduce nurses to the clinical examination of the cardiology patient and to a range of cardiac problems.

Other healthcare providers

Harvey can also contribute to the training programs of other types of healthcare providers. Echocardiography technicians can learn the bedside findings of the diseases they evaluate, and paramedics can learn selected findings that may be important in the acute prehospital setting. Pharmaceutical companies have requested training courses that include Harvey for their representatives.

Inter-professional education

The importance of teamwork in the delivery of healthcare is well recognized. One educational implication has been an increasing interest in the potential of multi-professional education. Not uncommonly, the facilities of clinical skills centers, where Harvey may be located, are shared among medical students, nursing students and students of other healthcare professions. It is important that the different users are not seen to compete for the same resources and that this is seen as an opportunity for shared teaching. Patient management problems may be developed with Harvey as a focus, and these may be addressed by an inter-professional group of students or trainees.

Learner Level

All user institutions utilize Harvey to train medical students in the later "clinical" years of their medical school curriculum. At 75% of these institutions the simulator is also used during physical diagnosis courses in the early medical student curriculum and in early postgraduate training. The experiences reflected in our survey demonstrate that Harvey can be used at any level of medical education.

Early medical school training

Harvey and the UMedic system can be used throughout the early phases of the curriculum to enrich discussions of the basic sciences. A normal "patient" can be examined and the findings correlated with normal anatomy and cardiovascular hemodynamics. An example of a patient with abnormal auscultatory events might then be added, with a review of the associated pathophysiology.

A clinical example with a problem-based learning approach can also be used, so that students can see what is expected of them in the context of medical practice. A cardiac problem such as myocardial infarction can be used as an example. Learning can be made more meaningful for students if Harvey and the UMedic programs are used to illustrate the clinical problem.

Later years of medical school curriculum

Harvey can be used to assist students to learn clinical skills in cardiology and to strengthen their understanding of the relevant pathophysiology. Harvey is not a replacement for contact with real patients, but can greatly enhance the value of time spent in the clinical context and increase the overall acquisition of required competencies. In many centers, Harvey plays a key role in clinical rotations by reinforcing bedside findings elicited from real cases seen on the wards and in ambulatory care settings.

Postgraduate training

Harvey is of value both for general postgraduate and for specialist cardiology training. In generalist training, Harvey can help postgraduate trainees to learn and/or maintain their basic auscultatory skills. It can also be used to develop additional skills and understanding related to more specialized cardiac practice. For example, cardiology fellows must be able to assess the severity of a valvular lesion based on the bedside findings.

Continuing education

Maintaining competence is a continuing challenge in medical education. The acquisition and retention of basic cardiac bedside skills are becoming requirements of certification organizations. For example, the American Board of Internal Medicine has emphasized these skills in the multimedia Clinical Skills Module of its Maintenance of Certification (MOC) Program.[15]

Harvey provides a convenient and attractive resource for "refresher" courses for family physicians and hospitalists. If used for this purpose, physicians value the experience and feel that they gain much needed competence and confidence in their auscultatory abilities.

Harvey can be used as a resource for short continuing medical education courses, much like "Grand Rounds." A clinical case is presented and the findings demonstrated on Harvey, with the pathophysiologic mechanisms and investigations discussed and explained using the UMedic system. Alternative diagnoses with their associated clinical findings can also be demonstrated on Harvey and with the UMedic system.

Examples of the Use of Harvey for Continuing Education	
Course	**Audience**
University of Miami Annual Teaching Conference in Clinical Cardiology and Neurology	Primary Care Physicians, Nurses, Nurse Practitioners and Physician Assistants
American College of Cardiology (ACC) Heart House	Nurses, Nurse Practitioners and Physician Assistants
American College of Osteopathic Internists (ACOI) Annual Convention and Scientific Sessions	Osteopathic Internists
Society for General Internal Medicine (SGIM) Annual Meeting	Academic Internists
Association of Physician Assistant Programs Annual Meeting	Physician Assistant Program Directors and Practitioners
Association for Medical Education in Europe (AMEE) Annual Conference	Practicing Physicians and Medical Educators
American Academy of Family Physicians (AAFP) Annual Scientific Sessions	Family Physicians
American College of Physicians (ACP) Annual Session and Postgraduate Courses	Internists
American Heart Association (AHA) Annual Scientific Sessions	Cardiologists, Internists and Nurses
Association of American Medical Colleges (AAMC) Annual Meeting	Clerkship Directors

Learning Environments

Learning Environments

Harvey teaches best when used in a variety of learning environments. The following summarizes several very effective settings.

Instructor teaching

While students can learn from Harvey with no instructor, we recommend that the initial session is carried out by an instructor. This allows an appropriate orientation and the opportunity for the instructor to express his or her curricular goals and demonstrate the technique of the bedside examination firsthand. We also recommend that additional instructor teaching sessions be scheduled during the course, to cover additional disease states and answer questions about cases reviewed by students during their self-learning sessions.

Small-group instructor teaching (Harvey bedside rounds)

This is the simplest system for instructor teaching (Figure 22). All that is needed is enough headsets for each of the students when they cluster around Harvey's bedside. The instructor should prepare by reviewing in the Harvey Learner Manual the description of the condition that he or she plans to cover during the session. The instructor will be able to assess the background level of skills and the needs of the students during this interactive session, and then provide focused teaching. Because these sessions are hands-on and interactive, students maintain a very high level of interest for up to two hours.

Figure 21 - Instructor using Harvey in small group session with medical students

Large-group instructor teaching (auditorium / lecture hall)

This is a powerful method to reach many learners at one time. It also requires additional equipment and a bit of practice by the instructor to demonstrate the findings so that all may share the bedside findings. Harvey is being used very successfully at schools to teach entire classes and at conferences to teach hundreds of learners (Figure 23). This format does not allow learners to have direct contact with Harvey during the session. However, the use of individual infrared headphones and a video camera/projector system allows each person to participate in the evaluation of the auscultatory and non-auscultatory physical findings.

Figure 22 - Instructor using Harvey in large-group setting

Large-group teaching need not be a passive learning experience. In a traditional lecture, the audience assumes a purely passive role and concentration wanes and declines after 20 to 30 minutes, with most people able to recall around three facts from an hour-long lecture. We have found the use of a computerized audience response system to be a very effective means to transform large group teaching sessions into active learning experiences, leading to more efficient acquisition and retention of knowledge. When using an audience response system,[16] questions are posed to learners, who anonymously enter their answers on individual keypads. The results are automatically tallied and displayed. The immediate feedback stimulates teacher-student focus and discussion.

Independent student self-learning (individual and small-group)

Most learning with Harvey falls into this category. Independent learning makes a very important contribution to a user's hands-on skills training (Figure 23). Students master the content being studied, while at the same time they develop the ability to work on their own and to take responsibility for their own learning. Because learners can proceed at their own pace, it provides an excellent means for "deliberate practice"* of bedside skills. The associated learning materials, especially UMedic, effectively substitute for a personal instructor. Small groups can similarly engage in self-directed learning; there is less individual hands-on time, but more opportunity to exchange ideas and solve problems together.

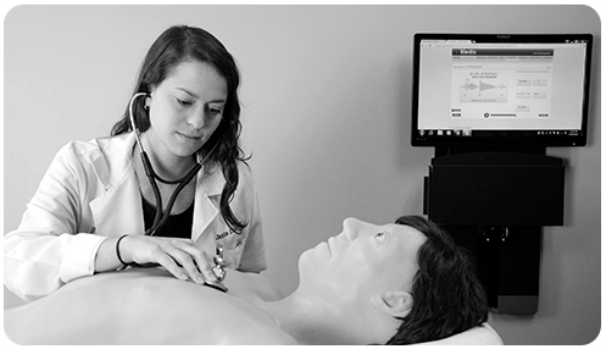

Figure 23 - Independent learning with Harvey

***Deliberate practice** has been defined as the "opportunity for an individual to tackle a well-defined task with appropriate difficulty for that individual, receive informative feedback and have opportunities for repetition and correction of errors."[17]

Students teaching students

One of the students is trained and prepares in advance, assumes the role of the instructor, reviews key findings, and acts as the facilitator during the session (Figure 24). The University of Miami has implemented an Academic Societies program in which senior medical students use Harvey to provide instruction and feedback to first-year medical students on the fundamentals of the cardiac bedside exam. We find this approach to be very exciting. The student-teachers are highly motivated and can become quite skillful. They save faculty instructor time and serve as role models for the students they teach. Instructor time must also be invested in training and monitoring the performance of the student-teacher.

Figure 24 – A student teaching other students with Harvey

Curriculum Integration of Harvey

Practical issues

Harvey must be made an integral part of the required curriculum. If it is an optional resource, students have much less incentive to use the simulator. Outcomes must also be tested, because "assessment drives learning."

Planning

The first step is to plan the initial experience with Harvey in a part of the curriculum that is easy for the Harvey "champion" to control. Examples include champions that are directors of the clinical skills center, the physical diagnosis course or a cardiology elective. To integrate Harvey throughout the entire curriculum will take cooperation among multiple faculty members. It will require leadership and a willingness to change by those involved. All planning must include specific learning goals and the testing of outcomes.

Inclusion in a timetable

Develop a timetable for the use of Harvey in different settings throughout the curriculum. This should include instructor-facilitated small-group sessions and independent self-learning sessions. Ideally an instructor first introduces Harvey to an entire class in an auditorium/lecture hall setting. An example of an effective timetable is shown below:

Plan to Utilize Harvey in a Four-year Medical School Curriculum

LEARNING GOALS	COURSE	MODULES	METHOD	TIME
Year 1 Normal cardiovascular physiology & bedside examination	Physiology and/or Early Clinical Skills	Normal (46) Normal (46)	Large-Group Lecture Setting Small-Group / Independent Learning	1.5 hours 1.5 hours
Year 2 Review normal and add classic valve lesions: pathophysiology & bedside examination	Pathophysiology and/or Advanced Clinical Skills (Physical Diagnosis Course)	Review Normal (46) Highlight MR (7), AS (13), AR (17), MS (4) MR, AS, AR, MS	Large-Group Lecture Setting Small-Group / Independent Learning	2 hours 6 hours
Year 3 Review common diseases, including the bedside examination, laboratory evaluation & treatment	Medicine Clerkship	Angina Pectoris (39) Inferior Infarction (40) Anterior Infarction (43) Hypertension (36) Cardiomyopathy (42)	Small Group / Independent Learning	7.5 hours
Year 4 Comprehensive review of cardiovascular curriculum	Adult and/or Pediatric Electives	Review previous modules, add congenital and acquired disease modules	Small Group / Independent Learning	15 – 20 hours in 4-week elective

Student orientation and assistance

Provide students with an orientation to the use of Harvey. This is a simple task carried out with small groups of learners at Harvey's bedside. Students may also be helped by providing appropriate study guides.[18] The Harvey Learner Manual includes information about orienting learners and serves as a study guide.

Faculty / Staff development

The first step is for the Harvey "champion" to carefully review this guide and the Harvey Learner Manual. If you have UMedic, the next step is to review the Bedside Findings section of several programs. Start with the normal patient (code 46), and then review at least two valve lesions such as aortic stenosis and mitral regurgitation. This will show you how an academic cardiologist with many decades of experience teaching with Harvey demonstrates and explains the findings. The last step is to go to Harvey's bedside and "try out" the simulator with the Harvey Learner Manual in hand. Review any condition you wish, and consult the manual for an explanation of the findings, along with a graphic representation of each finding.

Once Harvey's "champion" has carried out the above preparation, he or she can readily guide other faculty along the same route and ask the staff to review those sections of this guide that are pertinent to them. Once an instructor has had some experience teaching with Harvey, a very effective way of training another instructor is for that person to observe the more experienced one. Each will ultimately develop their own techniques, and they will learn from each other.

While Harvey is most often used to teach from a case-based approach, the simulator is also frequently used to teach from a "bedside finding" perspective. Appendix A provides a quick reference of the range of findings (both non auscultatory and auscultatory) that can be simulated in Harvey. Using these findings the instructor might start with the arterial pulses and proceed to venous pulses, precordial impulses, heart sounds, murmurs and breath sounds. A brief outline of this approach, as implemented at one user institution, is found in Appendix B. There is also a glossary ("Master Key") of pulses, impulses and acoustic events found in the Harvey Learner Manual that will help teach the "bedside finding" approach.

Finally, if the Harvey "champion" wishes to reach a large audience of your colleagues and potential instructors, he/she should consider a presentation at Grand Rounds. If much interest is generated, it will keep this person busy in the short term, but could provide a cadre of teachers in the long term. Also, do not forget that teaching trainees, including senior students, to teach their junior colleagues is an effective way to stimulate interest and develop additional instructors.

Curriculum evaluation

Evaluation of the use of Harvey should be included as part of the standard curriculum evaluation. Review how Harvey is used in the program and make adjustments as necessary. Students themselves may come up with ideas for using Harvey.

Different approaches

Our experiences, as well as user surveys and studies, reveal that Harvey is being used with a wide variety of educational approaches. At most schools, an instructor introduces the bedside examination, orients students and provides questions to stimulate further learning. Students then practice on their own to develop and hone their clinical skills using Harvey for "deliberate practice."

Small-group instructor teaching

This approach is employed at nearly 100% of institutions using Harvey. About half of the user institutions also carry out large-group interactive teaching. While instructor-led learning is a valuable educational method, it is most effective when combined with student self-learning.

Student self-learning

This approach is utilized by nearly 70% of institutions using Harvey. The companion self-assessment slide programs and the interactive UMedic system facilitate student self-learning and reduce the need for instructor time.

Case-based

The self-assessment slides and UMedic system provide a traditional case-based approach to learning, where information is given in a step-wise fashion as the student progresses through the case. This system is adopted at most user institutions.

Problem-based / Task-based

Harvey is also used with a problem- or task-based approach, in which the learner approaches the "patient" with a problem (e.g., heart murmur, chest pain) rather than a diagnosis (mitral regurgitation, acute pericarditis).

Integration

We will now discuss two types of integration, vertical and horizontal. The vertical integration approach ensures that students build new competencies on existing capabilities. For example, the "third heart sound" is visited several times throughout the curriculum:

- During the normal physiology course
- During a cardiac pathophysiology section
- During a clinical skills course on auscultation
- During a medicine clerkship as a sign of a patient in decompensated heart failure

The horizontal integration approach ensures that students recognize the relationship of the topic in one discipline to the same topic in another discipline. For instance, the presence of a heart murmur can serve as a focus for the integration of medical, surgical, pediatric, obstetric and psychological perspectives as students rotate through a range of clinical clerkships.

Inter-professional

An inter-professional perspective can be provided by participation of different members of the healthcare team (including physicians, nurses and paramedics) through joint learning in a centralized clinical skills center.

Community-based *versus* Hospital-based

As a result of increased patient turnover and decreased inpatient stays, the focus for student learning has shifted away from the teaching hospital environment to the community and ambulatory settings where students now gain their clinical experiences.

The fifty patient scenarios in the Harvey curriculum, especially when used with the UMedic programs, provide a wide variety of conditions that may be encountered either in the hospital or community setting. Usually the demands of taking care of acutely ill hospitalized patients limit the amount of thoughtful, deliberate use of the simulator that may be more feasible when caring for patients in an ambulatory setting.

Adaptive learning

At several institutions, students can take a special elective to provide additional “customized” learning opportunities. In such an adaptive curriculum, students spend different amounts of time studying a program or module depending on their needs. This is accomplished by pretesting all students prior to the course to assess their strengths and weaknesses, so that their independent learning time can be structured around their deficiencies. The student’s mastery of skills is assessed halfway through the course, feedback is given, and further studies are organized to meet the student’s needs. For example, the “Bedside-Only” option of the UMedic system allows learners to focus on physical exam skills in Harvey, rather than spending unnecessary time on sections covering diagnostic testing.

Systematic learning

The standardized curriculum in Harvey, coupled with specific learning goals, ensures that students systematically address relevant clinical topics in cardiology.

Learner Outcomes & Assessment

Learning Outcomes

In recent years, there has been a growing movement toward outcomes-based education.[19-23] This is a performance-based approach where the emphasis is on the product (in this case, what sort of practitioner will be produced), rather than on the educational process. Harvey has been shown to be a useful tool in aiding educators and students in the teaching and assessment of outcomes.

Our survey of users revealed that Harvey may contribute to the achievement of the following outcomes:

Physical examination skills

Harvey is used at all institutions to teach the fundamentals of the cardiac physical examination and to provide opportunities for deliberate practice of these important skills.

Patient investigation and management

Harvey's clinical findings can be combined with discussions that address diagnostic reasoning, differential diagnosis, and management of the condition suggested by the findings. This approach is being used by some medical teachers in an iterative process that allows immediate reprogramming of Harvey to provide a different set of "What if?" clinical findings, thereby extending the discussion to other diagnostic and management possibilities.

Communication skills

Harvey can be used in combination with standardized patient scenarios. The learner takes a history from a standardized patient (or through Harvey's built-in audio system), then examines Harvey (who has findings consistent with the patient presentation) and, finally, verbally communicates the findings and their meaning to either the patient or facilitator.

Understanding of basic science in clinical medicine

Harvey has also been shown to be a powerful tool for teaching and reinforcing knowledge and understanding of anatomy and pathophysiology. It allows on-demand access to a wide variety of individual clinical findings and/or patterns of physical findings in specific conditions that may be followed by review of the underlying pathophysiology.

Appropriate attitudes and ethical understanding

Harvey is also being used to frame discussions that relate specific findings to choosing appropriate cost-effective laboratory and imaging investigations. This approach has significant potential to encourage trainees to consider the human and societal costs of unnecessary investigations and inappropriate treatments throughout their training and in their practices.

Clinical reasoning and appropriate decision making

Harvey has often been used in conferences to present cases that lead to discussions of

management by experienced cardiologists and cardiac surgeons. The audience first becomes involved with the case by sharing the bedside findings and formulating their own diagnosis. They further benefit from the reasoning and decisions made by the experts.

Lifelong learning
Harvey provides an opportunity for clinicians to learn and review bedside skills through intermittent repetitive practice. This is necessary to maintain skills, especially those required to recognize uncommon cardiac conditions.

Assessment

Using Harvey as an assessment tool

Harvey is an excellent tool for testing bedside cardiovascular examination skills. It is an ideal "standardized patient" for assessment. Patient findings can be presented uniformly and the process of skills testing can then be made objective.

Harvey is used for formative assessment to monitor a student's progress through a course or a phase of their studies. It is also used for summative assessment at the end of different courses, as it meets the fairness criteria that all can be tested on the same materials and judged by the same standards.

Testing procedure

There is a simple procedure that allows instructors to examine learners without the latter knowing the patient scenario code. The patient scenario is activated by the instructor in the usual manner. The instructor then presses **C** on the keypad, and the code number disappears. (Do not enter another patient scenario code number or press **OK**.)

What should be assessed and how

Harvey has been used as an assessment tool in many different ways. Important examples include the following:

Entire cardiac examination

This comprehensive assessment system was developed as part of an NHLBI-sponsored multicenter study.[24] More than 200 students from five medical schools participated, with about half in the control group. The skills examination covered all significant aspects of the bedside cardiac examination. Major categories were vital signs, jugular venous pulses, carotid and peripheral arterial pulses, precordial movement, auscultation, and diagnostic impression. Each student individually examined both Harvey with a randomly selected patient scenario and a real patient with a defined cardiac condition; he or she then immediately completed an answer sheet by circling the graphic finding that best represented what they had visualized, palpated or heard on auscultation. Students trained on Harvey demonstrated a highly significant gain in the posttests involving Harvey *and* real patients, compared with students trained only on patients but with no exposure to Harvey. This type of individual testing is time consuming, but it has high validity and is very effective.

Auscultation only

This testing system focuses on the most important auscultatory findings. The findings chosen were judged by program directors of internal medicine and family medicine residencies to be extremely important (i.e., a practicing clinician should master recognizing them). Our consortium of cardiologists reviewed their decision and agreed. The findings include the following:

Important Auscultatory Findings	
Second Sound Splitting	Aortic Stenosis
Third Sound	Aortic Regurgitation
Fourth Sound	Mitral Stenosis
Systolic Clicks	Continuous Murmur
Innocent Murmur	Tricuspid Regurgitation
Mitral Regurgitation	Pericardial Rub

This test is most often carried out in a large-group setting. The patient scenario that has the desired auscultatory finding in Harvey is activated. All auscultate through headphones and then choose the answer from a list that includes the 12 findings. After exposure to Harvey, a highly significant gain in skills is observed.

Bedside findings based on skill level

We have also developed a series of questions for different bedside findings based on the expected level of the learner's skills. The following table uses the example of a fourth heart sound to demonstrate how the finding may be tested at different levels:

Harvey is set so that a fourth heart sound (S4) is present at the apex.

Difficulty / Learner Level	Variable Tested	Correct Answer
1 - 1st year medical student	Identify finding	Fourth heart sound
2 - 2nd year medical student	Identify finding and correlate it with underlying pathophysiology	Fourth heart sound - reduced left ventricular compliance
3 - 3rd/4th year medical student	Identify finding and correlate it with its underlying disease process and differential diagnosis	Fourth heart sound - hypertension, aortic stenosis, hypertrophic cardiomyopathy
4 - House Officer	Identify finding and correlate with the severity of the underlying disease process and management	Fourth heart sound - its presence in a "young" patient with aortic stenosis denotes severe disease and suggests the need for surgery

Sample multiple-choice questions for levels 1 and 2 are shown below:

Level 1. Choose the *best* description of the acoustic events heard at the apex.

a. S1 + S2 + third heart sound (S3)
b. Fourth heart sound (S4) + S1 +S2 *(correct)*
c. S1 + ejection sound + S2
d. S1 + S2 + mid diastolic murmur
e. S1 + systolic click + S2

Level 2. Which one of the following is most likely associated with the acoustic events at the apex?

a. Right ventricular dilatation
b. Mitral valve narrowing
c. Left atrial enlargement
d. Left ventricular hypertrophy (correct)
e. Right ventricular hypertrophy

The MIAMI Group has developed a comprehensive cardiology bedside skills assessment instrument as part of a computer-based testing system. A rigid eight-step procedure was followed.[25] This resulted in two equivalent examinations, each with 25 questions that have high reliability coefficients (KR-20) of 0.81 and 0.84. These testing instruments may be used as pre- and post-tests to assess the gain in skills after exposure to Harvey and/or UMedic.

Self-Assessment

Self-assessment is an integral part of the Harvey teaching system. Interactive questions are embedded into the slide programs and UMedic. They provide instant feedback for the learner. This system is highly developed in the UMedic programs, where incorrect answers result in mandatory remediation, with an explanation of why the answer was incorrect and an explanation of the right answer. If the answer is correct, further explanation is optional.

Objective Structured Clinical Examinations (OSCE)[26]

Harvey has also been integrated into OSCE stations covering the cardiovascular system using multiple choice questions, short answer questions and checklists. Several stations, including one with Harvey, may be structured around a “problem of the week,” with a series of linked stations testing a range of learning outcomes.

Examples of individual stations during a week in which the problem is atherosclerotic disease include:

1. Examination of the leg in a patient with peripheral vascular disease
2. Telephone conversation with a simulated patient with chest pain
3. Auscultation of a fourth heart sound and mitral regurgitation due to papillary muscle dysfunction in a patient with myocardial infarction (programmed in Harvey)

4. Advice to a simulated patient and his wife on discharge from the hospital following a myocardial infarction

Portfolios[27]

Students may collect a portfolio of evidence from a variety of sources documenting their mastery of the appropriate learning outcomes. These may be in the form of a printout from the UMedic program that verifies learner usage, or a logbook documenting the conditions examined and physical findings encountered during their exposure to Harvey (Appendix C provides a checklist from one institution to document performance of components of the cardiac examination).

Choosing the appropriate assessment instrument

This is an individual decision. A variety of factors should be considered, including those below:

What you wish to test
- the entire examination for one or more conditions
- a component of the examination such as auscultation

What level of complexity you wish to test
- identify a finding
- explain its pathophysiology
- decide the patient's management

What environment you wish to use
- individual
- in small or large groups
- as part of an OSCE

How you wish to test
- written or computer-based
- multiple choice questions or choosing the graphic representation of the finding
- observing the learner and using a checklist

Other considerations include:
- validity and reliability of the assessment instrument
- feasibility in terms of time and resources

A word of caution: While learner assessment is absolutely required, it takes a long time and some expertise to construct testing instruments that are valid and reliable, and to test each student individually by observation of his/her hands-on skills. First consider the advantages of systems that are easily administered and automatically graded. You might begin by:

- testing the most important findings
- in the most pertinent conditions
- at a basic level of difficulty
- in a group setting
- using an instrument that can be graded automatically

Research

Previous studies

Many descriptive, review and research articles published over the past 40+ years have demonstrated Harvey's utility in developing and carrying out educational studies. This table gives details of published articles in which Harvey was used.

Ref. #	Published	Type	Subjects	Group Size	Variable(s) Described / Studied
28	1974	Descriptive	N/A	-----	Harvey's (H) development
29	1980	Research	MS4	23	Bedside skills / "H" effectiveness
30	1980	Descriptive	MS4, MD	770	"H" development / user satisfaction
31	1980	Descriptive	N/A	-----	"H" development / use
32	1981	Research	MD	800	User satisfaction
33	1986	Review	N/A	-----	"H" use
34	1987	Research	MS2	203	Bedside skills, "H" effectiveness
24	1987	Research	MS4	208	Bedside skills, "H" effectiveness
35	1988	Review	N/A	-----	"H" use
36	1990	Descriptive	N/A	-----	"H" use
37	1991	Review	N/A	-----	"H" use
38	1992	Research	Int Res	63	Bedside skills
39	1993	Research	Int Res	56	Bedside skills / "H" effectiveness
40	1995	Review	N/A	-----	"H" use
41	1995	Research	Int Res	6	Bedside skills
42	1997	Review	N/A	-----	"H" use
43	1997	Research	EM Res, MD	46	Bedside skills
44	1999	Review	N/A	-----	"H" use
45	1999	Review	N/A	-----	"H" use
46	1999	Review	N/A	-----	"H" use
47	2000	Research	Ped Res	47	Bedside skills
48	2000	Review	N/A	-----	"H" use *(in Spanish)*
49	2000	Research	PA	53	Bedside skills / user satisfaction
50	2001	Review	N/A	-----	"H" use
51	2001	Research	EM Res, MD	39	Bedside skills
52	2001	Review	N/A	-----	"H" use
53	2002	Research	Res	67	Bedside skills
54	2003	Descriptive	MS	-----	"H" use
55	2003	Research	DO	64	Bedside skills
56	2007	Research	Res	28	Bedside skills

57	2008	Research	Res	28	Bedside skills
58	2009	Research	Res	251	Bedside skills
59	2009	Research	MS	146	Bedside skills
60	2010	Research	MS	77	Bedside skills
61	2011	Review	N/A	----	Clinical skills
62	2011	Research	Nurse	36	Bedside skills
63	2011	Research	MS	86	Bedside skills
64	2011	Research	Res	20	Bedside skills
65	2013	Research	MS	31	Bedside skills
66	2015	Research	PA	56	Bedside skills
67	2015	Research	MS	10	Bedside skills

Codes for subjects are:

N/A:	Not applicable	Ped Res:	Pediatric residents	MS( ):	Medical students (Year)
Int Res:	Internal medicine residents	MD:	Practicing Physicians		
EM Res:	Emergency medicine residents	PA:	Physician assistants	DO:	Doctor of Osteopathy
Nurse:	Nursing Students				

Further areas of research

Harvey has the potential to contribute to further educational research for a variety of populations, including the many types of learners that are currently taught with, or are using, the simulator. Research may focus on Harvey as an educational intervention or as an evaluation tool. Examples of the types of questions that could be answered by further research are found below.

Harvey as an educational intervention

Progressive development – sequential use of Harvey for development of progressive knowledge and skills

What is the cumulative benefit of using Harvey throughout a medical school curriculum?

Quantitative practice - amount of practice necessary to achieve an enduring level of performance

How often do different learners need “refresher” experiences to maintain an expected level of performance?

Problem-based learning

How can Harvey best be used as part of the “problem presentation”?

Faculty development – use to train house officers and young faculty to improve their bedside teaching skills

How much practice is needed to transfer these skills to actual patient settings?

Harvey as an Evaluation Tool

What is the quality of data obtained from Harvey compared to other sources used to evaluate the performance of learners at the end of a period of training?

What is the value of using Harvey for educational screening (e.g., as a test to determine if students require remediation in physical diagnosis or can proceed to a clinical elective)?

What is the cost of using Harvey for training compared to standardized patients and real patients?

Conclusion

We hope this guide has served its purpose: to provide users of Harvey an outline for its optimal use at their institution. New technologies and the changing medical education environment are likely to ensure that the use of simulation will continue to increase. The task for medical educators will be to embrace and harness this modality's potential, and use it to enhance the self-directed acquisition of skills throughout the lifelong medical education continuum.

References

References

1. Issenberg SB, Petrusa ER, McGaghie WC, et al, Effectiveness of a computer-based system to teach bedside cardiology. Acad. Med. 1999;74(Suppl.):S93-95.

2. Roldan CA, Shively BK, Crawford MH. Value of the cardiovascular physical examination for detecting valvular heart disease in asymptomatic subjects. Am J of Card. 1996; 77: 1327-1331.

3. Danford DA, Nasir A, Gumbiner C. Cost assessment of the evaluation of heart murmurs in children. Pediatrics 1993;91:365-368.

4. Mangione S, Nieman LZ, Gracely E, Kaye D. The teaching and practice of cardiac auscultation during internal medicine and cardiology training: a nationwide survey. Ann Intern Med.1993;119: 47-54.

5. Mangione S, Nieman LZ. Cardiac auscultatory skills of internal medicine and family practice trainees: a comparison of diagnostic proficiency (published erratum appears in J.A.M.A.1998;279:1444). J.A.M.A.1997;278:717-722.

6. Garrison P. Flying without wings. A Flight Simulation Manual. Blue Ridge Summit, PA:TAB Books, Inc., 1985, 1-31, 102-06.

7. Goodman W. The world of civil simulators. Flight International Magazine. 1978;18: 435.

8. Rolfe JM, Staples KJ. Flight Simulation. Cambridge: Cambridge University Press. 230-250.

9. Ressler EK, Armstrong JE, Forsythe GB. Military mission rehearsal: from sandtable to virtual reality. In: A Tekian, C McGuire, WC McGaghie (eds.), Innovative Simulations for the Evaluation of Professional Competence. Chicago: Department of Medical Education, University of Illinois Medical Center.1999.

10. Keys B, Wolfe J. The role of management games and simulations in education and research. J Manag.1990;16: 307-336.

11. Wachtel J. The future of nuclear power plant simulation in the United States. In: DG Walton (ed.),Simulation for Nuclear Reactor Technology.1985. Cambridge: Cambridge University Press.

12. Office of Naval Research. Visual elements in flight simulation. National Council of the National Academy of Science. Jan. 1973. Washington, D.C.

13. Society of Photo-Optical Engineers. Simulators and simulation. Society of Photo-Optical Engineers. 1975; 59 (Session 4): 141.

14. Collins JP, Harden RM. AMEE Medical Education Guide NO. 13: Real Patients, simulated patients and simulators in medical education. Medical Teacher. 1998;20:508-521.

15. Norcini J. Computer-based testing will soon be a reality. Perspectives. American Board of Internal Medicine Newsletter for Diplomates. Summer 1999:3.

16. Robertson LJ. Twelve tips for using a computerized interactive audience response system. Medical Teacher. 2000;22(3):237-239.

17. Ericsson KA. The road to excellence: the acquisition of expert performance in the arts and sciences, sports and games. K.A.Ericsson (ed.), 1996. Lawrence Erlbaum Associates, Mahwah, NJ. 1-50.

18. Harden RM, Laidlaw JM, Hesketh EA. AMEE Medical Education Guide No 16: Study guide-their use and preparation. Medical Teacher. 1999;21(3):248-265.

19. McNeir G. Outcome-based education, tool for restructuring. Oregon School Study Council Bulletin, Eugene. 1993;36(8).

20. Cohen AM (ed.). Relating curriculum and transfer. New directions for community colleges, No. 86. 1994 Summer;22(2).

21. Fitzpatrick KA. Restructuring to achieve outcomes of significance for all students. Educational Leadership. 1991; 48(8):18-22.

22. Terry PM. Outcome-based education: is it mastery learning all over again, or is it revolution to the reform movement? Paper presented at 7th Annual Midwest Education Society (CIES) Conference, Indiana.1996.

23. Harden RM, Crosby JR, David, MH. An introduction to outcome-based education. Part 1, AMEE No. 14: outcome-based education. Medical Teacher. 1999;21(1):7-14.

24. Ewy GA, Felner JM, Juul D, Mayer JW, Sajid A, Waugh RA. Test of a cardiology patient simulator with students in fourth-year electives. Journal of Medical Education.1987; 62:738-43.

25. Issenberg SB, McGaghie WC, Brown DD, et al. Development of multimedia computer-based measures of clinical skills in bedside cardiology. Proceedings of the 8th International Ottawa Conference on Medical Education and Assessment, 12-15 July 1998. Philadelphia, Pennsylvania.

26. Hart I. The objective structured clinical examination. In: Lloyd JS, Lansley DG (eds). How to evaluate residents. 1986; American Board of Medical Specialties, Chicago, IL:13-146.

27. Davis MH, Friedman Ben-David, Harden RM, et al. Portfolio assessment in medical students' final examinations. Medical Teacher. 2001; 23(4):357-366.

28. Gordon MS. Cardiology Patient Simulator: development of an animated manikin to teach cardiovascular disease. Am J Cardiol. 1974;34:350-355.

29. Gordon MS, et al,. “Harvey,” the Cardiology Patient Simulator: pilot studies on teaching effectiveness. Am J Cardiol. 1980;45:791-796.

30. Gordon MS, Ewy GA, Felner JM, et al. Teaching bedside cardiologic examination skills using Harvey, the cardiology patient simulator. Med Clin North Am. 1980;64:305-313.

31. Ewy GA, Kettel LJ. Cardiology patient simulator. Ariz Med. 1980;37(1):42-3.

32. Gordon MS, Ewy GA, Felner JM, et al. A cardiology patient simulator for continuing education of family physicians. Journal of Family Practice. 1981;13:353-6.

33. Gordon MS, et al. Learning through simulation: the value of patient simulators. J Am Coll Cardiol.1986;8:477-478.

34. Woolliscroft JO, Calhoun JG, Tenhaken JD, Judge RD. Harvey: the impact of a cardiovascular teaching simulator on student skill acquisition. Med Teach. 1987;9:53-57.

35. Felner JM, Gordon MS. Newer techniques in teaching cardiology. Emory University J of Med. 1988;2(3);151-157.

36. Sajid AW, Ewy GA, Felner, et al. Cardiology patient simulator and computer-assisted instruction technologies in bedside teaching. Medical Education. 1990;24:512-517.

37. Nammack GSS. Teaching auscultation with high-tech adjuncts. Cardiovascular Review & Reports.1991;12(8):46, 49-51,68.

38. St Clair EW, Oddone EZ, Waugh RA, Corey GR, Feussner JR. Assessing housestaff diagnostic skills using a cardiology patient simulator. Annals of Internal Medicine. 1992;117:751-6.

39. Oddone EZ, Waugh RA, Samsa G, Corey R, Feussner JR. Teaching cardiovascular examination skills: results from a randomized controlled trial. Am J Med. 1993;95:389-396.

40. Gordon MS, Mayer JW, Issenberg B: Simulation technology in medical education. Miami Medicine. 1995;66:33-35.

41. Westman EC, Matchar DB, Samsa GP, et al. Accuracy and Reliability of Apical S3 Gallop Detection. J Gen Intern Med. 1995;10(8):455-7.

42. Issenberg SB, Browne SM, Gordon MS. Medical education in the 21st century: simulation technology and multimedia computer instruction. Arquivos Científicos. 1997;36-38.

43. Jones JS, Hunt SJ, Carlson SA, Seamon JP. Assessing bedside cardiologic examination skills using “Harvey,” a cardiology patient simulator. Acad Emerg Med. 1997;4:980-985.

44. Issenberg SB, McGaghie WC: Assessing knowledge and skills in the health professions: a continuum of simulator fidelity: In: Innovative simulations for assessing professional competence. Chicago, IL: Dept. of Medical Education, University of Illinois Medical Center; 1999:157-174.

45. Gordon MS, Issenberg SB, Mayer JW, Felner JM. Developments in the use of simulators and multimedia computer systems in medical education. Med Teacher. 1999;21:32-6.

46. Issenberg SB, McGaghie WC, Hart IR, Mayer JW, et al. Simulation technology for health professional skills training and assessment. JAMA. 1999;282:861-866.

47. Gaskin PRA, Owens SE, Talner NS, et al. Clinical auscultation skills in pediatric residents. Pediatrics. 2000;105(6):1184-7.

48. Nurko J, Unzek S, Gitler R, Magana F, Hurtado D, Padilla L, Di Silvio M. El simulador Harvey de paciente cardiológico. La utilización de simulaladores, computadoras y equipo multimedia en el aprendizaje de la cardiología. An Med Asoc Med Hosp ABC (Anales Medicos). 2000;45(3):134- 139.

49. Issenberg SB, Gordon MS, Stewart GM, Felner JM. Bedside cardiology skills training for the physician assistant using simulation technology. Perspective on Physician Assistant Education. 2000;11(2):99-103.

50. Issenberg SB, Gordon MS, Gordon DL, et al. Simulation and new learning technologies. Medical Teacher. 2001;23(1):16-23.

51. Schwindt MG, Jones JJ and Bush CM. Accuracy and interobserver agreement in detecting “Gallop sounds” using a cardiology patient simulator. Academic Emergency Medicine. 2001;8(5):558.

52. McGaghie WC, Issenberg SB. Acquisition and maintenance of medical expertise from deliberate practice using simulation technology. Interface. 2000. 12(1) accessed: http://gasnet.org/interface/ 12.1.3mcgaghie.html July 17, 2001.

53. Issenberg SB, McGaghie WC, Gordon DL, Symes S, Petrusa ER, Hart IR, Harden RM. Effectiveness of a cardiology review course for internal medicine residents using simulation technology and deliberate practice. Teach Learn Med. 2002 Fall;14(4):223-8.

54. Issenberg SB, Pringle S, Harden RM, Khogali S, Gordon MS. Adoption and integration of simulation-based learning technologies into the curriculum of a UK undergraduate education programme. Med Educ. 2003 Nov;37 Suppl 1:42-9.

55. Issenberg SB, Gordon MS, Greber AA. Bedside cardiology skills training for the osteopathic internist using simulation technology. J AM Osteopath Assoc. 2003 Dec;103(12):603-7.

56. Hatala R, Issenberg SB, Kassen BO, Cole G, Bacchus CM, Scalese RJ. Assessing the relationship between cardiac physical examination technique and accurate bedside diagnosis during an objective structured clinical examination (OSCE). Acad Med. 2007 Oct;82(10 Suppl):S26-9.

57. Hatala R, Issenberg SB, Kassen B, Cole G, Bacchus CM, Scalese RJ. Assessing cardiac physical examination skills using simulation technology and real patients: a comparison study. Med Educ. 2008 Jun;42(6):628-36.

58. Hatala R, Scalese RJ, Cole G, Bacchus M, Kassen B, Issenberg SB. Development and validation of a cardiac findings checklist for use with simulator-based assessments of cardiac physical examination competence. Simul Healthc. 2009 Spring;4(1):17-21.

59. Fraser K, Peets A, Walker I, Tworek J, Paget M, Wright B, McLaughlin K. The effect of simulator training on clinical skills acquisition, retention and transfer. Med Educ. 2009 Aug;43(8):784-9.

60. Butter J, McGaghie WC, Cohen ER, Kaye M, Wayne DB. Simulation-based mastery learning improves cardiac auscultation skills in medical students. J Gen Intern Med. 2010 Aug;25(8):780-5.

61. McGaghie WC, Issenberg SB, Cohen ER, Barsuk JH, Wayne DB. Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. Acad Med. 2011 Jun;86(6):706-11.

62. Jeffries PR, Beach M, Decker SI, Dlugasch L, Groom J, Settles J, JOHN M. O'Donnell JM. Multi-center development and testing of a simulation-based cardiovascular assessment curriculum for advanced practice nurses. Nursing Education Perspectives. 2011 Sep; 32 (5):316-322

63. Fraser K, Wright B, Girard L, Tworek J, Paget M, Welikovich L, McLaughlin K. Simulation training improves diagnostic performance on a real patient with similar clinical findings. Chest. 2011 Feb;139(2):376-81.

64. Frost DW, Cavalcanti RB, Toubassi D. Instruction using a high-fidelity cardiopulmonary simulator improves examination skills and resource allocation in family medicine trainees. Simul Healthc. 2011 Oct;6(5):278-83.

65. Brydges R, Peets A, Issenberg SB, Regehr G. Divergence in student and educator conceptual structures during auscultation training. Med Educ. 2013 Feb;47(2):198-209.

66. Multak N, Newell K, Spear S, Scalese RJ, Issenberg SB. A multi-institutional study using simulation to teach cardiopulmonary physical examination and diagnosis skills to physician assistant students. J Physician Assist Educ. 2015 Jun;26(2):70-6.

67. Lin W, Lee GK, Loh JP, Tay EL, Sia W, Lau TC, Hooi SC, Poh KK. Effectiveness of early cardiology undergraduate learning using simulation on retention, application of learning and level of confidence during clinical clerkships. Singapore Med J. 2015 Feb;56(2):98-102.

68. The Medical School Objectives Writing Group. Learning objectives for medical student education - guidelines for medical schools: Report I of the medical school objectives project. Acad Med. 1999;74:13-18.

69. Ziv A, Small SD, Wolpe PR. Patient safety and simulation-based medical education. Medical Teacher. 2000;22(5):489-495.

Appendix

Appendix A - Examination Categories and Findings

Jugular Venous Pulse	Scenario #
Normal “a” wave larger than “v” wave	46/246
Giant “a” wave	20
Systolic “cv” wave	4
Equal “a” and “v” waves	23
Prominent “x” descent	30
Carotid Arterial Pulse	
Normal	46/246
Hypokinetic	13/213
Hyperkinetic	28
Bifid	1
Precordial Impulse (location / size)	
Normal location & size	46/246
Normal location & enlarged	33
Inferolaterally displaced & enlarged	17/217
Left parasternal & enlarged	3
Pulmonary location & enlarged	11
Absent apical impulse	4
Precordial Impulse (contour)	
Early systolic	46/246
Early brisk systolic	17/217
Sustained systolic	3
Presystolic + early systolic	39
Presystolic + sustained systolic (ss)	36/236
Sustained systolic + early diastolic	7
Presystolic + ss + early diastolic	6

Heart Rate & Respiratory Rate Per Minute (bpm & rpm)
All conditions with single code = 60 bpm & 12 rpm
Second scenario code = 90 bpm & 15 rpm

Heart Sounds and Murmurs
URSE – Upper Right Sternal Edge
ULSE – Upper Left Sternal Edge
LLSE – Lower Left Sternal Edge

Breath Sounds
LPLF – Lower Posterior Lung Fields
U&LLF – Upper & Lower Lung Fields
A&PLF – Anterior & Posterior Lung Fields
PLF – Posterior Lung Fields

Carotid Sounds
R>L C – Right greater than Left Carotid
UL C – Upper Left Carotid

First Heart Sound	Scenario # (Location)
Normal single	36 (LLSE)
Normal split	46/246 (LLSE)
Soft	40 (Apex)
Loud	3 (LLSE)
Second Heart Sound	
Normal Physiologic Splitting (NPS)	46/246 (ULSE)
NPS & loud P2	6 (ULSE)
Paradoxic splitting	48 (ULSE)
Persistent expiratory splitting	40 (ULSE)
Fixed splitting	23 (ULSE)
Single loud A2	36/236 (URSE)
Single loud P2	11 (ULSE)
Systolic Sounds	
Ejection sound	4 (ULSE)
Systolic click	9 (LLSE)
Diastolic Sounds	
Third heart sound	46/246 (Apex)
Fourth heart sound	36/236 (Apex)
Opening snap	3 (LLSE)
Systolic Murmurs	
Early peaking & short	22 (ULSE)
Late peaking & long	13/213 (URSE)
Holosystolic	25 (Apex)
Late systolic	9 (Apex)
Diastolic Murmurs	
Early decrescendo & long	17/217 (LLSE)
Early decrescendo & short	37 (LLSE)
Long diastolic	4 (Apex)
Mid diastolic	17/217 (Apex)
Breath Sounds	
Normal vesicular	46/246 (All lung fields)
Inspiratory crackles	40 (Bilateral LPLF)
Inspiratory & expiratory crackles	48 (Bilateral U&LLF)
Inspiratory crackles & expiratory wheezes	4 (Bilateral U&LLF)
Pleural rub	30 (Lower Left A&PLF)
Absent	42 (Lower Right PLF)
Carotid sounds	
Aortic stenosis radiation (R>L)	13/213 (R>L C)
Bruit	39 (UL C)

Appendix B – Faculty Notes from an Integrated Cardiology Course

Week 1: Arterial Pulses, JVP, Precordial Impulses and Heart Sounds	
Arterial Pulses	
1	Introduce students to examination of arterial pulse (rate, rhythm and volume)
2	Normal pulse: Harvey #46
3	Hyperkinetic pulse: Harvey #28
4	Hypokinetic pulse: Harvey #13
5	Bifid pulse: Harvey #1
Jugular Venous Pulses	
1	Introduce students to JVP examination
2	Normal JVP: Harvey #46
3	Giant “a” wave: Harvey #20
4	Pathologic “CV” wave: Harvey #4
Precordial Impulses	
1	Introduce students to precordial impulses
2	Normal apical impulse: location and contour: Harvey #46
3	Enlarged and sustained apical impulse (LVH): Harvey #33
4	Displaced apical impulse (LVD): Harvey #17
5	Left parasternal heave (RVH): Harvey #3
Heart Sounds	
1	Introduce students to heart sounds
2	Listen to first and second heart sound: Harvey #46 (upper right sternal edge)
3	Listen to physiological splitting of second sound: Harvey #46 (upper left sternal edge)
4	Listen to 3rd heart sound #46 (Apex)
5	Listen to 4th heart sound #36 (Apex)
Week 2: Introduction to Murmurs	
Murmurs - Systolic and Diastolic	
1	Introduce students to murmurs
2	How to time a murmur
3	Systolic murmur: Harvey #13 (upper right sternal edge): aortic stenosis
4	Diastolic murmur: Harvey #17 (lower left sternal edge): aortic regurgitation
5	Description of murmur: location, timing, duration, character (pitch), intensity (grading) and radiation
6	Listen to mitral murmurs
Week 3: Review and More Murmurs	
Common Murmurs	
1	Give students opportunity to ask questions and consolidate previous teaching
2	Listen to innocent murmur: Harvey #22
3	Aortic stenosis: Harvey #13
4	Aortic regurgitation: Harvey #17
5	Mitral stenosis: Harvey #4
6	Mitral regurgitation, chronic: Harvey #7

Appendix C – Sample Cardiac Examination Checklist

#	THE STUDENT APPROPRIATELY EVALUATED THE FOLLOWING:	
1	Heart rate and respiratory rate	
2	Blood pressure	
3	Carotid pulse - including contour and timing with other pulses or sounds	
4	Peripheral pulses - including brachials, radials and femorals	
5	Jugular venous pulse - including central venous pressure, contour and timing with arterial pulse or heart sounds	
6	Precordial inspection - including visible impulses	
7	Precordial palpation, apex - including location, size and contour	
8	Precordial palpation, parasternal - including location, size and contour	
9	Auscultation at aortic area (upper right sternal edge)	
10	Auscultation at pulmonary area (upper left sternal edge)	
11	Auscultation at tricuspid area (lower left sternal edge)	
12	Auscultation at apex	
13	Auscultation - use of bell vs. diaphragm	
14	Auscultation - timing with arterial impulse or other heart sounds	

Appendix D - Harvey Technical Specifications

Power Ratings

Input voltage:	100 - 240VAC
Input frequency:	50-60Hz
Maximum power:	5A

Weight and Size

Manikin and cabinet:	116 lbs (52.6 kg) 57“ L x 22” H x 28” D (144.78 cm x 55.88 cm x 71.12 cm)

Table or Surface for setting Harvey

Requirements:	2-3' x 6' (60.96 cm – 91.44 cm x 182.88 cm)

Environmental Condition

Operating temperature:	+10˚C - 30˚C
Storage temperature:	-15˚C - 50˚C
Humidity:	15-90% RH (non-condensing)

Michael S. Gordon Center for Research in Medical Education
University of Miami Miller School of Medicine
P.O. Box 016960 (D-41)
Miami, Florida 33101
Tel: (305) 243-6491
harvey.gcrme.miami.edu