Key Questions for Training and Practice

Incorporating simulation into a residency curriculum

James K. Takayesu, MD, MS;* Eric S. Nadel, MD;† Kriti Bhatia, MD;‡ Ron M. Walls, MD‡

ABSTRACT

The integration of simulation into a medical postgraduate curriculum requires informed implementation in ways that take advantage of simulation's unique ability to facilitate guided application of new knowledge. It requires review of all objectives of the training program to ensure that each of these is mapped to the best possible learning method. To take maximum advantage of the training enhancements made possible by medical simulation, it must be integrated into the learning environment, not simply added on. This requires extensive reorganization of the resident didactic schedule.

Simulation planning is supported by clear learning objectives that define the goals of the session, promote learner investment in active participation and allow for structured feedback for individual growth. Teaching to specific objectives using simulation requires an increased time commitment from teaching faculty and careful logistical planning to facilitate flow of learners through a series of simulations in ways that maximize learning. When applied appropriately, simulation offers a unique opportunity for learners to acquire and apply new knowledge under direct supervision in ways that complement the rest of the educational curriculum. In addition, simulation can improve the learning environment and morale of residents, provide additional methods of resident evaluation, and facilitate the introduction of new technologies and procedures into the clinical environment.

Keywords: simulation, curriculum, residency, teaching methods, emergency medicine, postgraduate, medical education

RÉSUMÉ

L'intégration de la simulation dans un programme de formation postdoctorale en médecine nécessite une mise en œuvre informée de manière à tirer avantage de la propriété unique qu'a la simulation de faciliter l'application guidée de nouvelles connaissances. Pour ce faire, il faut examiner tous les objectifs du programme de formation pour assigner à chacun d'eux la meilleure méthode d'apprentissage possible. Si l'on veut profiter pleinement des avantages de la formation par la simulation, il faut l'intégrer dans l'environnement d'apprentissage, et non simplement l'y ajouter. Cela nécessite une vaste réorganisation du programme didactique du résident.

La planification de la simulation est appuyée par des objectifs d'apprentissage précis qui définissent les buts de la séance, encouragent la participation active de l'apprenant et permettent une rétroaction structurée pour favoriser la croissance individuelle. L'enseignement axé sur des objectifs précis et basé sur la simulation requiert un investissement en temps plus important de la part du personnel enseignant et une planification logistique méthodique pour faciliter le flux d'apprenants à travers une série de simulations de manière à maximiser l'apprentissage. Lorsqu'elle est appliquée correctement, la simulation offre une occasion unique pour les apprenants d'acquérir et d'appliquer de nouvelles connaissances sous une supervision directe, complétant ainsi les autres volets du programme d'études. En outre, la simulation peut améliorer l'environnement d'apprentissage et le moral des résidents, fournir d'autres moyens de les évaluer et faciliter l'introduction de nouvelles technologies et procédures dans l'environnement clinique.

INTRODUCTION

Education in emergency medicine requires the integration of a broad range of medical knowledge into a functional base of clinical knowledge. This knowledge base must be sufficient to drive both symptom evaluation and the pursuit of simultaneous diagnostic and therapeutic interventions.[1] Traditionally, medical postgraduate learning occurs in 4 main contexts: bedside "apprenticeship," self-directed reading, didactic classroom sessions and case conferences. Medical simulation has emerged as a potentially valuable tool for learning and demonstrating competency across the spectrum from individual procedures to complex team-based skills, including directing resuscitation. Simulation offers a risk-free environment for residents to learn under the direct supervision of expert faculty. Residents use newly

From the *Department of Emergency Medicine, Massachusetts General Hospital, Harvard Medical School, Boston, Mass., and the †Harvard-Affiliated Emergency Medicine Residency Program and the ‡Department of Emergency Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, Mass.

Submitted Jan. 6, 2010; Revised Mar. 2, 2010; Accepted Mar. 3, 2010

This article has been peer reviewed.

CJEM 2010;12(4):349-53

acquired knowledge in simulations, allowing them to integrate it into their growing clinical knowledge base. When faced with the prospect of teaching with simulation, the educator must make decisions to ensure the technology is used effectively and efficiently with respect to the adult learning needs of residents. This article discusses our experience with the placement, planning and integration of simulation teaching into a residency curriculum.

WHY SHOULD I USE SIMULATION IN MY CURRICULUM?

Simulation can be expensive and resource-intensive. This necessitates a clear understanding of the educational goals of the overall residency curriculum so that simulation can be implemented effectively in combination with other teaching techniques that foster active adult learning.[2,3] Learning goals and objectives for the residency training program should be examined to determine the potential role of simulation in meeting those objectives. Often, simulation is "added on" to an otherwise unchanged curriculum, focusing on a few small areas, such as specific procedural skills or advanced cardiac life support. One must understand the learning and evaluative capabilities of simulation, and other teaching modalities, relative to the learning objectives for the curriculum, mapping each objective to the best teaching method (Appendix 1, available at www.cjem-online.ca). Simulation stimulates residents to apply knowledge in clinical care scenarios, allowing them to integrate new information in the context of what they already know. Faculty can observe the resident in this setting, evaluating performance gaps and giving immediate, grounded feedback. This can achieve a level of integrated learning not traditionally possible outside of the clinical environment.

Simulation is not a panacea, however. As adult learners, residents should have an opportunity to reflect on what knowledge they bring to the classroom. Seminars, literature reviews, small-group work, and lectures should be paired with simulations that permit residents to apply and integrate new knowledge in a clinically meaningful setting.[2] Thus specific learning objectives, such as recognition and management of cardiac dysrhythmias, can be taught in a simulation "course" that includes an assortment of teaching modalities and simulations, forming a tapestry of teaching methods that address both knowledge acquisition and application in various contexts (Appendix 1, available at www.cjem-online.ca). Learners can thus identify the leading edge of their current clinical knowledge and be prompted to seek feedback and new knowledge with the help of simulation.

HOW OFTEN CAN I USE SIMULATION?

Every residency curriculum has variable constraints that affect the implementation of simulation teaching. These include, but are not limited to, access to a simulation facility, design of simulation laboratories, classroom layout, availability of teaching faculty, educational budgets and a program's overall educational mission. In the context of our curriculum, simulation courses comprise approximately 20% of the 250 annual teaching hours. We teach 16–17 courses per year, distributed among other teaching formats covering topics that are less amenable to simulation (e.g., endocarditis). In our block-format curriculum, we begin each year with cardiovascular emergencies and follow an annually repeated sequence of content areas (Box 1) to ensure consistent and predictable coverage of educational material. This format allows each incoming resident class, and rising classes, exposure to topics essential to clinical practice in order of their approximate clinical importance. We also conduct an intensive educational program for all interns entering our hospital, regardless of their service of origin, systematically training sterile technique, central line placement, defibrillation and myriad other procedures before the start of clinical rotations. The curriculum design we present has

Box 1. Simulation course curriculum, 2009

Cardiovascular 1: acute coronary syndrome
Cardiovascular 2: dysrhythmia
Cardiovascular 3: CHF
Pulmonary 1: asthma, COPD, pneumothorax
Pulmonary 2: airway management
Environmental emergencies
Trauma 1: approach to trauma, trauma of the chest and abdomen
Trauma 2: trauma of the head, spine, extremities and in pregnancy
Neurology/psychiatry
Orthopedics
Toxicology
Ophthalmology
Infectious diseases
Pediatrics
Dental/otolaryngology
Genitourinary
Obstetrics/gynecology

CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease.

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

resulted from adapting our teaching methodology to the constraints of a 4-year academic residency, training 15 residents per year in a physical teaching space that includes a 4-room simulation laboratory and classroom. It is meant as an example, rather than an idealized form, of how to implement simulation education.

HOW DO I HELP MY RESIDENTS LEARN FROM SIMULATION?

Simulation requires the learner to suspend reality and perform in a fictitious environment. To optimize learning, residency leadership and simulation course directors must set clear expectations and motivation for both learners and faculty.[3] Clear educational goals and objectives at the beginning of the session should engage the audience by establishing the need for active participation in the simulation exercises, highlighting why they are paired with the other teaching sessions within the course.

As residents gain real-world clinical experience as their training progresses, their need for case complexity increases. Simulation exercises should be designed with several difficulty levels to meet the differing educational needs of residents in different stages of training.[4] Faculty may choose to segregate residents into groups by postgraduate year to facilitate teaching to these different learning needs. For example, a junior course may include a seminar on basic dysrhythmia recognition and therapies, procedure training in cardioversion and simulation cases involving simple tachydysrhythmia management. Senior residents may focus on more sophisticated differentiation between dysrhythmias, procedure training in transvenous pacemaker placement, and simulation cases involving dysrhythmia management in complex undifferentiated settings, such as thyroid storm or hypothermia. Alternatively, mixed resident groups can facilitate teaching and modelling between junior and senior residents. A senior resident may play the role of trauma captain with junior residents as part of the trauma team. At the end of the session, each resident would provide peer feedback in addition to the faculty's expert opinion.

HOW DO I HELP MY FACULTY TEACH IN SIMULATION?

Whether the intent is to teach a simple skill (e.g., lumbar puncture) or execute complex resuscitations, simulation requires that residents be divided into groups that permit participation and feedback. Our experience has shown that 4–6 residents per station allows for active participation of residents and individualized feedback by faculty. The need for small groups requires a significant commensurate increase in faculty teaching. Faculty may be reluctant to teach for fear that they lack sufficient knowledge on how to teach with simulation. Accordingly, faculty must be given appropriate preparation and guidance to teach in the simulation environment.[4] Effective recruitment and continued participation of teaching faculty, or "facilitators," requires a clear description of their teaching objectives and the simulation case scenarios. Course learning objectives must be written in language that focuses facilitators on evaluating residents' knowledge application in addition to teaching the basic informational content of the case.[3,4] The course director or the individual facilitators can use these objectives to plan the case scenario, organize supporting teaching materials (e.g., electrocardiograms, radiographs, laboratory reports) and structure their feedback on resident performance.[4]

As faculty become accustomed to the simulation teaching environment, more responsibility can be placed on them to assist with case design and debriefing content. Both the course director and the facilitators must ensure that they have in-depth knowledge of the specific content area, as the small-group format encourages discussion and questions by the learners, some of which may reach well beyond the core objectives of the session. Fortunately, these questions are comparable to those asked in the clinical environment, and faculty usually require minimal content preparation to manage these sessions.

Faculty facilitators should be trained in how to debrief residents after a simulation exercise, when knowledge gaps are identified and residents are primed to accept new knowledge.[2,3] Effective clinical care relies on a variety of competencies, including medical knowledge, procedural skills, teamwork, communication and interpersonal skills.[5,6] The richness of the simulation classroom allows observation of many of these fundamental aspects of medical expertise. The length and design of the debriefing session should therefore address more than just the medical knowledge applicable to the case.[7] As much as possible, it should include resident self-evaluation and faculty evaluation of clinical performance in a structured format.[7–9] Linking self-evaluation to faculty expert evaluation creates an opportunity for residents to understand the next step in their improvement[10] by allowing residents to reflect on their own performance and take away individual learning issues.

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

HOW DO I INTEGRATE SIMULATION INTO MY CLASSROOM?

Residency size, simulation laboratory design, teaching budget and faculty participation all play significant roles in the design of a simulation course. An ideal simulation would allow for one-on-one teaching in simulations, wherein a single resident performs under the critical eye of a faculty expert, and actors play ancillary staff roles such as paramedics, nurses, family members, consultants and others. Although essential for valid and reliable individual assessment of resident performance, the monetary and time cost of such a design is significant. Our classroom goals focus on learning and practising new concepts in bimonthly simulation courses that repeat yearly over a 4-year training program. With our classroom of approximately 45 residents, individual simulations are unachievable in our allotted course time of 3 hours, requiring that residents rotate in small groups through the stations.

Working with a small group in a simulation, rather than an individual resident, presents challenges for the facilitator. Facilitators often define team roles and functions (e.g., team leader, airway, intravenous access, family and consult liaison, procedure resident) at the beginning of the simulation session, asking participants to take on roles not previously played. Residents can also define roles if this is a learning objective of the exercise. With defined roles, not all residents are equal, but all can participate in learning.[4] The facilitator should involve the individual participants as much as possible during the simulation by playing different roles of family, consultant, supporting staff and others to engage those who may have less active roles or are noted to fall by the wayside. Alternatively, facilitators may choose to divide residents into 2 groups, with one group observing the performance of the other to allow for peer evaluation. The constraints on teaching with simulation are unique for each program and require careful consideration to balance educational objectives with the reality of integrating simulation into a program's individual curricula.

Planning for the flow of rotating resident groups through a sequence of simulation exercises requires careful planning and tight execution. During a 3-hour block of conference time, we typically divide the residents by postgraduate year (PGY), forming 2 groups (PGY1–2 and PGY3–4). Course directors may also choose to divide the groups across postgraduate years if their objectives include senior resident evaluation of junior resident performance or senior resident team leadership of junior residents. We teach a classroom seminar directed at knowledge acquisition for 90 minutes and use the other 90 minutes in the simulation laboratory to rotate groups of 4–6 residents through 3 stations of 30 minutes each. Adequate time is given for the simulation, debriefing and commute between stations.[4] Thirty-minute stations allow 25 minutes of simulation and debrief time plus 5 minutes for commuting, which avoids residents or faculty feeling rushed. Typically, our junior residents (PGY1–2) have their seminar in the first 90-minute block to provide them with basic content knowledge and structure in preparation for the simulation stations during the second half of the course. The senior residents (PGY3–4) often begin with simulations and use the seminar session in the second half of the course to fill in learning gaps exposed by the simulation experiences.

Depending on the learning objectives for the course, patient simulations, procedural simulations and computer-based simulation programs can be used in the rotations as well as nonsimulation stations that involve other small-group learning formats (Appendix 1, available at www.cjem-online.ca). The design of the stations is based on the learning objectives for the session and varies throughout the year based on the content (Box 1). Our simulation stations typically consist of 2 patient simulations and 1 procedural station. Depending on the topic to be covered, these stations may be substituted for computer-based simulations, small-group learning, mini-seminar, image/electrocardiogram review, oral board case or other teaching formats that fit into the 30-minute time frame.

CONCLUSION

Our understanding of the role of simulation in teaching residents is in its infancy.[4,7] Simulation, like any teaching technique, requires informed implementation within a greater educational curriculum in ways that take advantage of its unique ability to facilitate guided application of new knowledge. It requires a commitment to review all learning objectives of a training program to ensure that each is mapped to the best possible learning method. If simulation is to be fully integrated into the learning environment, extensive reorganization of the resident didactic schedule is essential, with a willingness to disassemble and reassemble the entire curriculum, rather than simply looking for opportunities to add simulation into the existing curriculum and schedule. Simulation planning is supported by clear learning objectives that define the goals of the session, promote learner investment in active par-

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

ticipation and allow for structured feedback for individual growth. Using simulation as a regular teaching exercise requires an increased time commitment from teaching faculty and careful planning to facilitate flow of learners through teaching stations in ways that maximize learning time relative to commute time. When employed effectively, simulation offers a unique opportunity for residents to learn and apply knowledge under direct supervision in ways that complement the rest of the educational curriculum. Future research should address issues such as how multiple participants in a simulation exercise impact learning, how to best structure simulation debriefing, what role peer evaluation plays in learning, whether integrated simulation affects competency achievement, how curricula can meet individual learning needs identified by competency assessments and how the role of simulation in learning changes as residents gain more real-world expertise through clinical training.

Competing interests: None declared.

REFERENCES

1. Thomas HA, Beeson MS, Binder LS, et al. The 2005 model of the clinical practice of emergency medicine: the 2007 update. *Ann Emerg Med* 2008;52:e1-17.
2. Armstrong E, Parsa-Parsi R. How can physician's learning styles drive educational planning? *Acad Med* 2005;80:680-4.
3. Collins J. Educational techniques for lifelong learning: principles of adult learning. *Radiographics* 2004;24:1483-9.
4. Binstadt ES, Walls RM, White BA, et al. A comprehensive medical simulation education curriculum for emergency medicine residents. *Ann Emerg Med* 2007;49:495-504.
5. Epstein RM, Hundert FM. Defining and assessing professional competence. *JAMA* 2002;287:226-35.
6. Frank JR, editor. *The CanMEDS 2005 physician competency framework*. Ottawa (ON): The Royal College of Physicians and Surgeons of Canada; 2005. Available: http://rcpsc.medical.org/canmeds/CanMEDS2005/index.php (accessed 2010 Feb. 25).
7. Bond W, Kuhn G, Binstadt E, et al. The use of simulation in the development of individual cognitive expertise in emergency medicine. *Acad Emerg Med* 2008;15:1037-45.
8. Bowen JL. Educational strategies to promote clinical diagnostic reasoning. *N Engl J Med* 2006;355:2217-25.
9. Rudolph JW, Simon R, Raemer DB, et al. Debriefing as formative assessment: closing performance gaps in medical education. *Acad Emerg Med* 2008;15:1010-6.
10. Norman G, Eva K, Brooks L, et al. Expertise in medicine and surgery. In: Ericsson KA, Charness N, Feltovich PJ, et al., editors. *The Cambridge handbook of expertise and expert performance*. New York (NY): Cambridge University Press; 2006. p. 339-54.

Correspondence to: Dr. James Takayesu, Massachusetts General Hospital, 5 Emerson Pl., Rm. 108, Boston MA 02114; jtakayesu@partners.org

RENSEIGNEMENTS AUX LECTEURS

Abonnement et ventes
Le *Journal canadien de la médecine d'urgence* (*JCMU*) est offert à titre gracieux aux membres de l'Association canadienne des médecins d'urgence (ACMU) dont la cotisation est à jour; les autres peuvent s'abonner annuellement. Tarifs pour 2010 (6 numéros) : Abonnements au Canada : individuels 225 $, établissements 399 $; aux États-Unis et ailleurs : individuels 254 $US, établissements 449 $US. Communiquez avec le bureau de l'ACMU au 800 463-1158. Exemplaire unique d'un numéro de l'année en cours 50 $; anciens numéros 50 $ (sujet à disponibilité). On doit faire le paiement à l'ordre de l'ACMU en argent canadien ou américain. Les cartes VISA et MasterCard sont également acceptées.

Changement d'adresse
Nous demandons un avis de 6 à 8 semaines afin d'assurer un service ininterrompu. Veuillez faire parvenir votre adresse postale actuelle, votre nouvelle adresse et la date à laquelle elle doit entrer en vigueur à : cjem@caep.ca ou faites parvenir un fax au 613 523-0190.

Tirés à part
Des tirés à part d'articles du *JCMU* sont disponibles en quantités minimales de 50. Pour des renseignements sur les commandes, veuillez communiquer avec la coordonnatrice des tirés à part, 800 663-7336 ou 613 731-8610 x2110, fax 613 565-7704, janis.murrey@cma.ca

Disponibilité électronique
Le *JCMU* est disponible sur le site Web de l'ACMU (cjem-online.ca).

Répertoriage
Le *JCMU* est répertorié par MEDLINE/PubMed, EMBASE, CINAHL, International Pharmaceutical Abstracts, BIOME/OMNI, Scirus, Cochrane Prehospital and Emergency Health Field et Pubs Hub.com.

Instructions pour les auteurs
Visitez le www.cjem-online.ca.

	Cardiovascular Unit Learning Objectives					
	Frequency	**Seminar***	**Reading Only**	**Patient Simulation***	**Computer Simulation**	**Procedure Room**
Cardiovascular physiology/shock	**Yearly**					
To understand the principals and use vasopressors and inotropes		X		X	X	
To describe the uses of CVP/PAWP monitoring		X		X		
Dysrhythmias	**Yearly**					
To recognize, understand and explain the significance of						
RBBB		X				
LBBB		X				
Bifascicular block		X				
Ventricular pre-excitation		X				
1st degree AV Block		X				
To interpret & resuscitate the following using drugs & pacing (transcutaneous/venous):						
2nd degree AV block						X
type I +/- AMI						X
type II +/- AMI		X		X		X
3rd degree block		X		X		X
SSS		X		X		X
To recognize, describe the pathophysiology and management of:						
PAC/PVC		X	X			
QT prolongation		X	X			
Paced rhythms		X	X	X		
To interpret and resuscitate the following rhythm disturbances:						
Atrial / Fibrillation/Flutter (stable and unstable))		X		X	X	
SVT (stable and unstable)				X	X	X
PAT (stable and unstable)				X	X	X
Torsades de pointes		X		X		
VT (with and without pulses)		X		X	X	
VF		X		X		
Complications of ventricular pre-excitation (WPW, etc.)		X				
To recognize the following electrolyte/medication disturbances in the EKG:						
Hypo/Hyperkalemia		X		X		
Digitalis overdose (acute and chronic)		X		X		
Hypo/Hypercalemia			X	X		X
Hypomagnesemia			X			
To be able to recognize and treat Pacemaker/AICD malfunction		X		X		
Acute Coronary Syndromes	**Yearly**					
To recognize and treat:						
Stable/unstable angina				X		
MI				X		
Atypical presentations				X		

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

To understand the principles of cardiac risk stratification by interpreting:						
Cardiac risk factors		X				
Exercise testing		X				
Cardiac imaging		X				
To interpret EKG finding of acute ischemia using:						
Standard 12 lead surface EKG		X		X		
R-sided leads (V4R)		X		X		
Posterior leads (V7-8-9)		X		X		
To know the time-based sensitivities of cardiac markers in AMI:						
Troponin		X		X		
CK/MB		X		X		
Myoglobin		X				
To be able to apply appropriate ACS therapies to both stable and unstable patients:						
IV/02/Monitor				X	X	
Antiplatelet agents (ASA, Plavix, (No Suggestions) inhibitors)				X		
Anticoagulation (Heparin, LMWH, Direct thrombin inhibitors)				X		
Nitroglycerin (including contraindication in complicated IMI's)				X	X	
Beta-Blockade				X	X	
Morphine				X	X	
Thrombolysis (understanding contraindications)				X		
Timely consultation for Percutaneous coronary intervention				X	X	
To be able to interpret & treat dysrhythmias due to ischemia & reperfusion						X
To recall the applications of ACE-inhibitors and history of glucose-insulin-potassium therapy in MI patients		X				
Congestive Heart Failure (CHF)	**Yearly**					
To understand the pathophysiology of Right versus Left-sided CHF		X		X		
To recognize the various causes of CHF						
High/low output states		X		X		
Valvular heart disease		X		X		
Cardiomyopathies		X				
MI		X		X		
Pulmonary disease (PE, COPD)		X		X		
To use diagnostics in the CHF patient including:						
Right and Left sided failure signs/symptoms				X		
CXR findings at various PAWP (stages 1,2,3)				X	X	X
BNP		X				
To be able to treatment stable and unstable presentations of Left-sided CHF:						
Patient positioning				X	X	
Nitroglycerin				X	X	
Diuretics				X	X	
Morphine				X	X	
CPAP/BIPAP/Intubation				X	X	X

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

Indications for vasoactive agents (dopamine, dobutamine)				X	X	
Indications for Intra-aortic balloon conterpulsation/PCI				X		
To be able to treat stable & unstable presentations of R-sided CHF:						
Medications contraindications			X	X		
The role of volume resuscitation in acute failure				X		
Cardiomyopathies	**Every 2 years**					
To understand the basic pathophysiology, presentation, and treatment of:						
Idiopathic dilated CMP		X				
Restrictive CMP		X				
Hypertrophic Obstructive CMP (IHSS)		X				
Toxin-induced CMP (ETOH, Adriamycin, sympathomimetic, Li)		X		X (see Toxicology)		
Nutritional Deficiency (thiamine, vit C, kwashiokor)			X			
Metabolic disorders (hemochromatosis, myxedema, thyrotoxicosis, uremia)			X			
Infiltrative (amyloid, sarcoid, endomyocardial fibrosis)			X			
Peri and post-partum				X (see OB/GYN)		
Myocarditis	**Every 2 years**					
To understand the various etiologic agents in myocarditis including:						
Viral		X				
Bacterial		X				
Parasitic (Chagas)		X				
HIV-associated		X				
To be able to treat the acute complications of myocarditis (see CHF)				X		
To understand the chronic treatment of myocarditis (steroids, IVIG, interferon, ACE-1, antidysrhythmics)		X				
Endocarditis	**Every 2 years**					
To understand the risk factors for BE						
Abnormal/prosthetic valves		X				
IVDU		X				
HD		X				
HIV-associated		X				
Others		X				
To understand the causes of endocarditis, including:						
Bacterial (non-viridans strep, staph, enterococci…)		X				
Marantic		X				
To recognize the variable clinical presentation of endocarditis due to Left v. Right-sided endocarditis (systemic v pulmonary complications)		X		X		
To enumerate the findings in the clinical evaluation of endocarditis including:						
Physical findings		X		X		
EKG (refer to conduction abnormalities)		X		X		
CXR		X		X		
To understand the role of the following diagnostics						
Labs/BCx3 sets		X				

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

Echocardiography (TTE v. TEE)		X				
To apply the appropriate treatment in endocarditis/suspected endocarditis:						
Antibiotics (with considerations of VRE and MRSA)		X		X		
Resuscitation for acute valvular and conduction failure				X		
To recommend prevention/prophylaxis for appropriate medical/ surgical treatments (oral or GU procedures)		X				
Valvular heart disease	**Every 2 years**					
To describe the clinical presentations of valvular disease including:						
AS-angina->syncope->CHF		X		X		
AI-acute (endocarditis) v. chronic		X		X		
MS-pulmonary congestive complications		X		X		
MR-acute (papillary mm. Rupture) v. chronic		X		X		
TS-rheumatic, post-endocarditic		X		X		
TR-rhematic, IVDU endocarditis		X		X		
MVP			X			
To evaluate and treat specific valve disorders and their acute presentations:						
AS						
Admission of symptomatic patients for surgical eval			X			
Valve replacement or valvuloplasty			X			
Afterload reduction in CHF		X		X	X	
AI						
Treatment of endocarditis		X		X		
Afterload reduction in CHF		X		X	X	
Emergent surgical evaluation for acute AI		X		X		
MS						
Rate control of A fib		X		X	X	
Treatment of pulmonary infections			X			
Preload reduction in CHF		X		X	X	
Transfusion of massive pulmonary hemorrhage		X		X		
MR						
Rate control of A fib		X		X	X	
BP mgmt and emergent surgery in post-MI chordal rupture		X		X		
Preload and afterload reduction in CHF		X		X		
TS				X		
Rate control of A fib		X		X	X	
TR						
Rate control of A fib		X		X	X	
Treatment of endocarditis when present		X		X		
To recognize the specific indications for valve replacement			X			
To recognize and treat the complications of valve replacement including:						
Valve thrombosis		X				
Valve failure		X				
Paravalvular leak			X			

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

Endocarditis		X				
Hemolysis			X			
DVT	**Every 2 years**					
To understand the risk factors for DVT		X				
To describe the pathophysiology and treatment of phlegmasia cerulea/alba dolens			X			
To diagnose DVT using:						
D-dimer		X		X		
Ultrasound						X
To treat the patient with DVT using:						
Anticoagulation (Heparin, LMWH, Direct thrombin inhibitors)		X		X		
Indications for thrombolysis		X		X		
PE	**Yearly**					
To recognize patients with risk factors for PE		X				
To understand the variable clinical presentations of PE				X		
To be able to evaluate a patient of variable clinical probability for PE (algorithm-oriented) using tools such as:						
Wells risk categorization (or similar)		X				
A-a gradient			X			
EKG findings		X		X		
CXR findings		X		X		
D-dimer		X		X		
CTA-PE		X		X		
V/Q		X		X		
Angiography		X		X		
Echocardiography (TTE v. TEE)		X		X		X
To treat the PE patient using the following:						
Anticoagulation		X		X		
IV resuscitation and Vasopressor therapy		X		X		
Indications for Thrombolysis		X		X		
Indications for Surgical thrombectomy		X		X		
To recognize the role and timing of hypercoagulability work-ups in PE patients			X			
Arterial Occlusive disease	**Every 2 years**					
To be able to evaluate the patient with arterial insufficiency using pulse examinations (palpation, Doppler, PVR)		X				X
To understand the treatment of acute and chronic arterial occlusive disease using:						
Anticoagulation		X				
Vascular consultation for thrombectomy/bypass		X				
Pericardial disorders	**Every 2 years**					
To understand the various causes of pericarditis including:						
Viral		X				
Bacterial/Mycobacterial		X				
Fungal		X				

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

Malignancy		X				
Autoimmune (SLE, RA, scleroderma, PAN, etc.)		X				
Medication-related (hydralazine, INH, etc.)		X				
Post-MI		X				
Post-traumatic/surgical		X				
To be able to diagnose pericarditis based on:						
Signs and symptoms		X		X		
EKG		X		X		
Echocardiography (r/o WMA/effusion in uncertain cases)		X		X		
Ancillary lab findings (BUN, TnI, ESR, etc)		X		X		
To implement the correct treatment for pericarditis						
ASA		X		X		
NSAID		X		X		
Indications for steroids		X		X		
Pain control		X		X		
To diagnose cardiac tamponade using:						
Beck's triad		X		X		
ECG		X		X		
Echocardiography		X		X		X
CXR findings		X		X		
To be able to treat acute tamponade using:						
Pericardiocentesis						X
Thoracotomy (traumatic)		X				
Indications for consultation for cath lab intervention		X		X		
Thoracic Aortic Dissection	**Every 2 years**					
To recall the risk factors for TAD		X				
To be able to describe the anatomic classifications of TAD (Stanford A, B; DeBakey I, II, III)		X				
To recognize the clinical presentation of TAD including its associated symptoms (stroke, paraplegia, hematuria, MI, etc.)		X				
To be able to suspect and diagnose TAD based on:						
CXR findings		X		X		
EKG (IMI, AV block)		X		X		
CTA		X		X		
TEE		X		X		
Aortography		X		X		
MRI		X				
To implement correct treatment for acute TAD						
IV access and volume resuscitation				X		
Blood pressure management (rate and pressure control)				X		
Location of A-line placement (R radial)				X		X
Blood product ordering (10 RBC, 10 plt, 10 FFP)				X		
Surgical v. medical management (A v. B)				X		
Abdominal Aortic Aneurysm	**Every 2 years**					
To understand the risk factors for AAA		X				
To describe the variable clinical presentations of AAA rupture		X				

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

To diagnose AAA and AAA rupture based on:						
Examination findings (pulsatile mass, pulse/neuro deficits, etc.)		X				
Ultrasound				X		X
CT				X		
Angio (limitations due to false-negative rate)		X				
To implement correct and timely treatment for AAA rupture:						
IV access and volume resuscitation				X		X
Blood product (pRBC, plt, FFP)				X		X
Surgical consultation				X		X
Hypertensive Emergencies	**Every 2 years**					
To differentiate between hypertensive Emergency and Urgency (I.e. end organ damage)		X				
To recognize the variability in end-organ damage in hypertensive						
CNS		X				
Renal		X				
Vascular		X				
Ocular		X				
Cardiac		X				
To recognize the causes of hypertensive emergencies						
Endogenous HTN		X				
Pre-eclampsia	X (see OB GYN)					
Acute renal failure	X (see Renal)					
Tyramine crisis			X			
Sympathomimetic use				X (see Toxicology)		
Herbal supplements			X			
To be able to treat hypertensive emergencies appropriately:						
Presentation guides BP control (30% MAP over 1st hour usually)				X		
Presentation determines agents used				X		
Magnesium & hydralazine in pre-eclampsia				X (see OB GYN)		
Avoidance of pure-beta antagonists in cocaine use				X (see Toxicology)		
Invasive BP monitoring						X
Cardiac transplant complications and treatment	**Every 2 years**					
To understand the basic principles of immunosuppressive therapy (CsA, etc.) and their toxicities (e.g. CNS with CsA)		X				
To recognize the opportunistic infections (CMV, PCP, nosocomial, zoster, TB, nocardia, etc.) in the transplant patient		X				
To understand the diagnostic difficulties posed by the transplant patient's denervated heart and immunosuppressed status		X				
To recognize Acute rejection evaluation						
ECG-low volts		X				
New CHF		X				
Dysrhythmias		X				
To be able to recommend appropriate antibiotic prophylaxis						
Abx for oral/GU procedures		X				

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press

VZIG when exposed		X				
* includes preparatory reading by residents						

https://doi.org/10.1017/S1481803500012458 Published online by Cambridge University Press