Presentation of the Cardiac Surgery Simulation Syllabus to the Thoracic Surgery Directors Association

A Comprehensive 6 Module Curriculum for Simulation Based Training in Cardiac Surgery from the

AHRQ Cardiac Surgery Simulation Training Grant

AHRQ Grant # 1R18HS020451-01

"Improved Patient Safety by Simulator Based Training in Cardiac Surgery"

AHRQ Cardiac Surgery Training Grant

AHRQ Grant # 1RH18RSO20451-01

- Collaboration of 8 institutions

  Cardiac Surgery Simulation Consortium

- $1,049,298 over three years

- 2 groups of 16 first year cardiothoracic residents - Total 32 residents

Improved Patient Safety by Simulator Based Training in Cardiac Surgery

AHRQ Grant # 1R18HS020451-01

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AHRQ Cardiac Surgery Simulation Grant

- Each center trained 1- 2 first year cardiothoracic residents or advanced I-6 residents in 3-4 hour sessions for 40 sessions each year covering 6 modules
- Each module ran 5-7 sessions
- Study included total 2 years of simulation experience
- All critical parts were videotaped
- All sessions conformed to the **Cardiac Surgery Simulation Syllabus** developed for the study by the investigators

AHRQ Grant Simulation Modules

BASIC PROCEDURES

1. Cardiopulmonary Bypass (CPB)
2. Coronary Artery Bypass Grafting (CABG)
3. Aortic Valve Replacement (AVR)

AHRQ Grant Simulation Modules

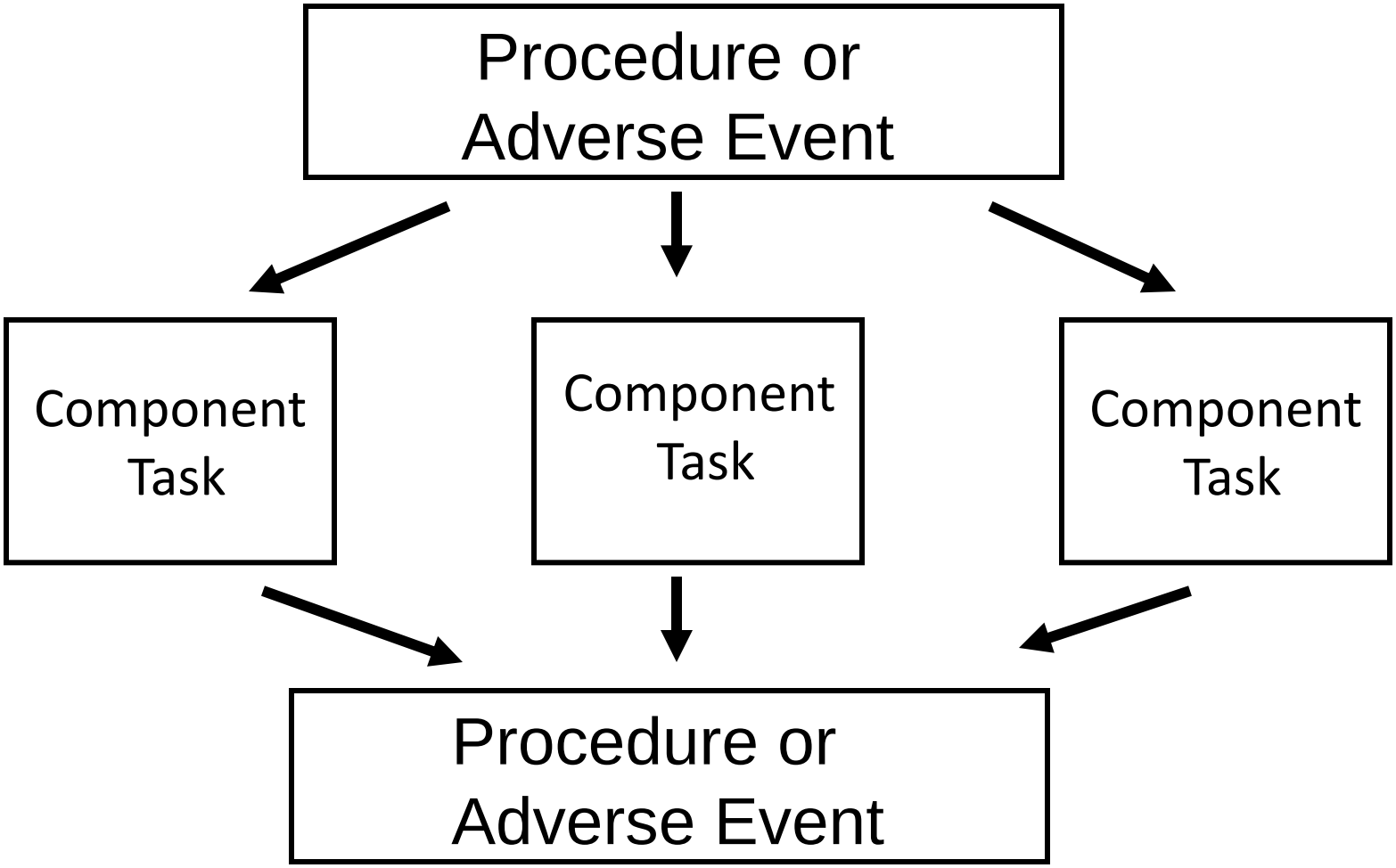
Significant Adverse Events

4. Massive Air Embolism (MAE)

5. Acute Intra-operative Aortic Dissection (AIAD)

6. Sudden Deterioration of Cardiac Function (SDCF)

Component Task Based Simulation Training in Cardiac Surgery



Deliberate Practice

“a highly structured activity, the explicit goal of which is to improve performance”

Improved Patient Safety by Simulator Based Training in Cardiac Surgery

AHRQ Grant # 1R18HS020451-01

- 27 Residents participated
- Over 15,000 data points recorded
- Over 120 individual simulation hours per resident
- Over 3000 total simulation hours
- Component task simulators developed for all component tasks
- Extensive video library recorded
- **Comprehensive curriculum syllabus written**

Improved Patient Safety by Simulator Based Training in Cardiac Surgery

AHRQ Grant # 1R18HS020451-01

Simulation Syllabus for Each Training Session

- Overview
- Goals and Objectives
- Teaching Plan
- Simulator(s) Set-up
- Conduct of Simulation
- Assessment Tools

Syllabus

Improved Patient Safety by Simulator Based Training in Cardiac Surgery

A curriculum of surgery simulation to teach cardiac surgery skills and decision-making

Funded by U.S. Department of Health and Human Services (HHS)
Agency for Healthcare Research and Quality
Grant # R18HS020451

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Module 1. Cardiopulmonary Bypass (CPB)

Harold M. Burkhart, M.D.
George L. Hicks, Jr., M.D.

CPB Module - OVERVIEW

The CPB Module is a four-week simulation-based training program leading to familiarity and competence with the surgical techniques of cardiopulmonary bypass. It has the following objectives:

1. The resident will be able to master and recite the steps of CPB from memory without hesitation.
2. The resident will be able to perform aortic cannulation, venous cannulation, cross-clamping, administration of cardioplegia, weaning from CPB, and decannulation on the Ramphal Cardiac Surgery Simulator with a Likert score of 5 for each step.
3. Residents are to repeat all steps until the session objectives are met.

Assessment using video is very helpful but at the discretion of the instructor.

It is recommended that residents gown, glove and wear masks to better simulate the OR setting.

The four-week CPB training program will consist of one half-day per week (approximately 4 hours) for each resident. The component task and full procedure schedule is:

Week 1: Fundamentals of CPB
Aortic Cannulation

Week 2: Venous Cannulation
Administration of cardiolpegia

Week 3: Full CPB run
Ramphal simulator

Weeks 4: Full CPB run
Ramphal simulator

Residents should have ample opportunity to practice between weekly sessions.

Each weekly session will begin with an evaluation of the component tasks covered in previous weeks.

CPB Session 1: Fundamentals of CPB and Aortic Cannulation

Overview

Week 1 of the Cardiopulmonary Bypass Module consists of 2 parts; an introduction to cardiopulmonary bypass and training in the component task of aortic cannulation. Through an introductory didactic session and subsequent practice, the resident will train in the components of conducting cardiopulmonary bypass. The resident will then use the aortic cannulation component task simulator to perform multiple aortic cannulations and de-cannulations. The skills learned will be:

1. Pre-bypass team briefing
2. CPB communication of steps and commands
3. Debriefing
4. Aortic cannulation and decannulation. Deairing and testing of line

Prerequisites

It is expected that the residents will have reviewed the TSDA Boot Camp lecture Intro to CPB, http://www.tsda.org/wp-content/uploads/2013/07/CPB-Skills.Print-Version.13.pdf, and the anatomical review of the anatomy of the heart by Dr. Gene A Grossi, which can be viewed on the TSDA curriculum site http://conferencecast.com/tsda/tsdaplayer/player1.php?fileid=grossi

Fundamentals of Cardiopulmonary Bypass Training

Objectives for Fundamentals of Cardiopulmonary Bypass Training

The objectives for CPB Week 1: Fundamentals of CPB are that by the end of the session:

1. The resident will be able to write down and recite the seven steps for CPB
2. The resident will be able to identify the component parts of the cardiopulmonary bypass circuit
    a. Review the lecture on CPB and pass the 10 question exam (90%)
3. The resident will be able to conduct a complete pre-bypass briefing
4. The resident will be able to conduct a simulated cardiopulmonary bypass run using all commands and check points of the Seven Steps of CPB.

Equipment and Materials Required:

Seven steps of cardiopulmonary bypass (Listed in Teaching Plan, #5)
10 Question CPB Test (See Appendix CPB 1-1)

Teaching Plan for Fundamentals of Cardiopulmonary Bypass

All parts of the teaching plan should be repeated as many times as necessary for the resident to be able to perform them perfectly (deliberate practice)

1. Administer the 10-question CPB test
2. Review Intro to CPB, which resident should have reviewed prior to session
3. Have a CPB circuit set up and review component parts with resident. Resident should be able to identify and state the function of all of the parts:
   a. Pumps
   b. Oxygenator
   c. Venous reservoir
   d. Tubing
   e. Cardioplegia
   f. Heat exchanger
   g. Safety devices

4. The resident will conduct a cardiac surgery preoperative briefing covering:
   a. Diagnosis
   b. Procedure
   c. Incision
   d. Significant surgical history (redo, patent grafts…)
   e. Cannulation
   f. Cardioplegia
   g. Temperature
   h. Questions

5. The resident will go through a mock CPB run covering all of the following 7 steps of CPB including appropriate communication to the team.
   1. Heparin
   2. Expose the heart
      Check BP/aorta

Aortic Cannulation Component Task Simulation

Objectives:

1. The resident will be able to place and secure the aortic cannula into the aorta.
2. The resident will be able to connect the arterial line and de-air it.
3. The resident will be able to de-cannulate the aorta and secure the purse strings.
4. The resident will perform complete aortic cannulation and de-cannulation a minimum of 10 times.

Resident should be given the opportunity to practice during the week after the session using the HeartCase of some equivalent simulation model or by having access to the simulation center.

The residents should be gowned, gloved and wear a mask to improve the real world environment for the session

Equipment required for each resident (may vary depending on cannulation technique being taught):

Aortic Cannulation Component Task Simulator (Appendix CPB 1-6)
Aortic cannulation simulation model (supplied from UNC)
Length of aorta (supplied from UNC)
2 bags of artificial blood
1 IV pole
Purse- string suture (2) (2-0 double-armed non-pledgeted suture)
Silk ties
2 tourniquet sliders
Needle driver
2 pairs of DeBakey forceps
2 small clamps
#11 blade on knife handle
Suture scissors
Metzenbaum scissors
2 tubing clamps
2 lap sponges

Set-up of Aortic Cannulation Component Task Simulation model
(See Appendix CPB 1-6)

Aortic length is placed in the silicone well.
Bag of artificial blood is hung.
One arm of Y is connected to the quick connect of the aortic length, the other arm is clamped with a tubing clamp.
Blood is infused into the aorta.
The arterial line is advanced by removing the tubing clamp from the Y.

Conduct of the simulation

1. During the simulation, the resident will be expected to perform the parts of the 7 Steps of CPB appropriate to aortic cannulation.

2. Starting at proximal end of the aorta and using the agreed upon method of the institution, the resident will
   a. Give heparin, check aortic pressure, palpate aorta
   b. Place the purse string(s), the slider(s), and clamp the slider(s)
   c. ACT check
   d. Clean off aorta at cannulation site. Be sure cannula is ready and clamped with tubing clamp if necessary
   e. Re-check aortic root pressure
   f. Open aorta with #11 blade
   g. Place aortic cannula
   h. Tighten and secure purse string(s)
   i. Fill aortic cannula into sponge by leasing clamp on cannula
   j. Advance arterial line by giving command. Arterial line is unclamped to allow it to fill
   k. Connect aortic cannula while line is being forwarded to remove air
   l. Check line for air
   m. Ask perfusionist to confirm proper pressure and flow
   n. Insure patient ready to come off bypass
   o. Come off bypass and decannulate aorta with purse strings being tied (Aortic line may be clamped or not depending on centers procedure)

Repeat procedure until no errors using more distal parts of aorta. Aorta can also be turned to expose clean aorta. A minimum of 10 repetitions is recommended.

APPENDIX CPB 1-5

CPB Week 1 Assessment - Aortic Cannulation Assessment Tool (ACAT) –

REPETITION ASSESSMENT (first or last)

RESIDENT NAME_____YR OF TRAINING_____ DATE_____

EVALUATOR_____

	Poor 1	2	3	4	**Excellent** 5
1. Aortic site	Does not palpate aorta Interferes with graft or aortotomy BP not mentioned		Minimal aortic evaluation Close to grafts or aortotomy BP noted		Palpates and evaluates aorta Adequate spacing for grafts or aortotomy BP noted, appropriate

Additional Comments:

_____

	1	2	3	4	5
2. Needle angles	Not aware of angles Does not consider subsequent angles		Understand angles, not consistent Partial consideration of subsequent angles		Consistent correct angles Consistent adjustment for subsequent angles

Additional Comments:

_____

	1	2	3	4	5
3. Bite	Irregular entry/exit Hesitant, multiple punctures		Mostly regular entry/exit Mostly single puncture		Consistent regular entry/exit Consistent single puncture

Additional Comments:

_____

	1	2	3	4	5
4. Spacing	Uneven/irregular spacing Irregular distance from previous bite		Mostly even spacing Mostly consistent distance from previous bite		Consistent even spacing Consistent distance from previous bite

Additional Comments:

_____

	1	2	3	4	5
5. Needle holder use	Awkward finger placement Unable to rotate instrument Awkward and not facile Inconsistent needle placement		Functional finger placement Hesitant when rotating Moderate facility Generally good placement		Comfortable, smooth finger placement Smooth rotation High facility Consistent proper placement

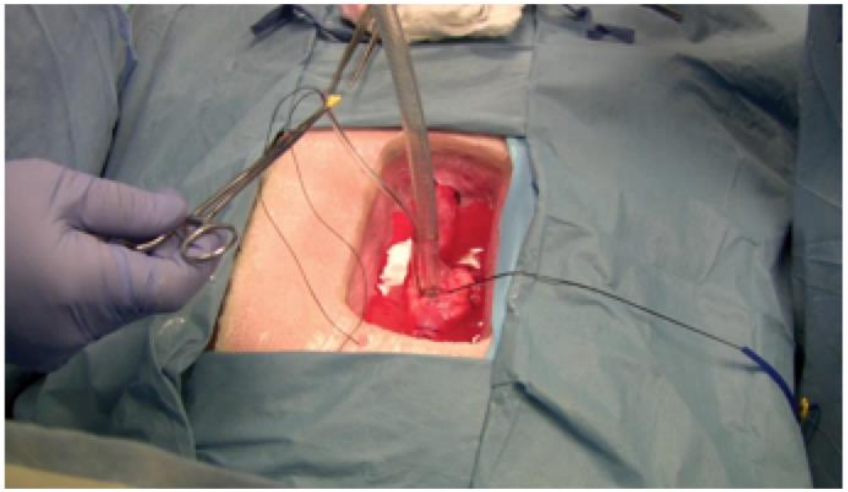
Additional Comments:

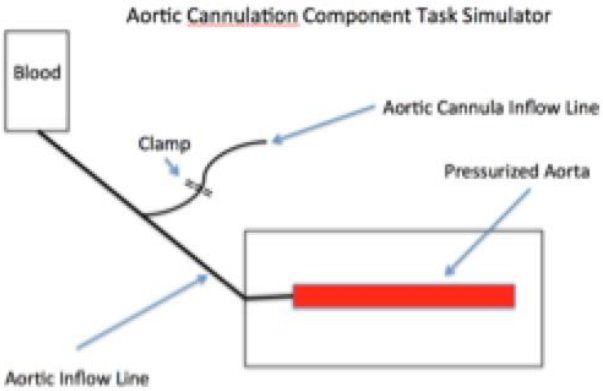
_____

	1	2	3	4	5
6. Use of forceps	Awkward or no traction Unable to expose Not use to stabilize needle		Moderate proper traction Able to assist in exposure Able to stabilize but rough		Consistent proper traction Consistent proper exposure Knows when to stabilize, gentle

Additional Comments:

APPENDIX CPB 1-6: AORTIC CANNULATION TASK SIMULATOR





Improved Patient Safety by Simulator Based Training in Cardiac Surgery

AHRQ Grant # 1R18HS020451-01

Simulation Syllabus

v. 1.0
July 25, 2012

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Improved Patient Safety by Simulator-Based Training in Cardiac Surgery

AHRQ Grant # 1R18HS020451-01

1. Cardiopulmonary Bypass (CPB) Module

Harold M. Burkhart, MD
George L. Hicks, Jr., MD

August 1, 2011

The seven week CPB training program will consist of one half-day per week (approx. 4 hours) for each resident. The component parts schedule is:

Week 1: **Fundamentals of CPB**

Week 2: Fundamentals of CPB
Aortic Cannulation

Week 3: Fundamentals of CPB
Aortic Cannulation
Venous Cannulation

Week 4: Fundamentals of CPB
Aortic Cannulation
Venous Cannulation
Cardioplegia

Weeks 5, 6, 7: Full CPB on Ramphal Simulator

Objectives

The objectives for this week are:

1. The resident will be able to write down the 7 Steps of CPB from memory
2. The resident will be able to place and secure the aortic cannula into the aorta within 8 minutes
3. The resident will be able to connect the arterial line and de-air it.
4. The resident will be able to de-cannulate the aorta and secure the purse strings
5. The resident will perform complete aortic cannulation and de-cannulation a minimum of 10 times.

The cannulation and de-cannulation technique practiced will be specific to the training center. Only one technique will be taught at each center. The simulation will provide better training if the resident is gowned, gloved, and masked during the session

Teaching Plan

Equipment required for each resident (may vary depending on cannulation technique being taught):

Aortic cannulation simulation model (supplied from UNC)
Length of aorta (supplied from UNC)
2 bags of artificial blood
1 IV pole
Purse string suture (2)
Silk ties
2 tourniquet sliders
Needle driver
2 pairs of deBakey forceps
2 small clamps

Set-up of Aortic Cannulation Simulation model

Aortic length is placed in the silicone well
Bag of artificial blood is hung
One arm of Y is connected to the quick connect of the aortic length, the other arm is clamped with a tubing clamp.
Blood is infused into the aorta
The arterial line is advanced by removing the tubing clamp from the Y

Conduct of the simulation

1. Resident must write from memory the 7 steps of CPB. During the simulation, the resident will be expected to perform the parts of the 7 Steps appropriate to aortic cannulation

2. Starting at proximal end of the aorta and using the agreed upon method of the institution, the resident will
   a. Give heparin, check aortic pressure, palpate aorta
   b. place the purse string(s), the slider(s), and clamp the slider(s)
   c. ACT check
   d. Clean off aorta at cannulation site. Be sure cannula is ready and clamped with tubing clamp if necessary
   e. Re-check aortic root pressure
   f. Open aorta with #11 blade
   g. Place aortic cannula
   h. Tighten and secure purse string(s)
   i. Fill aortic cannula into sponge by leasing clamp on cannula
   j. Advance arterial line by giving command. Arterial line is unclamped to allow it to fill
   k. Connect aortic cannula while line is being forwarded to remove air

CPB Week 3 Assessment - Venous Cannulation Assessment Form (VCAF)

Atrial_____ Bi-caval_____

RESIDENT NAME_____YR OF TRAINING_____ DATE_____
EVALUATOR_____ TIME TO COMPLETION_____

	Poor				**Excellent**
1. Atrial/Bi-caval site	1	2	3	4	5
	Does not identify atrial appendage or venous sites Injury to RCA		Notes general area atrial appendage or venous sites Close to RCA		Identifies atrial appendage or ven Appropriately away from RCA

Additional Comments:
_____
_____

2. Needle angles	1	2	3	4	5
	Not aware of angles Does not consider subsequent angles		Understand angles, not consistent Partial consideration of subsequent angles		Consistent correct angles Consistent adjustment for subsequent angles

Additional Comments:
_____
_____

3. Bite	1	2	3	4	5
	Irregular entry/exit Hesitant, multiple punctures		Mostly regular entry/exit Mostly single puncture		Consistent regular entry/exit Consistent single puncture

Additional Comments:
_____
_____

4. Spacing	1	2	3	4	5
	Uneven/irregular spacing Irregular distance from previous bite		Mostly even spacing Mostly consistent distance from previous bite		Consistent even spacing Consistent distance from previous bite

Additional Comments:
_____
_____

Improved Patient Safety by Simulator Based Training in Cardiac Surgery

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- Resident time is a major problem
- Deliberate practice is an effective way to improve skills
- Faculty commitment very important
- Adverse events can be orchestrated for training
- A comprehensive syllabus is essential

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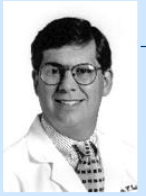

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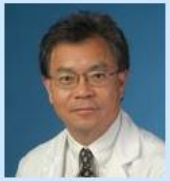

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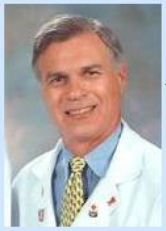

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Introduction

The Syllabus for Simulation Based Training in Cardiac Surgery (The Syllabus) is composed of training in 6 basic cardiac surgery modules: 3 basic cardiac surgery procedures and 3 important intraoperative adverse events:

Cardiopulmonary bypass (CPB)
Coronary artery bypass graft surgery (CABG)
Aortic valve replacement (AVR)

Massive intraoperative air embolism (MAE)
Acute intraoperative aortic dissection (AIAD)
Sudden perioperative deterioration of cardiac function (SDCF).

Each of the modules is broken down into its important component tasks; detailed simulation exercises on component task simulators are outlined in the syllabus. In the last few sessions of each module, the learned component tasks are combined into full cardiac surgery procedures using the Ramphal Cardiac Surgery Simulator. The principles of task and procedure mastery by repetitions, coaching, and debriefing are emphasized throughout the 29 sessions of the curriculum.

For each simulation session, the module provides the following:

Session overview
Prerequisites
Objectives
Equipment and materials required
Simulation set-up
Conduct of the simulation
Assessment tools

We have found it helpful to video-record the simulation sessions for more detailed review and analysis.

Each session is designed to take between 2 and 4 hours and each module takes between 4 and 7 sessions to complete. The actual time needed will depend on the individual residents ability to meet the goals and objectives for each session. Defined benchmarks and prerequisites should be attained by the trainee prior to advances through the curriculum.

An important concept to remember is that mastery of a skill comes from multiple supervised repetitions of a task along with self-practice. The ultimate goal of the CABG module, for example, is not to complete a coronary bypass procedure but rather to **repeat the components involved as many times as possible** with the goal of mastery. In addition, the mentor must balance in-depth supervision and coaching with allowing the trainee to make his or her own mistakes.

The Syllabus does not prescribe a particular method for a given task but rather leaves it up to the individual institution to train its residents in its own way of doing a given task or procedure. This also applies to the Emergency Action Plans used in the adverse events modules.