

New Cardiac Vital Sign: Assess and Manage Stroke Volume

Program Description:

This innovative, reality based program is designed to involve the learner in real life situations regarding the identification and proper management of normal and abnormal hemodynamic situations. The learner has three opportunities for learning material, i.e. classes (video with illustrations), library (animated books) and near virtual reality interactive rooms. The content presented is based on the best available science (evidence based practice), using national or international standards when possible. In this program, information from the Center for Medicare and Medicaid Services is used, as well as the concept of "stroke volume protocol" implementation.

The program is targeted to the practicing clinicians. It is not designed to create experts, but clinicians who are competent at addressing the major aspects of hemodynamic monitoring. References are provided for additional learning opportunity.

Using research that indicates how learning best takes place; this program is structured to engage the learner, using real life learning skills. The learners fill whatever learning needs they have in our short, targeted classroom videos or learn on their own in our interactive library. Once the learner feels ready to proceed, they enter our virtual reality hospital. Our hospital allows the learner to enter their specific clinical area, e.g. MICU, SICU, CTCCU, ED, floor. They can also enter other clinical areas at their interest. The clinical areas are divided into learning/practicing rooms and testing/evaluation rooms.

The program is web based so learning can occur anytime, anywhere. The learner can complete the class in a given time period, e.g. 2-4 weeks. The specific clinical area the learner is employed can be completed in about 2 hours, including the testing/evaluation phase. Except for the testing section, the learner can enter and leave the program whenever they want. This allows improved use so the learner can learn at their convenience, either at work or at home.

Program Objective:

The objective of this program is to:

Develop the knowledge base of practicing clinicians to recognize and successfully manage patients with normal and abnormal hemodynamics.

Participant Learning Objectives:

At the completion of this course, the participant will be able to:

1. Discuss the strengths and limitations of technologies for measuring hemodynamics
2. Discuss the implications of Doppler technology on patient safety
3. Discuss the implications of using Doppler technology on nursing learning time
4. Describe the economic implications of using new hemodynamic monitoring, e.g.
 - a. How doppler technology can be used to reduce LOS and generate revenue
 - b. Reduction in the time it takes to educate nurses and physicians with new technology
5. Discuss how use of stroke volume /index can be used to easily titrate fluid therapy
6. Describe how use of Doppler technology reduces nursing and physician education time

Learning Rooms - The learner enters rooms in each clinical area. Each room has a different problem to solve. As the learner enters a room, they must act as they would in real life. The room is interactive, including the patient. If the learner wants information, they must seek the information. As in real life, no information is given without their effort. The learner must make an assessment and if treatment is indicated, administer that treatment. Treatments can be accessed in real life format, e.g. medication carts. Depending on the treatment selected, the patient may get better. Incorrect answers are identified for the learner and suggestions are made to help learning. The learner must solve the problem before being allowed to advance. However, the learner can leave the room if they want and complete the same room at a later time.

There are 8 learning rooms in each clinical area; each designed to teach specific aspects of identifying and treating hemodynamics. The key teaching points in each room are:

- 1) Identification of a patient who is normal (1 room where patient is normal)
- 2) Identification and treatment of a patient who requires fluid therapy (1 room)
- 3) Identification and treatment of a patient who requires inotropic therapy (1 room)
- 4) Identification and treatment of patient who requires vasopressor therapy (1 room)
- 5) Identification and treatment of patient who requires preload reduction (1 room)
- 6) Identification and treatment of patient who requires afterload reduction (1 room)
- 7) Identification and treatment of patient who requires removal of vasopressor therapy (1 room)
- 8) Identification and treatment of patient who requires treatment of septic shock (1 room)

Testing Rooms – in the evaluation section, the hospital room is identical to the learning rooms. However, in these rooms, once the learner has selected a response, no guidelines are given whether the answer is correct or not. The learner chooses to exit the room at any time. Success will be identified by if the learner has completed all the required steps to ensure the patient was adequately treated.

The testing cases involve four of the most important aspects of hemodynamic recognition and treatment:

- 1) Identification and treatment of patient who requires inotropic therapy (1 room)
- 2) Identification and treatment of patient who requires fluid therapy (1 room)
- 3) Identification and treatment of patient who requires vasopressor therapy (1 room)
- 4) Identification and treatment of patient who requires removal of therapy (1 room)

Bibliography / Reference List

Hemodynamic Interpretation

1. Bilkovski RN, Rivers EP, Horst HM. Targeted resuscitation strategies after injury. *Curr Opin Crit Care* 2004; 10:529-538.
2. Dawson NV, Connors AF Jr, Speroff T, Kemka A, Shaw P, Arkes HR. Hemodynamic assessment in managing the critically ill: is physician confidence warranted? *Med Decis Making* 1993; Jul-Sep;13(3):258-66.
3. Eisenberg PR, Jaffe AS, Schuster DP. Clinical evaluation compared to pulmonary artery catheterization in the hemodynamic assessment of critically ill patients. *Crit Care Med*. 1984 Jul;12(7):549-53.
4. Iregui MG, Prentice D, Sherman G, Schallom L, Sona C, Kollef MH. Physicians' estimates of cardiac index and intravascular volume based on clinical assessment versus transesophageal Doppler measurements obtained by critical care nurses. *Am J Crit Care* 2003;12(4):336-42.
5. Mimoz O, Rauss A, Rekik N, Brun-Buisson C, Lemaire F, Brochard L. Pulmonary artery catheterization in critically ill patients: a prospective analysis of outcome changes associated with catheter-prompted changes in therapy. *Crit Care Med* 1994; Apr;22(4):573-9.
6. Molitoris BA. Renal blood flow in sepsis: a complex issue. *Crit Care* 2005 Aug 9(4):327-8.
7. Piazza O, Zito G, Valente A, Tufano R. Effects of dopamine infusion on forearm blood flow in critical patients. *Med Sci Monit* 2006 Feb;12(2):CR90-93. Epub 2006 Jan 26.
8. Roeck M, Jakob SM, Boehlen T, Brander L, Knuesel R, Takala J. Change in stroke volume in response to fluid challenge: assessment using esophageal Doppler. *Intensive Care Med* 2003;10:1729-35.
9. Rodriguez RM, Berumen KA. Cardiac output measurement with an esophageal doppler in critically ill Emergency Department patients. *J Emerg Med* 2000 Feb;18(2):159-64.
10. Staudinger T, Locker GJ, Laczika K et al. Diagnostic validity of pulmonary artery catheterization for residents at an intensive care unit. *J Trauma* 1998 May;44(5):902-6.
11. Trezeciak S, Dellinger RP, Abate NL, Cowan RM, et al. Translating research to clinical practice: a 1-year experience with implementing early goal-directed therapy for septic shock in the emergency department,*.
Chest 2006 Feb;129(2):225-32.
12. Uriel N, Torre-Amione G, Milo O, et al. Echocardiographic ejection fraction in patients with acute heart failure: correlations with hemodynamic, clinical, and neurohormonal measures and short-term outcome. *Eur J Heart Fail* 2005;7:815-9.
13. Ware LB, Matthay MA. Acute pulmonary edema. *NEJM* 2005;335:2788-96.

SvO₂

1. Ahrens TS. SvO₂ monitoring. *Critical Care Nursing Clinics of North America* 1999; 11:33-48
2. Bradley SM, Atz AM. Postoperative management: the role of mixed venous oxygen saturation monitoring. *Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu.* 2005;:22-7.
3. Caspani ML, Savioli M, Crotti S, Bruzzone P, Gattinoni L. Heat stress: characteristics, pathophysiology and avoidable mistakes. *Minerva Anesthesiol.* 2004 Jul-Aug;70(7-8):617-24.
4. Dueck MH, Klimek M, Appenrodt S, Weigand C, Boerner U. Trends but not individual values of central venous oxygen saturation agree with mixed venous oxygen saturation during varying hemodynamic conditions. *Anesthesiology* 2005; Aug;103(2):249-57.
5. Gan TJ, Soppitt A, Maroof M, Habib E, Robertson K, Moretti E, Dwane P, Glass P. Goal-directed intraoperative fluid administration reduces length of hospital stay after major surgery. *Anesthesiology* 2002, 97:820-826.
6. Krivec B, Voga G, Podbregar M. Monitoring mixed venous oxygen saturation in patients with obstructive shock after massive pulmonary embolism. *Wien Klin Wochenschr.* 2004 May 31;116(9-10):326-31.
7. Ladakis C, Myrianthefs P, Karabinis A, Karatzas G, Dosios T, Fildissis G, Gogas J, Baltopoulos G. Central venous and mixed venous oxygen saturation in critically ill patients. *Respiration.* 2001;68(3):279-85.
8. McKendry M, McGloin H, Saberi D, Caudwell L, Brady AR, Singer M: Randomised controlled trial assessing the impact of a nurse delivered, flow monitored protocol for optimisation of circulatory status after cardiac surgery. *BMJ* 2004; 329:258.
9. Monnet X, Rienzo M, Osman D, Anguel N, Richard C, Pinsky MR, Teboul JL: Esophageal Doppler monitoring predicts fluid responsiveness in critically ill ventilated patients. *Intensive Care Med* 2005; 31:1195-1201.
10. Nakazawa K, Hikawa Y, Saitoh Y, Tanaka N, Yasuda K, Amaha K. Usefulness of central venous oxygen saturation monitoring during cardiopulmonary resuscitation. A comparative case study with end-tidal carbon dioxide monitoring. *Intensive Care Med.* 1994 Jul;20(6):450-1.
11. Pearse D, Dawson D, Fawcett J, Rhodes A, Grounds RM, Bennett ED: Early goal-directed therapy after major surgery reduces complications and duration of hospital stay. A randomized controlled trial [ISRCTN38797445]. *Crit Care* 2005; 9:R687-R693.
12. Pieri M, Brandi LS, Bertolini R, Calafa M, Giunta F. Comparison of bench central and mixed pulmonary venous oxygen saturation in critically ill postsurgical patients. *Minerva Anesthesiol.* 1995 Jul-Aug;61(7-8):285-91
13. Pinsky MR, Vincent J-L: Let us use the pulmonary artery catheter correctly and only when we need it. *Crit Care Med* 2005, 33:1119-1122.
14. Rady MY, Rivers EP, Nowak RM. Resuscitation of the critically ill in the ED: responses of blood pressure, heart rate, shock index, central venous oxygen saturation, and lactate. *Am J Emerg Med.* 1996 Mar;14(2):218-25.
15. Rady MY. The role of central venous oximetry, lactic acid concentration and shock index in the evaluation of clinical shock: a review. *Resuscitation.* 1992 Aug-Sep;24(1):55-60.
Rasanen J, Peltola K, Leijala M. Superior vena caval and mixed venous oxyhemoglobin saturations in children recovering from open heart surgery. *J Clin Monit.* 1992 Jan;8(1):44-9.
16. Reinhart K, Kuhn HJ, Hartog C, Bredle DL. Continuous central venous and pulmonary artery oxygen saturation monitoring in the critically ill. *Intensive Care Med.* 2004 Aug;30(8):1572-8.
17. Reinhart K, Rudolph T, Bredle DL, Hannemann L, Cain SM. Comparison of central-venous to mixed-venous oxygen saturation during changes in oxygen supply/demand. *Chest.* 1989 Jun;95(6):1216-21.
18. Rivers E, Nguyen B, Havstad S, Ressler J, Muzzin A, Knoblich B, Peterson E, Tomlanovich M; Early Goal-Directed Therapy Collaborative Group. Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med.* 2001 Nov 8;345(19):1368-77.
19. Rivers EP, Ander DS, Powell D. Central venous oxygen saturation monitoring in the critically ill patient. : *Curr Opin Crit Care.* 2001 Jun;7(3):204-11.
20. Schou H, Perez de Sa V, Larsson A. Central and mixed venous blood oxygen correlate well during acute normovolemic hemodilution in anesthetized pigs. *Acta Anaesthesiol Scand.* 1998 Feb;42(2):172-7.
21. Stenqvist O, Olsson M, Karlson KL. Luxury lung perfusion in end-stage liver disease during liver transplantation. *Acta Anaesthesiol Scand.* 1999 Apr;43(4):447-51.
22. Turnaoglu S, Tugrul M, Camci E, Cakar N, Akinci O, Ergin P. Clinical applicability of the substitution of mixed venous oxygen saturation with central venous oxygen saturation. *J Cardiothorac Vasc Anesth.* 2001 Oct;15(5):574-9.
23. Varpula M, Tallgren M, Saukkonen K, Voipio-Pulkki LM, Pettila V. Hemodynamic variables related to outcome in septic shock. *Intensive Care Med* 2005 Aug;31(8):1066-71
24. Wendt M, Hachenberg T, Albert A, Janzen R. Mixed venous versus central venous oxygen saturation in intensive medicine. *Anasth Intensivther Notfallmed.* 1990 Feb;25(1):102-6.
25. Yu DT, Platt R, Lanken PN, Black E, Sands K, Schwatz J, Hibberd PL, Graman PS, Kahn K, Snyderman D, Parsonnet J, et al.: Relationship of pulmonary artery catheter use to mortality and resource utilization in patients with severe sepsis. *Crit Care Med* 2003, 31:2734-2741.

Lactate

1. De Backer D. Lactic acidosis. *Minerva Anesthesiol.* 2003 Apr;69(4):281-4. Fall
2. Szerlip HM. Lactic acidosis: from sour milk to septic shock. *J Intensive Care Med* 2005;20:255-71.
3. Husain FA, Martin MJ, Mullenix PS, Steele SR, Elliott DC. Serum lactate and base deficit as predictors of mortality and morbidity. *Am J Surg* 2003;185:485-91.
4. Martin MJ, FitzSullivan E, Salim A, Berne TV, Towfigh S. Use of serum bicarbonate measurement in place of arterial base deficit in the surgical intensive care unit. *Arch Surg* 2005;140:745-51
5. Mizock BA, Falk FL. Lactic acidosis in critical illness. *CCM* 1992;20:80-93
6. Nguyen HG, Rivers EP, Knoblich BP, Jacobsen G, Muzzin A, Ressler JA, Tomlanovich MC. Early lactate clearance is associated with improved outcome in severe sepsis and septic shock. *CCM* 2004;32:1637-42
7. Suistomoaa M, Ruokonen E, Kari A, Takala J. Time-pattern of lactate and lactate to pyruvate ratio in the first 24 hours of intensive care emergency admissions. *Shock* 2000;14:8-12.

Economic

1. Chytra I, Pradl R, Bosman R, Pelnar P, Kasal, Zidkova A. Esophageal Doppler-guided fluid management decreases blood lactate levels in multiple-trauma patients: a randomized controlled trial. *Critical Care* 2007 Feb 22;11(1):1-9.
2. Conway DH, Mayall R, Abdul-Latif MS, Gilligan S, Tackaberry C. Randomized controlled trial investigating the influence of intravenous fluid titration using esophageal Doppler monitoring during bowel surgery. *Anesthesia* 2002 Sept;57(9):845-849.
3. Gan TJ, Soppitt A, Maroof M, El-Moalem H, Robertson K, Moretti E, Dwane P, Glass PS. Goal-directed intra-operative fluid administration reduces length of hospital stay after major surgery. *Anesthesiology* 2002;97:820-826.
4. Mark JB, Steinbrook RA, Gugino LD, et al. Continuous noninvasive monitoring of cardiac output with esophageal Doppler during cardiac surgery. *Anesth Anlg* 1986;61:1013-1020.
5. McKendry M, McGloin H, Saberi D, Caudwell L, Brady AR, Singer M. Randomized controlled trial assessing the impact of a nurse delivered, flow monitored protocol for optimization of circulatory status after cardiac surgery. *BMJ* 2004;329(7460):258 (31 July), doi:10.1136/bmj.38156.767118.7C.
6. Mythen MG, Webb AR. Peri-operative plasma volume expansion reduces the incidence of gut mucosal hypoperfusion during cardiac surgery. *Archives of Surgery* 1995;130:423-429.
7. Price JD, Sear JW, Venn RW. Peri-operative fluid volume optimization following proximal femoral fracture. In: *The Cochrane Database of Systemic Review* 2004, Issue 1 [database online]. Hoboken (NJ): John Wiley & Sons, Ltd.[Art No.:CD003004]. Available: DOI: 10.1002/14651858.CD003004.pub2. Sons, Ltd.[ArtNo.:CD003004
8. Registered Nurses Association of Ontario (RNAO). Client centered care: a summary of recommendations. Toronto (ON): Registered Nurses Association of Ontario (RNAO);2006: 2p.
9. Sinclair S, James S, Singer M. Intraoperative intravascular volume optimization and length of hospital stay after repair of proximal femoral fracture: randomized controlled trial. *BMJ* 1997 October 11;315:909-912.enn R, Steele A, Richardson P, Poloniecki J, Grounds M, Newman P. Randomized controlled trial to investigate influence of the fluid challenge on duration of hospital stay and perioperative morbidity in patients with hip fractures. *British Journal of Anesthesia* 2002;88:65-71.
10. Wakeling HG, McFall MR, Jenkins CS, Woods WGA, Miles WFA, Barclay GR, Fleming SC. Intraoperative esophageal Doppler guided fluid management shortens postoperative hospital stay after major bowel surgery. *Br J Anaesth.* 2005 Nov;95(5):634-42. Epub 2005 Sep 9.

