

MANUAL:		POLICY #:	
SUBJECT:	Guidelines for noninvasive and invasive hemodynamic monitoring of patients	EFFECTIVE DATE:	
		REVISED DATE:	
		AUTHORIZED APPROVAL:	
PERSONNEL COVERED:	Nursing, respiratory and physician care providers of relevant patients in intensive care unit environments	PAGE:	1 OF 4

PURPOSE

The purpose of this policy is to define clinical guidelines for the care of the (surgical) ICU patient whose physiologic condition might warrant noninvasive or invasive monitoring. These conditions include, but are not limited to, hypovolemic/hemorrhagic shock, cardiogenic shock, and vasodilatory shock including septic shock and severe sepsis.

DEFINITION

- *Noninvasive monitoring* refers to that which does not require intra-arterial, intravenous or trans-coelomic/visceral insertion. Noninvasive monitoring includes focused transthoracic echocardiography.
- *Invasive monitoring* refers to that which requires intra-arterial, intravenous or trans-coelomic/visceral insertion. Invasive monitoring includes arterial, central venous and pulmonary artery catheters and transesophageal echocardiography. Because of their nature, invasive monitors can be expected to have greater complications—including infectious—than do noninvasive monitors. Thus, standards regarding the insertion and maintenance care should be more rigorous for invasive than for noninvasive monitors.
- *Hypovolemic/hemorrhagic shock* is organ hypoperfusion resulting from loss of preload that may be due to acute blood loss anemia, or losses from significant diarrhea, bowel obstruction, ileus or high output fistulae.
- *Cardiogenic shock* is organ hypoperfusion resulting from inadequate cardiac performance/contractility that may be due to ischemia or tension pneumothorax.
- *Vasodilatory shock* is organ hypoperfusion resulting from inadequate vasomotor tone that may be due to liver failure, medications with vasodilatory properties (e.g. general anesthesia), anaphylaxis, neurogenic shock, septic shock or severe sepsis.
 - o *Severe sepsis*: is the septic inflammatory response syndrome (with perturbations in temperature, pulse rate, respiratory rate and/or white blood cell count) + a documented source of infection + hypoperfusion, hypotension and/or organ dysfunction.
 - o *Septic shock*: is severe sepsis requiring the administration of pressors to maintain normotension (MAP $\geq$ 65 mm Hg).

POLICY

This policy governs the following:

- Who is authorized to insert/apply monitoring devices.
- What monitoring devices are covered.

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- Why the monitors are inserted in various shock states.
- Where the monitors are inserted.
- How the monitors are inserted and maintained, and
- When the monitors are discontinued.

EQUIPMENT

- Arterial catheter—radial or femoral percutaneous insertion or other sites via cutdown, with or without pulse contour analysis (FloTrac)
- Central venous catheter—internal jugular, subclavian or femoral venous location
- Pulmonary artery catheter—through cordis in site as above
- Transesophageal echocardiography
- Transthoracic echocardiography

PROCEDURE

- **WHO:** Credentialed providers are authorized to insert monitoring devices. Alternatively, trainees or non-credentialed advance care practitioners (PAs, NPs) may insert these devices under the direct supervision of a credentialed provider. In the latter circumstance, the credentialed provider must be “shoulder to shoulder” with the learner and immediately available to take over the procedure, if indicated. Credentialed providers are authorized to perform echocardiography. Appropriately trained intensivists and their trainees may perform limited focused bedside transthoracic echocardiography. The intent of this limited examination is to assess volume status/fluid responsiveness and cardiac performance. More in depth assessments should be performed by trained specialists.
- **WHAT:** The policy regarding invasive devices pertains to arterial, venous, and pulmonary arterial catheters and transesophageal echocardiography.
- **WHY:** Monitors are applied or inserted in patients with shock or potential shock states to afford “access” for administration of volume or hypertonic fluids, to record measures of hemodynamic status (arterial, venous or capillary wedge pressures, oxygenation status, and cardiac function (cardiac output, ejection fraction, stroke volume, systemic and pulmonary vascular resistance) and to direct therapy to correct abnormal values. Hemodynamic measures will be obtained by nursing staff as directed in physician orders. Interventions and their effects on hemodynamic status will be recorded in the medical record. Arterial catheters will be placed in all patients requiring the initiation and continued use of a pressor. It may be possible to discontinue these catheters in patients on stable or decreasing doses of vasoactive agents. Central catheters will be placed in all patients in whom hypertonic fluid is administered (alternatively, a PICC may be sufficient) or in those in whom routine or continuous central venous pressure or oxygenation readings are required. Continued need for central venous access should be assessed frequently. If sufficient data to address clinical questions and guide therapy can be acquired by use of noninvasive means, this may be the preferred modality due to lower infectious and mechanical complications compared to the use of invasive monitors. Further, the use of pulse contour analysis (FloTrac) and central venous oximetry with or without focused transthoracic echocardiography may provide sufficient data to address clinical questions and guide therapy compared to use of a pulmonary artery catheter. The latter has not been shown to improve outcome in patients in shock in multiple randomized, clinical trials and may provide erroneous readings in patients with severe ARDS, abdominal hypertension and tricuspid insufficiency. There may be instances in which the use of a pulmonary artery

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catheter is beneficial due to unobtainable or inaccurate data gleaned from other modalities {e.g. in patients in whom transthoracic echocardiography is not possible due to body habitus or the presence of subcutaneous emphysema or in whom FloTrac readings are unreliable (cardiac rhythm other than sinus)}.

- **WHERE:** All invasive devices will be inserted bedside in the ICU. Those inserted in an emergent or “code” situation where routine precautions as described below have not been followed will be considered contaminated and will be replaced as soon as it is safe to do so. The subclavian vein is the preferred access site for all patients with a normal coagulation profile and renal function. Patients who have undergone multicavitary and/or thoracic surgery may be candidates for alternate site selection. Ultrasound guidance will be used in all instances in which femoral or internal jugular venous catheterization is performed. Ultrasound guidance may also be helpful for arterial catheterization or in distal subclavian (=axillary) vein cannulation.
- **HOW:** All invasive devices (including arterial lines but excluding transesophageal echocardiography) will be placed in a sterile manner after performance of a surgical “timeout,” documenting correct site and patient. Maximum barrier precautions will be utilized to include the use of full-length drapes. The procedure will be documented in the medical record by the nurse and provider. The nurse will be present for performance of the procedure and will notify the provider if a break in sterile technique has occurred and if the patient requires reparation and draping. Site preparation and maintenance will use contemporary, evidence-based methods and may include chlorhexidine washes, patches and antibiotic “locks.” Site and dressing maintenance will follow nursing procedures. Continued need for invasive devices will be assessed frequently, at a minimum on daily rounds. PA catheters will not be maintained for a period greater than five (5) days. Routine guidewire changes (for infection surveillance or time allocation) will not be performed. Guidewire changes may be appropriate for catheters with a short (i.e. <48 hour) dwell time that have mechanical dysfunction.
- **WHEN:** Invasive monitors will be removed when they are no longer needed or when there is a complication or suspicion for a complication (infectious or mechanical) associated with their use.

PERFORMANCE REVIEW

The ICU director along with the multidisciplinary team will meet on a regular basis to identify and address issues through quality assurance and continuous quality improvement activities. The SICU database will track relevant patient data. This information will be reviewed and discussed regularly to identify opportunities for improvement.

DISCLAIMER

These clinical guidelines may not be appropriate for all patients under all circumstances. New information and evidence may become available that renders their content less valid. Practitioners must utilize their clinical judgment to determine what is helpful to them and what is appropriate.

REFERENCE(S)

- Antonelli M, Levy M, Andrews PDJ, Chastre J, et al. Hemodynamic monitoring in shock and implications for management. *Intensive Care Medicine*. 2007; 33: 575-590.

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RELATED POLICIES AND PROCEDURE(S)

- Guidelines for management of severe sepsis and septic shock
- Surgical “timeout” policy and form

Effective/Revision Dates for Policy # <insert policy number>		
Effective:	00/00/0000	<replace with revising committee name>
Revised:	00/00/0000	
	00/00/0000	
	00/00/0000	
Keywords:		