Volume 3, No.1

SAFE PRACTICES in Patient Care

Helping to promote a culture of safety

Thermometers are essential tools for the delivery of patient care, and the basic monitoring of patient temperature should be a safe practice. Preventing thermometer contamination and microbial transmission are fundamental to proper nursing care. In their article, Ms. Beiningen and Ms. Klinkenborg describe prevention strategies for two of the most common thermometers, electronic and infrared, which are used with multiple patients. Hand hygiene, protective coverings, attention to environmental and touch contamination, and routine disinfection procedures are powerful, effective preventive strategies.

Examination of the bone marrow is the most valuable diagnostic test to evaluate hematologic disorders. Bone marrow aspiration and biopsy are also used to stage lymphoproliferative disorders and for prognostic purposes in chronic lymphoproliferative disorders such as chronic lymphatic leukemia. The value of bone marrow examination continues to grow as advances are made in diagnostic testing and more applications are discovered. The safety and comfort of the procedure have improved with the development of more precise collection equipment. While physicians usually perform the procedure, there is greater reliance on nurse practitioners and nurses. In her article, Ms. Trewhitt describes how this new responsibility is an opportunity for nursing to advocate for patient safety and comfort.

Infection Control in Thermometry

By Gwen M. Beiningen, RN, MS, CIC, and Ronda Klinkenborg, RN, BA, CCRN

As part of the health-status assessment, hospitalized patients have frequent temperature measurements. These measurements are important in the provision of quality healthcare. As with other multiple patient-use devices, the potential for contamination of thermometers and microbial transmission generates concern.

Bacteriologic studies of infrared and electronic thermometers have found evidence of contamination on the devices and their handles, cases, and probe covers. This contamination has been implicated in microbial transmission and disease outbreaks.[1-10] These inherent risks are comparable to those of other multiple patient-use devices.

Touch contamination and inadequate disinfection are reported as likely causes of device contamination and possible transmission.[1-10] In addition, the thermometer may be an important vector of microbes, as it can potentially introduce organisms directly into the patient's gastrointestinal tract.[1] Understanding these risks provides insight into prevention.

> Preventing the touching and environmental contamination of probes and probe disinfection are the most basic and fundamental steps in preventing microbial spread.

Types of thermometers

There is a variety of clinical thermometers. Some require contact with mucous membranes, such as the mouth, rectal cavity, or ear canal, while others require skin contact. In intensive care units (ICUs), probes within blood lines are used for more invasive measurements.

The oldest type is the glass-bulb thermometer. Mercury-containing glass-bulb thermometers are being phased out of healthcare use. Disposable dot-matrix (phase-change) thermometers are made of either a thin flexible plastic strip or adhesive strip or patch. These products are available for oral, rectal (with a protective sheath), temporal, or axillary measurements. This article will not discuss glass-bulb and dot-matrix thermometers.

Electronic and infrared thermometers allow for faster, more convenient temperature measurement. Predictive electronic thermometers commonly contain a sensor, i.e., thermoresistor or thermistor. These sensors alter resistance with temperature changes. A computer or other circuit measures the resistance and converts it to a temperature reading. Several models on the market are designed for oral or axillary use. Others have a specifically designated rectal probe.

Infrared thermometers detect heat on the skin surface. They do not emit anything but sense natural thermal radiation emitted

Continued on page 5

Supported by an educational grant from Kendall, a business unit of Tyco Healthcare Group LP

Bone marrow aspiration and biopsy: *Doing it right to improve patient safety*

by Kathryn G. Trewhitt, CRNP, MS, AOCNP

Bone marrow aspiration and biopsy are important diagnostic procedures, performed with the goals of detection, confirmation, and staging of many hematopoietic and some non-hematopoietic diseases. In the oncology setting, specially trained nurse practitioners now commonly perform bone marrow aspiration and biopsy, once the sole domain of physicians. In some states, registered nurses can be certified to perform the procedure. Nurses assist with patient assessment before and after the procedure. Patients depend on them for moral support as well. The procedure is generally characterized as safe and low risk; however, rare complications can be serious. This article will emphasize issues pertinent to patient safety. Greater understanding of indications, potential hazards, and careful technique promote patient safety and comfort while ensuring optimum specimen procurement.

Indications

Bone marrow aspiration and biopsy may be requested for many reasons; table 1 lists the most common. Aspiration and biopsy aid diagnostic evaluation of patients with abnormal blood counts or cells atypical on peripheral smear, including pancytopenia, leukopenia, leukocytosis, thrombocytopenia, thrombocytosis, or unexplained anemia. Classification of anemia can often be determined by laboratory assays performed on peripheral blood, as in iron deficiency anemia. However, diagnosis of hypoproliferative anemias characterized by normal iron studies may require bone marrow evaluation to differentiate etiology.[1]

Whether or not bone marrow examination is necessary for the staging of malignant disease depends on an understanding of the natural history of the disease and the impact that detection of bone marrow infiltration will have on treatment decision. Clear indications include staging in Hodgkin's disease, non-Hodgkin's lymphoma, neuroblastoma, Ewing's sarcoma, primitive neuroectodermal tumor, and rhabdomyosarcoma. Though some nonhematologic tumors, such as breast cancer and small-cell carcinoma of the lung, may metastasize to the bone marrow, the bone marrow is seldom the sole site, and detection of marrow infiltration has not been found to alter the treatment of patients with extensive disease.[2]

Table 1. **Indications for bone marrow examination**

- Atypical cells in peripheral blood
- Pancytopenia, thrombocytopenia, unexplained anemia
- Hepatosplenomegaly
- Diagnosis and staging of lymphomas and leukemias
- Monitoring for residual disease during treatment for lymphomas and leukemias
- Staging small-cell tumors of childhood (e.g., neuroblastoma)
- Lipid storage disease (e.g., Gaucher disease)
- Microbiologic culture for fever of unknown origin
- Chromosomal abnormality
- Chromosomal analysis after stem-cell transplant
- Evaluating marrow damage from radiation, drugs, chemicals

Search for infectious etiology, such as opportunistic mycobacterial or fungal infections in an immunocompromised patient with fever of unknown origin, is another indication for bone marrow biopsy. The procedure is also helpful for diagnosis when a granulomatous disease such as sarcoidosis is suspected.

Bone marrow examination has applications for surveillance in patients undergoing intensive treatment with chemotherapy and stem cell transplant. In acute myeloid leukemia, bone marrow aspiration is performed before treatment and at regular intervals to evaluate for remission and residual disease.[3] After allogeneic peripheral blood stem cells transplant, chimeric studies on aspirate can detect degree of donor cell engraftment, or the percentage of donor or host cells.

There may be a question when aspirate and/or biopsy are required. For complete hematological evaluation, both bone marrow aspiration and biopsy should be performed. The aspirate is helpful for analysis of differential cell counts and cell morphology. Flow cytometry, cytogenetics, and molecular studies can also be performed on aspirate. The aspirate alone may be all that is required in the followup for residual disease, as in an acute leukemia patient. However, most clinical scenarios require inspection of core biopsy to determine overall cellularity and patterns of infiltration by various malignant and storage diseases. Also, in cases of a dry tap, or the failure to obtain aspirate fluid or adequate bone spicules, touch imprints must be prepared from the biopsy for morphologic evaluation. Examples of cases when a dry tap may occur include a chronic myelogenous leukemia patient with fibrotic marrow, a patient with aplastic anemia, or a patient with hairy cell leukemia whose marrow is packed with leukemic cells. The biopsy is most critical for diagnosis in lymphoma and other lymphoproliferative diseases. In a study of bone marrow examination in Hodgkin's disease, out of 21 cases with positive biopsies only 5 showed positive aspirates.[4]

Bilateral biopsies were once routine, when staging lymphoma, in order to improve the rate of detection. Recent studies show that one larger specimen, about 2–3 cm obtained with an 8-gauge needle, yields more tissue with higher detection rates.[5] A specimen should be at least 1.6 cm to allow for shrinkage during processing.

Contraindications and complications

There are few contraindications for bone marrow aspiration and biopsy. Hemorrhage is the most common, though rare, complication. Most reported bleeding complications have occurred in patients with multiple risk factors. With thorough patient assessment, careful technique, and prophylactic platelet or coagulation factor replacement in some cases, the procedure is safe and well tolerated. Patients with bleeding disorders, such as hemophiliacs with deficiencies in Factor VIII or IX, would require replacement of these coagulation factors and longer post-procedure observation. Thrombocytopenia is not a contraindication; however, platelet infusion is advisable for patients whose platelet counts are less than 15,000. Tissue trauma, associated with a difficult procedure in an obese patient, along with severe thrombocytopenia, increase the risk for hemorrhage.[6] In a morbidly obese patient, it is preferable to perform a biopsy from the posterior superior iliac crest under CT guidance rather than to choose the anterior iliac crest.[7] There is a greater chance for retroperitoneal hemorrhage with the anterior approach. This poses a greater hazard, since detection of retroperitoneal bleeding is delayed when compared with hemorrhage into the buttock or thigh. Patients with bone resorption disorders, such as osteoporosis and multiple myeloma, are also at increased risk for retroperitoneal hemorrhage.

Complications have occurred in patients on anticoagulation therapy. A survey of hematologists from Australia and New Zealand

suggests there is no standard approach to performance of bone marrow biopsy on patients on anticoagulation therapy.[8] Heparin and warfarin should be withheld until activated partial thromboplastin time (PTT) and prothrombin time (PT) are within normal range. Low-molecular-weight heparin (LMWH) is often prescribed today, and its anticoagulation effects are not reflected in the PT and PTT. LMWH should not be taken sooner than 24 hours prior to the procedure to minimize risk of bleeding. Aspirin and nonsteroidal medications should also be avoided prior to biopsy.

Local infection and radiation of a proposed sample site are contraindications. In patients with neutropenia or diffuse skin disease, such as cutaneous T-cell lymphoma, prophylactic antibiotics may be considered. Fibrotic marrow may result from radiation, and an alternative site should be chosen for a more suitable specimen.

The total thickness of the sternum is about one centimeter, and biopsy is never attempted at the sternal site. Only when the posterior and anterior iliac crests have disease or are not accessible due to morbid obesity is the sternum considered for aspiration. There is risk for penetration of the mediastinum, cardiac tamponade, pneumothorax, and pulmonary emboli. Sternal aspiration should be performed by a physician. It is absolutely contraindicated in patients with bone resorption disorders or lytic bone disease of the sternum or ribs.

Bone marrow architecture

Bone marrow is the principle site of blood formation. Myeloid, erythroid, and megakaryocytic lineages make up the hematopoietic cell compartment. The stromal component supports proliferation of the hematopoietic or totipotent stem cells. At birth, hematopoietic tissue is contained in all bones. With age, the ratio of adipose tissue in the marrow increases. By adulthood, hematopoietic-rich marrow is about 50 percent prevalent and is found primarily in the bones of the axial skeleton, including the sternum, ribs, vertebrae, clavicles, scapulae, skull, pelvis, and proximal ends of the humeri and femurs. Extramedullary hematopoiesis may be present when the body is under extraordinary stress, as in severe hemolytic anemia. Hematopoietic cellularity is generally thought to be uniformly distributed in all areas of production, so sampling from a single site is felt to be representative.

Figure 1. SNARECOIL™ Needle (Tyco Healthcare Kendall)

Sample sites

In both adults and children older than 18 months, the posterior superior iliac crest is most often chosen for bone marrow aspiration and biopsy. Patient safety and comfort, as well as ease of collection, make this the preferred site. When the posterior superior iliac crest is not accessible, the anterior iliac crest is the second choice. Patients with mobility limitations, obesity, radiation, or infection to the area of the posterior site may require the anterior approach. Identification of the landmarks can be difficult in the morbidly obese patient. CT guidance may be necessary to avoid increased manipulation and to reduce the risk for bleeding. In rare cases, the sternum is chosen for aspiration alone. In children younger than 18 months, the anterior tibia may be used for aspiration only.

The sequence of bone marrow aspiration or biopsy has been debated. If the aspirate is obtained first, sinusoidal blood can adversely affect the core specimen by causing an artifactual hypocellularity. If the biopsy is obtained first, the tissue trauma causes a cascade of thromboplastic substances to be released, affecting the quality of the aspirate. Thus it is important to obtain the aspirate and the biopsy from slightly different sites, whatever the order. For patient comfort, the aspirate is usually obtained first.[5]

Biopsy equipment

Engineering advances in aspiration and biopsy needles have improved the quality of specimens and eased the collection process for both the practitioner and the patient. Newer needles are variations of the Illinois aspiration and Jamshidi needles, in use since the 1970s. The Illinois aspiration needle is either 15-, 16-, or18-gauge, with a removable stylet so that it is adjustable from about 3/8 of an inch to 2 inches. The depth guard must be in place for a sternal aspiration so that it cannot penetrate beyond the sternum. The Jamshidi needle has a removable stylet and can be used for aspiration as well as biopsy. It is available in three gauges (8, 11, 13) and is 3.5–4 inches in length. One disadvantage to obtaining an aspirate with a Jamshidi needle is that the specimen may clot. Also, more force is required for the larger needle to penetrate the bone. Reports of needle breakage are rare with sharp, disposable equipment.

Recent improvements include ergonomic handle design and internal core capturing devices to ensure retrieval of quality specimens. The SNARECOIL™ needle by Tyco Healthcare Kendall and Core-Lock™ device by World Wide Medical Technologies are examples (figure 1). The core retrieval devices in these needles allow deeper penetration of the needle, because it is not necessary to maneuver the needle to free the specimen. This is less uncomfortable for the patient and the result is a longer, nonfragmented specimen. Pathologists report superior specimens with fewer artifacts. Newer needles are being designed with guards to prevent accidental needlesticks during withdrawal from the patient and when the specimen is being handled.

Patient assessment and informed consent

Patient assessment and preparation are essential to performance of successful bone marrow evaluation and prevention of complications. Besides patient identification information, the practitioner should know primary diagnosis, clinical indications for procedure, and history of recent treatment with chemotherapy, radiation, bone marrow transplant, blood transfusion, or surgery to pelvic bone or sternum. Secondary diagnoses (such as bleeding disorder, cardiac or pulmonary disease) are important to know. It is essential to be informed of the patient's allergies, especially to iodine and Lidocaine; and about the patient's medications, including aspirin, warfarin, heparin, antibiotics, growth factors, and mineral supplements. It is important to know about medical conditions that may interfere with informed consent or cooperation, such as language barrier, anxiety, pain intolerance, or obesity. The practitioner should verify pertinent laboratory data, such as recent complete blood count (CBC) with differential, and coagulation and iron studies. For comparison, peripheral blood for CBC with differential should also be obtained on the same day as bone marrow collection.

While obtaining the patient history, the practitioner has an opportunity to discuss the procedure and to answer any questions the patient may have. Full disclosure of the potential risks for bleeding, infection, and pain, and the interventions to reduce those risks, must be made.

Managing procedural pain

Successful performance of bone marrow aspiration and biopsy implies good pain control as well as procurement of adequate specimen. Patients are likely to require repeated procedures at different points in their disease treatment. A comfortable experience helps to prevent anticipatory anxiety about future invasive procedures. Local anesthesia with Lidocaine, administered to the level of the periosteum, is usually effective for pain control. Sodium bicarbonate mixed with the Lidocaine reduces the initial sting of the Lidocaine; however, patients do need to be forewarned of transient pain, not masked by

Lidocaine, at the moment of aspiration. Some adult patients with high anxiety or low pain threshold may benefit from premedication with orally administered analgesics and benzodiazepines, in addition to local anesthesia. Besides giving explanations during the procedure, practitioners can facilitate relaxation techniques (such as controlled breathing, progressive muscle relaxation, distraction, and visual imagery) to ease patient anxiety.

Conscious sedation is another option for management of pain and anxiety, and it is used more routinely in pediatric patients. With conscious sedation, defined as a state of sedation and analgesia, there is the risk of progressing into a state of deep sedation, with the loss of protective reflexes. Anesthesia personnel, monitoring, and resuscitation equipment are required when conscious sedation is administered. Patients must recover in a post-anesthesia setting and be accompanied by an adult. These factors increase cost and affect patient convenience. Despite these limitations, conscious sedation should be considered in patients who are highly anxious or in whom the procedure may be more technically difficult. Regarding patient safety, it is important to note that a retrospective study has found that there was no increase in morbidity or mortality in patients who received deep sedation for bone marrow biopsy and aspiration in a monitored outpatient setting.[9]

Peforming aspiration/biopsy

Equipment needed for the procedure is listed in table 2. Except for bone marrow needles, sterile gloves, special tubes, and preservatives, most supplies are available in packaged sterile kits. Most prepared kits include povidone-iodine for skin disinfection. According to the 2002 Centers for Disease Control and Prevention guidelines,[10] a 2-percent solution of chlorhexidine gluconate is superior to povidone-iodine in the prevention of intravascular catheter-related infections. Aseptic preparation of the skin with chlorhexidine, when available, is recommended before the procedure.

Table 3 outlines the correct procedure for obtaining a bone marrow sample. In an obese patient, certain modifications in the procedure may help to avoid the need for CT scan assistance and may help to decrease pain and complications.[11] These include placing the patient in a flat, prone position rather than side-lying, to minimize gluteal tissue over the site for easier location of landmarks. The practitioner can use a spinal needle for local anesthesia and location of iliac crest, leaving the needle in situ until ready to insert the biopsy needle. This helps to maintain the correct angle and ensures needle insertion into the anesthetized area if tissue shifts. An oral benzodiazepine may also help to relax tense muscle. Throughout the procedure, the practitioner should maintain pressure on the gluteal tissue when anchoring the needle in order to shorten distance to the bone.

In a hospital or clinic, a hematology technician is usually present at the bedside to prepare the aspirate smears. When no technician is available, the aspirate must be quickly placed into a tube containing EDTA anticoagulant and dispatched to a laboratory for preparation.

Table 2. **Equipment for sampling bone marrow**

- sterile gloves
- sterile drape
- Illinois bone marrow aspiration needle and/or Jamshidi biopsy needle (8-,11- or 13-gauge)
- obturator
- 25-gauge 5/8-inch and 22-gauge 1.5-inch needles
- number-11 scalpel blade
- 10-cc Luer slip tip syringes (3)
- Lidocaine 1%
- sodium bicarbonate (1 meq/mL)
- chlorhexadine gluconate 2% or povidone-iodine
- 4-inch x 4-inch gauze sponges
- pressure dressing and tape

Optional

- heparinized 10-cc syringe (preservative-free 1000 U/mL) for special studies
- 3.5-inch or 5-inch spinal needle
- specimen bottle with formalin
- tube with EDTA anticoagulant

Table 3. **Procedure for sampling bone marrow at the posterior superior iliac crest**

1. Obtain informed consent for bone marrow aspiration and/or biopsy.
2. Assist patient into prone position. Have patient assume lateral decubitus position, with knees flexed, if unable to maintain prone position.
3. Palpate the iliac crest and follow it to locate posterior superior spine. The usual site is about 2 finger-widths below the iliac crest and 3 finger-widths from the midline. Mark site with pen.
4. With sterile technique, cleanse the surrounding skin with chlorhexidine gluconate 2% solution (if unavailable, use povidone-iodine). Apply sterile fenestrated drape to area. After solution is dry, swipe the center area with alcohol swab.
5. Draw up 8 mL of 1% Lidocaine and 2 mL of sodium bicarbonate solution into a 10-cc syringe. Change to a 25-gauge needle and inject a small amount of buffered Lidocaine intradermally. Then change to 22-gauge 1.5-inch needle, and inject deeper into tissue in circular formation. At the same time, locate, tap, and inject into the iliac crest to anesthetize the periosteum. A spinal needle may be needed in an obese patient to penetrate to the depth of the periosteum. Wait at least 2 minutes for the Lidocaine to take effect.
6. Check operation of the bone-marrow needle. Loosen and relock the stylet of the Jamshidi needle with the cap secured.
7. With a surgical blade, make a small incision.
8. Introduce the needle into the incision. Hold the capped end firmly with the palm of the hand, and anchor the shaft between the middle and index fingers of the other hand. Advance the needle with steady pressure and a slight rotating motion into the soft tissue of the periosteum. Ask the patient if the anesthesia is adequate—the sensation should be pressure, not pain. Inject additional Lidocaine if needed. Then continue to advance the needle into the cortical bone, about 1 mm to the marrow. Gently maneuver about 1–2 mm further.
9. Unlock the cap and remove the stylet. Attach an empty 10-cc syringe to the needle. As you prepare to aspirate the marrow, instruct the patient to take a deep breath to minimize the painful pulling sensation. Quickly aspirate 0.5–1 cc of aspirate, and hand syringe to technician. If no fluid is obtained, advance the needle about 1–2 mm further. A good specimen will have visible bone spicules. If no aspirate is obtained after multiple attempts, proceed to biopsy and later try another site for aspiration. A dry tap is usually due to poor positioning.
10. When special studies are ordered, draw up additional aspirate into heparinized syringes. Advise patient that he may feel momentary pain before each pull.
11. To obtain the core biopsy, replace the stylet and cap. Pull back the needle to the level of the periosteum. Then, redirect the needle and advance it toward the anterior iliac spine, just into the cortex. Remove the stylet and replace the cap. Continue to maneuver the needle about 1–2 cm into the marrow. Remove the cap and gently reinsert the stylet, until resistance is met, to determine the length of the biopsy specimen (ideally 1.5–2 cm). Then replace the cap.
12. To free the specimen from the surrounding bone, twist the needle 360 degrees clockwise and counterclockwise about 3 times. Then rock and rotate the needle. (If using a newer needle with core retrieval device, follow directions to free the core, and do not rock and rotate the needle.) The needle may be pulled back about 2 mm, then redirected at a slightly different angle to cut the specimen. Then slowly, with a rotating motion, withdraw the needle through the skin.
13. With a blunt obturator inserted into the distal end of the needle, push the core through the hub directly onto the technician's slide or into a specimen cup.
14. Apply gauze to entry site and apply pressure for 3–5 minutes. If povidone-iodine was used for skin preparation, remove it from site with alcohol. Apply pressure dressing. Instruct patient to remain supine with pressure to site for about 30 minutes.
15. Tell patient that dressing should be kept dry and in place for 24 hours. Patient should avoid soaking in a bath or swimming for one week. Provide directions for observation of the site and reporting of signs and symptoms (pain at the site, or femoral or lumbosacral neuropathy, fever, extension of erythema, swelling or drainage).
16. Verify labeling and disposition of the specimens. Complete procedure note.

Implications for nursing

The value of bone marrow examination continues to grow as advances are made in diagnostic testing and more applications are discovered. The safety and comfort of the procedure have improved with the development of more precise collection equipment.

There is greater reliance on nurse practitioners and nurses for both performance of bone marrow procedures and supportive care of patients. Nurse practitioners also serve as preceptors for physicians learning the procedure in some institutions. With this growing responsibility is an opportunity for nursing to advocate for patient safety and comfort. Besides careful patient assessment and sampling technique, provision of effective pain management has been proven to reduce com-

plications. With development of expertise in bone marrow collection, nurse practitioners and nurses help patients to face future procedures with less anxiety.

References

1. Hillman RS, Ault KA, editors. Hematology in clinical practice: a guide to diagnosis and management. 2nd ed. New York: McGraw-Hill, Health Professions Division; 1998.
2. Ozkalemkas F, Ali R, Ozkocaman V, Ozcelik T, Ozan U, Ozturk H, Kurt E, Evrensel T, Yerci O, Tunali A. The bone marrow aspirate and biopsy in the diagnosis of unsuspected nonhematologic malignancy: a clinical study of 19 cases. BMC Cancer. 2005;5:144.
3. Ryan DH, Cohen H J. Bone marrow aspiration and morphology. In: Hoffman R, Benz EJ, Shattil SJ, Furie B, Cohen HJ, Silberstein LE, McGlave P, editors. Hematology: Basic principles and practice. 3rd ed. New York: Churchill Livingstone; 2000. p. 2460-2479.
4. Sharma S, Ahuja A, Murari M. Bone marrow biopsy in Hodgkin's disease. Indian J Pathol Microbiol. 2004;47(3):364-6.
5. Riley RS, Hogan TF, Pavot DR, Forysthe R, Massey D, Smith E, Wright L Jr, Ben-Ezra JM. A pathologist's perspective on bone marrow aspiration and biopsy: I. Performing a bone marrow examination. J Clin Lab Anal. 2004;18(2):70-90.
6. Bain BJ. Bone marrow biopsy morbidity: review of 2003. J Clin Pathol. 2005;58(4):406-8.
7. Devaliaf V, Tudor G. Bone marrow examination in obese patients. Br J Haematol. 2004;125(4):538-9.
8. Eikelboom JW. Bone marrow biopsy in thrombocytopenic or anticoagulated patients. Br J Haematol. 2005;129(4):562-3.
9. Burkle CM, Harrison BA, Koenig LF, Decker PA, Warner DO, Gastineau DA. Morbidity and mortality of deep sedation in outpatient bone marrow biopsy. Am J Hematol. 2004;77(3):250-6.
10. O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG, Masur H, McCormick RD, Mermel LA, Pearson ML, Raad II, Randolph A, Weinstein RA. Guidelines for the prevention of intravascular catheter-related infections. Centers for Disease Control and Prevention. MMWR Recomm Rep. 2002;51(RR-10):1-29.
11. Ghosh K. Bone marrow examination in obese patients: CAT or not to CAT! Br J Haematol. 2004;127(2):230-1; author reply 231.

Kathryn G. Trewhitt, RN, MS, CRNP, AOCNP holds a Master of Science degree from the University of Maryland, Baltimore, where she also earned her BSc in Nursing. She is an acute-care nurse practitioner and clinical nurse specialist who specializes in oncology. Ms. Trewhitt currently practices at the National Cancer Institute's Experimental Transplant Unit and Outpatient Clinic, which is part of the Medical Oncology Clinical Research Unit in Bethesda, Maryland.

Infection Control in Thermometry—Continued from page 1

from the skin. Infrared technology is used in tympanic and temporal artery thermometers. When inserted into the ear canal, a tympanic thermometer senses and digitally displays the temperature of the region that lies within the probe's field of view. Temporal artery thermometers measure the temperature of skin that lies over this specific artery. It is also possible to scan the femoral artery, lateral thoracic artery, or axilla to obtain a temperature reading with temporal artery thermometry.

Contamination

Sources or vectors of patient-to-patient microbial transmission include a myriad of healthcare devices. Thermometry-specific reports emphasize the role of rectal thermometers and their colonization with gastrointestinal microbes. This colonization has been associated with microbial transmission to other patients via contaminated thermometers. Although gastrointestinal colonization is a concern, other microbes from patients, workers, and the healthcare environment may be implicated in device contamination.[1-10]

Regardless of the type of microbe, preventive measures remain the same. Actions to prevent thermometer contamination and the spread of gastrointestinal microbes will also prevent the spread of other organisms and reduce the risk of colonization.

The potential for contamination on surfaces and medical devices, such as thermometers, is impacted by various factors:

- number of people in the surroundings
- number of people who touch the device
- degree of microbial activity
- moisture levels
- presence of material on a surface that supports microbial growth
- removal of suspended microbes from the air
- type of surface and orientation, e.g., horizontal or vertical

Infrared and electronic thermometers are handled in a manner that places them at risk for contamination, based on these potentials.

Touch contamination

High-touch surfaces provide repeated opportunities for hand contamination and microbial transmission.[11] Many environmental surfaces that were found to be contaminated with vancomycin-resistant enterococci (VRE) in outbreak investigations had been touched frequently by the patient or healthcare worker.[12] Examples of high-touch surfaces are bedrails, doorknobs, bed linens, gowns, over-bed tables, blood pressure cuffs, computer tables, bedside tables, and various medical devices, including thermometers.[13,14]

The potential for contamination increases when VRE-infected patients have diarrhea or multiple body-site colonization.[14,15] Other important factors for the dispersion of pathogens to environmental surfaces are the misuse of gloves and inadequate patient, family, or visitor hygiene.

Environmental contamination

The "5-second rule" does not apply in healthcare. Simply touching a contaminated surface presents an opportunity for microbial spread. Any item that contacts a thermometer may cause contamination. A contaminated thermometer becomes a vector of infection for the next patient who uses the device. Healthcare workers should be cautious about potential environmental sources of contamination, e.g., the placement of infrared and electronic thermometers in bed with patients, storing used and unused probes together in transport caddies, and storing devices in contaminated areas.

Figure 1. FASTEMP™ isolation chamber (Tyco Healthcare Kendall)

Patient isolation and other precautions

Patient isolation and other precautions are intended to stop the transmission of specific microbes of concern. A variety of infection-control strategies is used to minimize the risk of microbial transmission. Some important preventive strategies include hand hygiene, protective personal equipment, patient placement, and the limitation of patient transport and activities outside the isolation room. Patient-care devices need special handling before re-use.

A protective barrier prevents contact between isolated patients to prevent microbial transmission.[16] Infrared and electronic thermometers can use protective barriers to prevent the contamination of patients in isolation. If possible, each patient should have a dedicated thermometer for individual use. Otherwise, the device should be cleaned and disinfected before use by the next patient.

Probe covers or sheaths

Preventing the touching and environmental contamination of probes and probe disinfection are the most basic and fundamental steps in preventing microbial spread. Probe covers or sheaths provide a barrier between the temperature-sensing probe and patient. This barrier can be useful in minimizing contact with microbes that may reside on the probe surface. In addition, a probe cover may provide a secondary level of protection for the probe tip. Protective sheaths are especially useful in these situations:

- for surfaces often touched by gloved hands during patient care
- when the likelihood of contamination with body substances is high
- when the device is difficult to clean

Plastic or fluid-resistant covers are suitable material for barrier protection.[11] However, just as disposable gloves minimize but do not eliminate hand contamination, disposable probe covers minimize but do not eliminate thermometer contamination. In theory, probe covers prevent cross contamination between patients, given that all other infection prevention strategies are in place and well practiced. When handled inappropriately, the probe cover and thermometer are

subject to hand contamination and present as a possible source of microbial transmission.[17] For example, when a worker with unwashed hands places a cover on the probe, it becomes contaminated by touch. Workers who use disposable covers must be aware of this possibility and be alert to avoid a false sense of security.

Isolation chambers for electronic thermometers are available to assist in preventing probe contamination (figure 1). These products have separate cartridges or chambers for oral and rectal probes. The route of probe administration determines which chamber is placed on the thermometer. The user cannot accidentally place the oral probe into the rectal chamber and vice versa. Aside from this advantage, the risks of hand and environmental contamination are comparable.

Special populations

Immunocompromised patients are a special concern. Their health status places them at higher risk of acquiring infection. These individuals generally have greater risk of bacterial, fungal, parasitic, and viral infections from endogenous and exogenous sources. Standard precautions and transmission-based precautions should be followed. When meticulously employed, these preventive strategies should reduce the risk of infection from other patients and environments.[16]

Diapered pediatric patients and incontinent patients more heavily colonize their environment. The Centers for Disease Control (CDC) recommends the use of contact precautions to manage incontinent or diapered patients with acute diarrhea of a likely infectious etiology. Close physical contact between workers and infants and young children—e.g., holding, feeding, playing, diapering, and maintaining the hygiene of respiratory secretions — provides many opportunities for transmission of infectious agents, further emphasizing the need for meticulous handling of multiple patient-use devices such as infrared and electronic thermometers.[16]

Infection prevention strategies

Published guidelines and recommendations focus on general medical equipment; therefore, suggested preventive strategies are based on the guidelines that apply to thermometers.

Hand hygiene

The importance of hand hygiene cannot be understated. Focusing on temperature measurement, the HICPAC 2002 guidelines for hand hygiene in health-care settings suggest that healthcare workers' hands should be decontaminated at the following times:[11]

- before direct contact with patients
- after contact with a patient's intact skin
- after contact with body fluids or excretions, mucous membranes, and non-intact skin
- if moving from a contaminated-body site to a clean-body site during patient care
- after contact with inanimate objects, including medical equipment in the patient's immediate vicinity
- after removing gloves

Hand hygiene should be completed after each temperature reading. Gloves should be worn if contact with mucous membranes and body substances is anticipated.[14]

Cleaning and disinfection

Medical devices should be cleaned routinely based on the potential for contamination, such as direct patient contact, degree and frequency of hand contact, and potential surface contamination.[11] The definition of "routine" disinfection is determined by individual facilities, based on the potential for contamination. In addition, devices should be disinfected when soiled and after use in the isolation room.

For infrared and electronic thermometers, two components are considered for disinfection. The thermometer apparatus and probe are considered as separate units that require disinfection. Probes that contact mucous membranes require a higher level of disinfection than thermometers that contact intact skin only.

Chemical disinfection

Follow the thermometer and disinfectant manufacturers' instructions for cleaning and maintaining these devices. Thermometer manufacturers should provide disinfection instructions specific to their equipment. These instructions should include:

- compatibility with disinfectants
- ability to be wet or immersed
- specific decontamination for servicing

Medical equipment for which manufacturers' cleaning instructions are not available should be disinfected with a detergent or disinfectant with an EPA-registered chemical.

Alcohol is recommended for the disinfection of some thermometers. Avoid the use of alcohol to disinfect large environmental surfaces. Both 60–90% ethyl alcohol and isopropyl alcohol are used to disinfect small surfaces, such as rubber stoppers of medication vials, and the external surfaces of small medical equipment such as stethoscopes.

Alcohol evaporates rapidly. Meeting the recommended contact time for minimum disinfection needs is difficult to achieve, limiting the usefulness of alcohol on large surfaces. In addition, alcohol can damage some surfaces (e.g., discoloring, swelling, hardening, and cracking rubber or plastics) with prolonged contact. Because alcohol can be a coolant and may lower temperature readings, follow the manufacturer's instructions about wait times between alcohol disinfection and subsequent thermometer use.

If the device is contaminated with blood or other body substances, it should be cleaned with an EPA-registered hospital disinfectant, labeled as tuberculocidal or with kill claims for HIV and hepatitis B virus. When using sodium hypochlorite (bleach), an EPA-registered product is preferred over household chlorine bleach.

Probes without protective covers have specific disinfection needs. Probes that contact intact skin should be disinfected between uses, according to the manufacturer's instructions and the above guidelines. Probes without covers that contact the oral or rectal cavity, i.e., mucous membranes, should be discarded if disposable or receive high-level disinfection or sterilization after use, according to the manufacturer's recommendations. Guidance for high-level disinfection and sterilization is provided by the CDC and other national organizations.[11,18]

Occasionally, the manufacturer's instructions for disinfection may limit the options of appropriate disinfectants and the design complexity of a device may impede the cleaning process. Manufacturers are becoming more aware of the need to offer appropriate disinfectant options and to market devices that are easily cleaned and disinfected. When making purchasing decisions for infrared and electronic thermometers, the evaluation criteria should include the provision that the product can be appropriately disinfected with nationally recommended chemical products.

Prevention of environmental contamination

Healthcare workers should be aware of where the thermometer is placed and avoid surfaces that may be contaminated. Surfaces should be clean, and only cleaned items should be located in the immediate vicinity. Avoid placing the thermometer in the bed or on other surfaces during the delivery of patient care. Specific caddies should be designated for transporting or storing thermometers. Store thermometers and supplies in a designated clean storage area away from used or contaminated items.

Use of probe covers and alternatives

Use protective probe covers according to the manufacturer's instructions. These covers can help to minimize the contamination of non-critical patient-care devices. After covers are used, remove and discard them immediately. Probe covers are single-use, disposable items that should be discarded according to facility policy. After cover disposal, healthcare workers should remove gloves and perform hand hygiene.[11]

All items that are used in the delivery of patient care should be routinely cleaned with an appropriate disinfectant and according to

the manufacturer's instructions. While the sheath may protect the probe from contamination, other potentials for touch contamination exist above and on the exterior of the sheath.

Use of infrared and electronic thermometers in patient isolation

Whenever possible, dedicate thermometers to a single patient in isolation to avoid sharing between patients. If this precaution is not possible, the thermometer should be cleaned and disinfected prior to use with another patient.[16]

Compliance with infection prevention strategies

The medical literature is filled with reports of inadequate infection-prevention techniques by healthcare staff who handle patient-care equipment, including thermometers. When transmission has been associated with thermometer use, compliance with basic preventive strategies may be poor.[1,2,5-7,10,19]

Methods to improve compliance are behavior-based. Behaviors can be difficult to change. Techniques to improve compliance include the following: [14]

- Provide education about equipment for the delivery of patient care and the potential for hand contamination and cross-transmission of microbes.
- Base infection-prevention strategies on national recommendations.
- Provide facility policies to healthcare workers.
- Reeducate healthcare staff periodically.
- Improve preventive strategies.
- Identify reasons for lapses in infection-prevention strategies. Address barriers and develop resolutions.
- Pursue management support.
- Develop practical methods to meet minimum standards for cleaning, disinfection, and probe-cover use.
- Include workers in decision-making to improve compliance.
- Purchase infrared and electronic devices that promote compliance with infection-prevention strategies.
- Monitor adherence to infection-prevention strategies periodically.
- Observe practices.

Summary

Thermometers are essential tools for the delivery of patient care. The basic monitoring of patient temperature should be a safe practice. Steps to prevent thermometer contamination and microbial transmission should be hard-wired into the healthcare worker's routine. Prevention strategies for electronic and infrared thermometers are fundamental for all medical devices that are used with multiple patients. Hand hygiene, attention to environmental and touch contamination, and routine disinfection procedures are powerful, effective preventive strategies.

References

1. Brooks SE, Veal RO, Kramer M, Dore L, Schupf N, Adachi M. Reduction in the incidence of C diff associated diarrhea in an acute care hospital and a skilled nursing facility following replacement of electronic thermometers with single use disposables. Infect Control Hosp Epidemiol. 1992;13:98-103.
2. V Dijk Y, Bik EM, Hochstenbach-Vernouij S, v d Vlist GJ, et al. Management of an outbreak of Enterobacter cloacae in a neonatal unit using simple preventive measures. J Hosp Infection. 2002;51:21-26.
3. Im SW, Chow K, Chau PY. Rectal thermometer mediated cross infection with Salmonella wandsworth in a paediatric ward. J Hosp Infection. 1981;2:171-4.
4. Jernigan JA, Siegman-Igra Y, Guerrant RC, Farr BM. A randomized crossover study of disposable thermometers for prevention of Clostridium difficile and other nosocomial infections. Infect Control Hosp Epidemiol. 1998;19:494-499.
5. Livornese LL Jr, Dias S, Samel C, Romanowskit B, et al. Hospital-acquired infection with vancomycin-resistant Enterococcus faecium transmitted by electronic thermometers. Ann Intern Med. 1992;117:112-16.
6. Macrae MB, Shannon KP, Rayner DM, Kaiser AM, et al. A simultaneous outbreak on a neonatal unit of two strains of multiply antibiotic resistant Klebsiella pneumoniae controllable only by ward closure. J Hosp Infection. 2001;49:183-92.
7. Manian FA, Meyer L, Jenne J. Clostridium difficile contamination of blood pressure cuffs: a call for closer look at gloving practices in the era of universal precautions. Infect Control Hosp Epidemiol. 1996;17:180-182.
8. McAllister TA, Roud JA, Marshall A, Holland BM, Turner TL. Outbreak of Salmonella eimsbuettel in newborn infants spread by rectal thermometers. Lancet. 1986;1:1262.
9. Porwancher R, Sheth A, Remphrey S, Taylor E, et al. Epidemiological study of hospital acquired infection with vancomycin-resistant Enterococcus faecium: possible transmission by an electronic ear-probe thermometer. Infect Control Hosp Epidemiol. 1997;18;771-773.
10. Van den Berg RWA, Claahsen HL, Niessen M, Muytjens HL, et al. Enterobacter cloacae outbreak in the NICU related to disinfected thermometers. J Hosp Infection. 2000;45:29-34.
11. Centers for Disease Control and Prevention, Healthcare Infection Control Practices Advisory Committee (HICPAC). Guidelines for environmental infection control in healthcare facilities. 2003. Available from: http://www.cdc.gov/ncidod/dhqp/gl_environinfection.html
12. Bonilla HF, Zervos MJ, Kauffman CA. Long-term survival of vancomycin-resistant Enterococcus faecium on a contaminated surface. Infect Control Hosp Epidemiol. 1996;17:770–1.
13. Noskin GA, Stosor V, Cooper J, Peterson L. Recovery of vancomycin-resistant enterococci on fingertips and environmental surfaces. Infect Control Hosp Epidemiol.1995;16:577–81.
14. Boyce JM, Pittet D; Healthcare Infection Control Practices Advisory Committee; HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Guideline for Hand Hygiene in Health-Care Settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. MMWR Recomm Rep. 2002;51(RR-16):1-45.
15. Bonten MJM, Hayden MK, Nathan C, et al. Epidemiology of colonisation of patients and environment with vancomycin-resistant enterococci. Lancet. 1996;348:1615–9.
16. Garner JS. Guideline for isolation precautions in hospitals. The Hospital Infection Control Practices Advisory Committee. Infect Control Hosp Epidemiol. 1996;17(1):53-80. Erratum in: Infect Control Hosp Epidemiol, 1996;17(4):214.
17. Smith L, Prince HN, Johnson E. Bacteriologic studies on electronic hospital thermometers. Infect Control. 1981;2:315-6.
18. Rutala W. APIC Guideline for Selection and Use of Disinfectants. Am J Infect Control. 1996;24:313-42.
19. Blumenthal I. Which thermometer? Lancet. 1991;337:1483.

Gwen Beiningen, *RN, MS, CIC fills three roles—Infection Control Coordinator, Infection Control Nurse, and Employee Health Nurse—at Sioux Valley Hospitals and Health System in Sioux Falls, South Dakota. She earned her BSN and her MS (with a focus in Education) from South Dakota State University. Ms. Beiningen is active in several professional associations, including APIC (Association for Professionals in Infection Control and Epidemiology) for whom she has served as chair of the Annual Conference Committee.*

Ronda Klinkenborg *RN, BA, CCRN has been critical care nurse for over 15 years and is currently Rescue Nurse at Sioux Valley Hospital. She has been active in the development of educational programs for Sioux Valley Hospital, as well as involved in nursing development as Speaker of the Senate (Sioux Valley Nursing Association).*

This continuing education activity was approved by the Vermont State Nurses Association, Inc., an accredited approver by the American Nurses Credentialing Center's Commission on Accreditation (ANCC).

Provider approved by The California Board of Registered Nursing. Provider # CEP 1447

Upon completion of this offering the learner will be able to:

1. Describe indications for bone marrow evaluation.
2. List safety considerations for the patient undergoing bone marrow examination.
3. Describe nursing interventions for pain management during bone marrow examination.
4. Explain the source of microbial contamination associated with thermometry devices.
5. List the prevention strategies to reduce the risk of contamination of thermometry devices.

To earn continuing education credit, do the following:

1. Read both articles.
2. Complete the post test for the article. (You may make copies of the answer form.) Mark your answers clearly with an "X" in the box next to the correct answer.
3. Complete the participant evaluation.
4. Mail or fax the post test and evaluation forms to address below.
5. To earn 1.5 contact hours of continuing education, you must achieve a score of 70% or more. If you do not pass the test you may take it over one more time.
6. Your results will be sent within four weeks after forms are received.
7. The fee has been waived through an educational grant from Kendall, a business unit of Tyco Healthcare Group LP.
8. Answer forms must be postmarked by August 31, 2008.

Please check our website
www.safe-practices.org
for renewal updates.

Mail or fax to:
Saxe Healthcare Communications
PO Box 1282
Burlington, VT 05402
Fax: 802.872.7558

Safe Practices in Patient Care is a serial newsletter distributed free of charge to health professionals. *Safe Practices* is published by Saxe Healthcare Communications and is funded through an education grant from Kendall, a business unit of Tyco Healthcare Group LP. Our goal is to present clinically and evidence-based safe practices to help reduce medical errors. Opinions expressed in *Safe Practices* are those of the authors and not necessarily of the editorial staff of Saxe Healthcare Communications or Kendall. The publisher and Kendall disclaim any responsibility or liability for such material. We welcome opinions and subscription requests from our readers.

Please direct your correspondence to:

Saxe Healthcare Communications
PO Box 1282
Burlington, VT 05402
info@saxecommunications.com
Fax: 802.872.7558

1. **Which of the following variables adversely affect the quality of the bone marrow biopsy specimen:**
   a. fragmented specimen
   b. excess sinusoidal blood
   c. core length of 2 cm
   d. both A and B

2. **Diagnostic indicators important to review before bone marrow collection include**
   a. mineral panel, PT, PTT
   b. PT, PTT, EKG
   c. CBC, PT, PTT
   d. iron studies, CBC, EKG

3. **A potential complication of bone marrow examination is**
   a. fatigue
   b. neuropathy
   c. infection
   d. headache

4. **Failure to obtain bone marrow aspirate may occur in which of the following patients?**
   a. prostate cancer
   b. aplastic anemia
   c. non-Hodgkins lymphoma
   d. acute myelogenous leukemia

5. **Indications for bone marrow evaluation include all of the following except:**
   a. monitor for residual disease in acute myeloid leukemia
   b. atypical cells in peripheral blood
   c. iron deficiency anemia
   d. staging non-Hodgkin's lymphoma

6. **Patient factors that increase the risk for hemorrhage include**
   a. anticoagulation therapy
   b. obesity
   c. osteoporosis
   d. all of the above

7. **Local anesthesia must reach the level of the periosteum.**
   a. True
   b. False

8. **Conscious sedation poses an increased risk to the patient undergoing bone marrow examination in a monitored setting.**
   a. True
   b. False

9. **Potential for contamination on surfaces and medical devices, such as thermometers, is heightened by all of the following, except:**
   a. a high number of people touching the device
   b. a high level of activity
   c. high moisture levels
   d. the absence of material on a surface that supports microbial growth

10. **Environmental surfaces found to be contaminated with VRE:**
    a. were touched frequently by the patient or healthcare worker
    b. do not include bedrails, doorknobs, BP cuffs, and thermometers
    c. were less contaminated when the patient had diarrhea
    d. were less contaminated when the patient had a multiple body-site colonization

11. **Environmental contamination potentials that the worker should be cautious about include all of the following, except:**
    a. placement of infrared and electronic thermometer in bed with the patient
    b. allowing used and unused probes to be stored together in the same transport caddy
    c. storage in contaminated areas
    d. proper cleaning of devices after patient use

12. **Infection control strategies used to minimize the risk of transmission of microbes when patients are isolated or in precautions include:**
    a. improper hand hygiene
    b. special cleaning of patient-care equipment prior to use with the next patient
    c. unlimited patient transport
    d. unlimited activities outside the isolation room

13. **Probe covers and protective sheaths are useful:**
    a. for surfaces often touched by gloved hands during patient care
    b. when the likelihood of contamination with body substances is low
    c. when the device is easy to clean
    d. to eliminate the need for proper cleaning of equipment

14. **Healthcare worker's hands should be decontaminated:**
    a. before and after having direct contact with patient's skin
    b. after contact with body fluids or excretions, mucous membranes and non-intact skin
    c. if moving from a contaminated body site to a clean body site
    d. all of the above

15. **Medical devices should be cleaned routinely based on the potential for contamination, such as:**
    a. direct patient contact
    b. degree and frequency of hand contact
    c. potential surface contamination
    d. all of the above

16. **Methods of improving infection-control strategies include all of the following, except:**
    a. provide education about equipment for the delivery of patient care and the potential for hand contamination and cross-transmission of microbes
    b. recognize that preventive strategies work just as well without management input and support
    c. base infection-prevention strategies on national recommendations
    d. reeducate staff periodically

Participant's Evaluation

What is the highest degree you have earned (circle one) ? 1. Diploma 2. Associate 3. Bachelor's 4. Master's 5. Doctorate

Indicate to what degree did this program meet the objectives: Using 1 = strongly disa gree to 6 = strongly a gree rating scale, please cir cle the number that best r eflects the extent of your agreement to each statement.

	Strongly Disagree					Strongly Agree
1. Describe a Luer connector,	1	2	3	4	5	6
2. Explain how Luer-connector misconnections occur and give an example,	1	2	3	4	5	6
3. Identify recommendations and practice behaviors used to reduce or prevent Luer-connector misconnections,	1	2	3	4	5	6
4. Utilize recommendations to reduce Luer-connector misconnections in the critical-care setting.	1	2	3	4	5	6

Name & Credentials _____

Position/Title _____

Address _____

City _____ State _____ Zip _____

Phone _____ Fax _____

Mail to: Saxe Communications, PO Box 1282, Burlington, VT 05402 Fax: 802.872.7558

Mark your answers with an X in the box next to the correct answer

	A	B	C	D
1	☐	☐	☐	☐
2	☐	☐	☐	☐
3	☐	☐	☐	☐
4	☐	☐	☐	☐
5	☐	☐	☐	☐
6	☐	☐	☐	☐
7	☐	☐	☐	☐
8	☐	☐	☐	☐
9	☐	☐		
10	☐	☐	☐	☐
11	☐	☐		
12	☐	☐	☐	☐
13	☐	☐	☐	☐
14	☐	☐		
15				
16				

For immediate results, take this test online at www.saxtesting.com

Safe Practices. V.3 No.2 **Score** ____ **14**