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Important Risk Information

NEXTERONE (amiodarone HCl) Premixed Injection is contraindicated in patients with:

- Known hypersensitivity to any of the components of NEXTERONE, including iodine
- Cardiogenic shock
- Marked sinus bradycardia
- Second- or third-degree atrio-ventricular (AV) block unless a functioning pacemaker is available
- NEXTERONE should be administered only by physicians who are experienced in the treatment of life-threatening arrhythmias, who are thoroughly familiar with the risks and benefits of amiodarone therapy, and who have access to facilities adequate for monitoring the effectiveness and side effects of treatment.

- Hypotension is the most common adverse reaction seen with intravenous amiodarone. In clinical trials, treatment-emergent, drug-related hypotension was reported in 16% (228/1386) of patients treated with intravenous amiodarone. Clinically significant hypotension during infusions was seen most often in the first several hours of treatment and appeared to be related to the rate of infusion. Monitor the initial rate of infusion closely and do not exceed the recommended rate. In some cases, hypotension may be refractory and result in a fatal outcome. Treat hypotension initially by slowing the infusion; additional standard therapy may be needed, including: vasopressors, positive inotropic agents and volume expansion.

- In 4.9% (90/1836) of patients in clinical trials, drug-related bradycardia that was not dose-related occurred while patients were receiving intravenous amiodarone for life-threatening VT/VF. Treat bradycardia by slowing the infusion rate or discontinuing NEXTERONE. Treat patients with a known predisposition to bradycardia or AV block with NEXTERONE in a setting where a temporary pacemaker is available.

- Elevations of blood hepatic enzyme values ALT, AST, GGT are commonly seen in patients with immediately life-threatening VT/VF. In patients with life-threatening arrhythmias, the potential risk of hepatic injury should be weighed against the potential benefit of NEXTERONE therapy. Carefully monitor patients receiving NEXTERONE for evidence of progressive hepatic injury. In such cases, consider reducing the rate of administration or withdrawing NEXTERONE.

- Like all antiarrhythmics, NEXTERONE may cause worsening of existing arrhythmias or precipitate a new arrhythmia. Monitor patients for QTc prolongation during infusion with NEXTERONE. Reserve the combination of amiodarone with other antiarrhythmic therapies that prolong the QTc to patients with life-threatening ventricular arrhythmias who are incompletely responsive to a single agent.

- There have been postmarketing reports of acute-onset (days to weeks) pulmonary injury in patients treated with intravenous amiodarone. Findings included pulmonary infiltrates and masses on X-ray, bronchospasm, wheezing, fever, dyspnea, cough, hemoptysis, and hypoxia. Some cases have progressed to respiratory failure or death. Two percent (2%) of patients were reported to have acute respiratory distress syndrome (ARDS) during clinical studies involving 48 hours of therapy. Pulmonary toxicity including pulmonary fibrosis is a well-recognized complication of long-term amiodarone use.

- Amiodarone inhibits peripheral conversion of thyroxine (T4) to triiodothyronine (T3) and may cause increased T4 levels, decreased T3 levels, and increased levels of inactive reverse T3 (rT3) in clinically euthyroid patients. Amiodarone can cause either hypothyroidism or hyperthyroidism. Evaluate thyroid function prior to treatment and periodically thereafter, particularly in elderly patients, and in any patient with a history of thyroid nodules, goiter, or other thyroid dysfunction. Because of the slow elimination of amiodarone and its metabolites, high plasma iodide levels, altered thyroid function, and abnormal thyroid function tests may persist for several weeks or even months following NEXTERONE withdrawal.

- The most important adverse reactions were hypotension, asystole/cardiac arrest/pulseless electrical activity (PEA), cardiogenic shock, congestive heart failure, bradycardia, liver function test abnormalities, VT, and AV block. The most common adverse reactions leading to discontinuation of intravenous amiodarone therapy were hypotension (1.6%), asystole/cardiac arrest/PEA (1.2%), VT (1.1%), and cardiogenic shock (1%).

- Drug Interactions

- Since amiodarone is a substrate for CYP3A and CYP2C8, drugs/substances that inhibit these isoenzymes may decrease the metabolism and increase serum concentration of amiodarone.

- Amiodarone inhibits p-glycoprotein and certain CYP450 enzymes, including CYP1A2, CYP2C9, CYP2D6, and CYP3A. This inhibition can result in unexpectedly high plasma levels of other drugs which are metabolized by those CYP450 enzymes or are substrates for p-glycoprotein. HMG-CoA reductase inhibitors that are CYP3A4 substrates in combination with amiodarone have been associated with reports of myopathy/rhabdomyolysis. Limit the dose of simvastatin in patients on amiodarone to 20 mg daily. Limit the daily dose of lovastatin to 40 mg. Lower starting and maintenance doses of other CYP3A4 substrates (e.g., atorvastatin) may be required.

- Some drugs/substances are known to accelerate the metabolism of amiodarone by stimulating the synthesis of CYP3A (enzyme induction). This may lead to low amiodarone serum levels and potential decrease in efficacy. Fluoroquinolones, macrolide antibiotics, and azoles are known to cause QTc prolongation. There have been reports of QTc prolongation, with or without TdP, in patients taking amiodarone when fluoroquinolones, macrolide antibiotics, or azoles were administered concomitantly.

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Indications

NEXTERONE (amiodarone HCl) Premixed Injection is indicated for initiation of treatment and prophylaxis of frequently recurring ventricular fibrillation (VF) and hemodynamically unstable ventricular tachycardia (VT) in patients refractory to other therapy. NEXTERONE also can be used to treat patients with VT/VF for whom oral amiodarone is indicated, but who are unable to take oral medication. During or after treatment with NEXTERONE, patients may be transferred to oral amiodarone therapy.

Use NEXTERONE for acute treatment until the patient’s ventricular arrhythmias are stabilized. Most patients will require this therapy for 48 to 96 hours, but NEXTERONE may be safely administered for longer periods if necessary.

NEXTERONE should be administered only by physicians who are experienced in the treatment of life-threatening arrhythmias, who are thoroughly familiar with the risks and benefits of amiodarone therapy, and who have access to facilities adequate for monitoring the effectiveness and side effects of treatment.

Please see Important Risk Information and Brief Summary of Full Prescribing Information on adjacent pages. Store in carton to protect from light until ready to use.

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NEXTERONE (amiodarone HCl) Premixed Injection for intravenous use

Brief Summary of Prescribing Information. See PI for Full Prescribing Information.

1 INDICATIONS AND USAGE
NEXTERONE is indicated for initiation of treatment and prophylaxis of frequently recurring ventricular fibrillation (VF) and hemodynamically unstable ventricular tachycardia (VT) in patients refractory to other therapy. NEXTERONE also can be used to treat patients with VT/VF for whom oral amiodarone is indicated, but who are unable to take oral medication. During or after treatment with NEXTERONE, patients may be transferred to oral amiodarone therapy [see Dosage and Administration (2) in full prescribing information]. Use NEXTERONE for acute treatment until the patient's ventricular arrhythmias are stabilized. Most patients will require this therapy for 48 to 96 hours, but NEXTERONE may be safely administered for longer periods if necessary.

2 CONTRAINDICATIONS
NEXTERONE is contraindicated in patients with:
- Known hypersensitivity to any of the components of NEXTERONE Premixed Injection, including iodine. Hypersensitivity reactions may involve rash, angioedema, cutaneous/mucosal hemorrhage (bleeding), fever, arthralgias (joint pains), eosinophilia (abnormal blood counts), hepatitis (liver), thrombotic thrombocytopenic purpura, or severe periarteritis (inflammation around blood vessels).
- Cardiogenic shock.
- Marked sinus bradycardia.
- Second- or third-degree atrio-ventricular (AV) block unless a functioning pacemaker is available.

3 WARNINGS AND PRECAUTIONS
NEXTERONE should be administered only by physicians who are experienced in the treatment of life-threatening arrhythmias, who are thoroughly familiar with the risks and benefits of amiodarone therapy, and who have access to facilities adequate for monitoring the effectiveness and side effects of treatment.

3.1 Hypotension
Hypotension is the most common adverse reaction seen with intravenous amiodarone. In clinical trials, treatment-emergent, drug-related hypotension was reported as an adverse effect in 16% (95/580) of 1850 patients treated with intravenous amiodarone. Clinically significant hypotension during infusions was seen most often in the first seven hours of treatment and was not dose related, but appeared to be related to the rate of infusion. Hypotension necessitating alterations in intravenous amiodarone therapy was reported in 3% of patients, with permanent discontinuation required in less than 2% of patients.

Treat hypotension initially by slowing the infusion; additional standard therapy may be needed, including the following: vasopressor drugs, positive inotropic agents, and volume expansion. Should the initial rate of infusion closely and do not exceed the recommended rate [see Dosage and Administration (2) in full prescribing information]. In some cases, hypotension may be refractory and result in a fatal outcome [see Adverse Reactions (6.2) in full prescribing information].

3.2 Bradycardia and Atio-ventricular Block
In 90 (4.9%) of 1836 patients in clinical trials, drug-related bradycardia that was not dose-related occurred while they were receiving intravenous amiodarone for life-threatening VT/VF. Treat bradycardia by slowing the infusion rate or discontinuing NEXTERONE. In some patients, inserting a pacemaker is required. Despite such measures, bradycardia was progressive and terminal in 1 patient during the controlled trials. Treat patients with a known predisposition to bradycardia or AV block with NEXTERONE in a setting where a temporary pacemaker is available.

3.3 Liver Enzyme Elevations
Elevations of blood hepatic enzyme values [alanine aminotransferase (ALT), aspartate aminotransferase (AST), and gamma-glutamyl transferase (GGT)] are commonly seen in patients with immediately life-threatening VT/VF. Interpreting elevated AST activity can be difficult because the values may be elevated in patients who have had recent myocardial infarction, congestive heart failure, or multiple electrical defibrillations. Approximately 54% of patients receiving intravenous amiodarone in clinical studies had baseline liver enzyme elevations, and 13% had clinically significant elevations. In 81% of patients with both baseline and on-therapy data available, the liver enzyme values either improved during therapy or remained at baseline levels. Baseline abnormalities in hepatic enzymes are not a contraindication to treatment.

Acute, centrolobular confluent hepatocellular necrosis leading to hepatic coma, acute renal failure, and death has been associated with the administration of intravenous amiodarone at a much higher loading dose concentration and much faster rate of infusion than recommended [see Dosage and Administration (2) in full prescribing information]. In patients with life-threatening arrhythmias, the potential risk of hepatic injury should be weighed against the potential benefit of NEXTERONE therapy. Carefully monitor patients receiving NEXTERONE for evidence of progressive hepatic injury. In such cases, consider reducing the rate of administration or withdrawing NEXTERONE.

3.4 Proarrhythmia
Like all antiarrhythmic agents, NEXTERONE may cause a worsening of existing arrhythmias or precipitate a new arrhythmia. Proarrhythmia, primarily torsade de points (TdP), has been associated with prolongation, by intravenous amiodarone, of the QTc interval to 550 ms or greater. Although QTc prolongation occurred frequently in patients receiving intravenous amiodarone, TdP or new-onset VF occurred infrequently (less than 2%). Monitor patients for QTc prolongation during infusion with NEXTERONE. Reserve the combination of amiodarone with other antiarrhythmic therapies that prolong the QTc to patients with life-threatening ventricular arrhythmias who are incompletely responsive to a single agent.

Fluoroquinolones, macrolide antibiotics, and azoles are known to cause QTc prolongation. There have been reports of QTc prolongation, with or without TdP, in patients taking amiodarone when fluoroquinolones, macrolide antibiotics, or azoles were administered concomitantly [see Drug Interactions (7) in full prescribing information].

Amiodarone causes thyroid dysfunction in some patients, which may lead to potentially fatal breakthrough or exacerbated arrhythmias. 5.5 Pulmonary Disorders Early-onset Pulmonary Toxicity
There have been postmarketing reports of acute-onset (days to weeks) pulmonary injury in patients treated with intravenous amiodarone. Findings have included pulmonary infiltrates and masses on X-ray, bronchospasm, wheezing, fever, dyspnea, cough, hemoptysis, and hypoxia. Some cases have progressed to respiratory failure or death.

ARDS
Two percent (2%) of patients were reported to have adult respiratory distress syndrome (ARDS) during clinical studies involving 48 hours of therapy. Pulmonary Fibrosis
Only 1 of more than 1000 patients treated with intravenous amiodarone in clinical studies developed pulmonarv toxicity. In that patient, the condition was diagnosed 3 months after treatment with intravenous amiodarone, during which time the patient received oral amiodarone. Pulmonary toxicity is a well-recognized complication of long-term amiodarone use [see package insert for oral amiodarone].

5.6 Loss of Vision
Cases of optic neuropathy and optic neuritis, usually resulting in visual impairment, have been reported in patients treated with oral amiodarone. In some cases, visual impairment has progressed to permanent blindness. Optic neuropathy and neuritis may occur at any time following initiation of therapy. A causal relationship to the drug has not been clearly established. Perform an ophthalmic examination if symptoms of visual impairment appear, such as changes in visual acuity and decreases in peripheral vision. Re-evaluate the necessity of amiodarone therapy if optic neuropathy or neuritis is suspected. Perform regular ophthalmic examination, including fundoscopy and slit-lamp examination, during administration of NEXTERONE.

5.7 Long-Term Use
There has been limited experience in patients receiving intravenous amiodarone for longer than 3 weeks. See package insert for oral amiodarone.

5.8 Thyroid Abnormalities
Amiodarone inhibits peripheral conversion of thyroxine (T4) to triiodothyronine (T3) and may cause increased T4 levels, decreased T3 levels, and increased levels of inactive reverse T3 (rT3) in clinically euthyroid patients. Amiodarone is also a potential source of large amounts of inorganic iodine and can cause either hypothyroidism or hyperthyroidism. Evaluate thyroid function prior to treatment and periodically thereafter, particularly in elderly patients, and in any patient with a history of thyroid nodules, goiter, or other thyroid dysfunction. Because of the slow elimination of amiodarone and its metabolites, high plasma iodide levels, altered thyroid function, and abnormal thyroid function tests may persist for several weeks or even months following NEXTERONE withdrawal. There have been postmarketing reports of thyroid nodules/thyroid cancer in patients treated with amiodarone. In some instances hyperthyroidism was also present [see Adverse Reactions (6.2) in full prescribing information].

Hypothyroidism and Thyrotoxicosis
Hyperthyroidism occurs in about 2% of patients receiving amiodarone, but the incidence may be higher among patients with prior inadequate dietary iodine intake. Amiodarone-induced hyperthyroidism usually poses a greater hazard to the patient than hypothyroidism because of the possibility of thyrotoxicosis and arrhythmia breakthrough or aggravation, all of which may result in death. There have been reports of death associated with amiodarone-induced thyrotoxicosis. Consider the possibility of hypothyroidism if any new signs of arrhythmia appear. Identify hyperthyroidism by relevant clinical signs and symptoms, subnormal serum levels of thyroid stimulating hormone (TSH), abnormally elevated serum free T4, and elevated or normal serum T3. Since arrhythmia breakthroughs may accompany amiodarone-induced hyperthyroidism, aggressive medical treatment is indicated, including, if possible, dose reduction or withdrawal of amiodarone. Amiodarone hyperthyroidism may be followed by a transient period of hypothyroidism.

The institution of antithyroid drugs, β-adrenergic blockers or temporary corticosteroid therapy may be necessary. The action of antithyroid drugs may be especially delayed in amiodarone-induced thyrotoxicosis because of substantial quantities of preformed thyroid hormones stored in the gland. Radioactive iodine therapy is contraindicated because of the low radiiodine uptake associated with amiodarone-induced hyperthyroidism.

When aggressive treatment of amiodarone-induced thyrotoxicosis has failed or amiodarone cannot be discontinued because it is the only drug effective against the resistant arrhythmia, surgery may be an option. Experiences as a treatment for amiodarone-induced thyrotoxicosis is limited, and this form of therapy could induce thyroid storm. Therefore, surgical and anesthetic management require careful planning.

Neonatal Hypo- or Hyperthyroidism
Amiodarone can cause fetal harm when administered to a pregnant woman. Although amiodarone use during pregnancy is uncommon, there have been a small number of published reports of congenital goiter/hypothyroidism and hyperthyroidism associated with oral administration. Inform the patient of the potential hazard to the fetus if NEXTERONE is administered during pregnancy or if the patient becomes pregnant while taking NEXTERONE.
Hypothyroidism
Hypothyroidism has been reported in 2% to 4% of patients in most series, but in 8% to 10% in some series. This condition may be identified by relevant clinical symptoms and particularly by elevated serum TSH levels. In some clinically hypothyroid amiodarone-treated patients, free T3/T4 index values may be normal. Manage hypothyroidism by reducing the NEXTERONE dose and considering the need for thyroid hormone supplement. However, therapy must be individualized, and it may be necessary to discontinue oral amiodarone in some patients.

5.9 Surgery
Perform close perioperative monitoring in patients undergoing general anesthesia who are on amiodarone therapy as they may be more sensitive to the myocardial depressant and conduction defects of halogenated inhalational anesthetics.

5.10 Corneal Refractive Laser Surgery
Advise patients that most manufacturers of corneal refractive laser surgery devices contraindicate corneal refractive laser surgery in patients taking amiodarone.

5.11 Electrolyte Disturbances
Correct hypokalemia or hypomagnesemia whenever possible before initiating treatment with NEXTERONE, as these disorders can exaggerate the degree of QTc prolongation and increase the potential for TdP. Give special attention to electrolyte and acid-base balance in patients experiencing severe or prolonged diarrhea or in patients receiving concomitant diuretics.

6 ADVERSE REACTIONS

6.1 Clinical Trials Experience
Because clinical trials are conducted under widely varying conditions, adverse reaction rates observed in the clinical trials of a drug cannot be directly compared to rates in the clinical trials of another drug and may not reflect the rates observed in practice.

In a total of 1836 patients enrolled in controlled and uncontrolled clinical trials, 14% of patients received intravenous amiodarone for at least one week, 5% received it for at least 2 weeks, and 2% received it for at least 3 weeks, and 1% received it for more than 3 weeks, without an increased incidence of severe adverse reactions. The mean duration of therapy in these studies was 5.6 days; median exposure was 3.7 days.

The most important adverse reactions were hypotension, astystole/cardiac arrest/pulseless electrical activity (PEA), cardiacogenic shock, congestive heart failure, bradycardia, liver function test abnormalities, VT, and AV block. Overall, treatment was discontinued for about 9% of the patients because of adverse reactions. The most common adverse reactions leading to discontinuation of intravenous amiodarone therapy were hypotension (1.6%), astystole/cardiac arrest/PEA (1.2%), VT (1.1%), and cardiacogenic shock (1%).

Table 4 lists the most common (incidence ≥2%) adverse reactions during intravenous amiodarone therapy considered at least possibly drug-related. These data were collected in clinical trials involving 1836 patients and life-threatening VT/VF. Data from 18% of assigned treatment groups are pooled because none of the adverse reactions appeared to be dose-related.

Table 4: ADVERSE REACTIONS IN PATIENTS RECEIVING INTRAVENOUS AMIODARONE IN CONTROLLED AND OPEN-LABEL STUDIES (≥2% INCIDENCE)

<table>
<thead>
<tr>
<th>Study Event</th>
<th>Controlled Studies (n=814)</th>
<th>Open-Label Studies (n=1022)</th>
<th>Total (n=1836)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body as a whole</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fever</td>
<td>24 (2.9%)</td>
<td>13 (1.2%)</td>
<td>37 (2.0%)</td>
</tr>
<tr>
<td><strong>Cardiovascular System</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bradycardia</td>
<td>49 (6.0%)</td>
<td>41 (4.0%)</td>
<td>90 (4.9%)</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>18 (2.2%)</td>
<td>21 (2.0%)</td>
<td>39 (2.1%)</td>
</tr>
<tr>
<td>Heart arrest</td>
<td>29 (3.5%)</td>
<td>26 (2.5%)</td>
<td>55 (2.9%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>165 (20.2%)</td>
<td>123 (12.0%)</td>
<td>288 (15.8%)</td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>15 (1.8%)</td>
<td>30 (2.9%)</td>
<td>45 (2.4%)</td>
</tr>
<tr>
<td><strong>Digestive System</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver function tests normal</td>
<td>35 (4.2%)</td>
<td>29 (2.8%)</td>
<td>64 (3.4%)</td>
</tr>
<tr>
<td>Nausea</td>
<td>29 (3.5%)</td>
<td>43 (4.2%)</td>
<td>72 (3.9%)</td>
</tr>
</tbody>
</table>

Other adverse reactions reported in less than 2% of patients receiving intravenous amiodarone in controlled and uncontrolled studies included the following: abnormal kidney function, atrial fibrillation, diarrhea, increased ALT, increased AST, lung edema, nodal arrhythmia, prolonged QT interval, respiratory disorder, shock, sinus bradycardia, Stevens-Johnson syndrome, thrombocytopenia, VF, and vomiting.

6.2 Post-Marketing Experience
The following adverse reactions have been identified during post-approval use of amiodarone. Because these reactions are reported voluntarily from a population of uncertain size, it is not always possible to reliably estimate their frequency or establish a causal relationship to drug exposure.

**Body as a Whole:** anaphylactoid/anaphylactic reaction (including shock), fever

**Cardiovascular:** hypotension (sometimes fatal), sinus arrest

**Dermatologic:** toxic epidermal necrolysis (sometimes fatal), exfoliative dermatitis, erythema multiforme, Stevens-Johnson syndrome, skin cancer, pruritus, angiodema

**Endocrine:** syndrome of inappropriate antidiuretic hormone secretion (SIADH)

**Hematologic:** pancytopenia, neutropenia, hemolytic anemia, aplastic anemia, thrombocytopenia, agranulocytosis, granuloma

**Hepatic:** hepatitis, cholestasis, cirrhosis

**Injection Site Reactions:** pain, erythema, edema, pigment changes, venous thrombosis, phlebitis, thrombophlebitis, cellulitis, necrosis, and skin sloughing

**Musculoskeletal:** myopathy, muscle weakness, rhabdomyolysis

**Nervous System:** hallucination, confusional state, disorientation, and delirium, pseudotumor cerebri

**Pancreatic:** pancreatitis

**Respiratory:** bronchospasm, possibly fatal respiratory disorders (including distress, failure, arrest and ARDS), bronchiolitis obliterans organizing pneumonia (possibly fatal), dyspnea, cough, hemoptysis, wheezing, hypoxia, pulmonary infiltrates and/ or mass, pleuritis

**Thyroid:** thyroid nodules/thyroid cancer

**Vascular:** vasculitis

7 DRUG INTERACTIONS
Since amiodarone is a substrate for CYP3A and CYP2C8, drugs/substances that inhibit these isoenzymes may decrease the metabolism and increase serum concentration of amiodarone.

Amiodarone inhibits p-glycoprotein and certain CYP450 enzymes, including CYP1A2, CYP2C9, CYP2D6, and CYP3A. This inhibition can result in unexpectedly high plasma levels of other drugs which are metabolized by those CYP450 enzymes or are substrates for p-glycoprotein.

HMCo-reductase inhibitors that are CYP3A4 substrates in combination with amiodarone has been associated with reports of myopathy/rhabdomyolysis.

Limit the dose of simvastatin in patients on amiodarone to 20 mg daily. Limit the daily dose of lovastatin to 40 mg. Lower starting and maintenance doses of other CYP3A4 substrates (e.g., atorvastatin) may be required.

Some drugs/substances are known to accelerate the metabolism of amiodarone by stimulating the synthesis of CYP3A (enzyme induction). This may lead to low amiodarone serum levels and potential decrease in efficacy.

Fluoroquinolones, macrolide antibiotics, and azoles are known to cause QTc prolongation. There have been reports of QTc prolongation, with or without TdP, in patients taking amiodarone when fluoroquinolones, macrolide antibiotics, or azoles were administered concomitantly.

8 USE IN SPECIFIC POPULATIONS

8.1 Pregnancy Category D
Reproductive and teratology studies performed in rabbits and rats at doses of up to 100 mg/kg per day (about 1.4 times the maximum recommended human dose on a body surface area basis) revealed no evidence of embryotoxicity at 5 mg/kg and no teratogenicity was observed at any dosage in rabbits. Maternal toxicity and embryotoxicity were observed in rats in the 100 mg/kg group.

Use NEXTERONE during pregnancy only if the potential benefit to the mother justifies the risk to the fetus.

8.2 Labor and Delivery
It is not known whether the use of amiodarone during labor or delivery has any immediate or delayed adverse effects.

8.3 Nursing Mothers
Amiodarone and one of its major metabolites, desethylamiodarone (DEA), are excreted in human milk, suggesting that breast-feeding could expose the nursing infant to a significant dose of the drug.

8.4 Pediatric Use
The safety and effectiveness of amiodarone in pediatric patients have not been established; therefore, the use of amiodarone in pediatric patients is not recommended.

8.5 Geriatric Use
Clinical studies of amiodarone did not include sufficient numbers of subjects aged 65 and over to determine whether they respond differently from younger subjects. Carefully consider dose selection in an elderly patient.

10 OVERDOSAGE
There have been cases, some fatal, of amiodarone overdose. Effects of an inadvertent overdose of intravenous amiodarone include hypotension, cardiogenic shock, bradycardia, AV block, and hepatotoxicity. Treat hypotension and cardiogenic shock by slowing the infusion rate or with standard therapy: vasopressor drugs, positive inotropic agents, and volume expansion. Bradycardia and AV block may require temporary pacing. Monitor hepatic enzyme concentrations closely. Amiodarone is not dialyzable.

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One of the themes for this issue reminds us of the continuing importance of managing cardiovascular risk factors. Our longstanding familiarity with these findings can sometimes lead to complacency that we already know about them and their role in cardiovascular health problems, some of which can take lives many years before their natural time of departure. One of those familiar risk factors is a sedentary lifestyle, often simply characterized as a life lacking exercise. We have known for many years that an occupational history of sedentary work together with a lifestyle history nearly devoid of physical exertion often coexist in patients who present to us with cardiovascular health problems such as hypertension as well as worrisome metabolic profiles, obesity, diabetes, and a myriad of related disorders. As a result, health care professionals may consider a “sedentary lifestyle” and “lack of exercise” as, more or less, 2 sides of the same coin that may gradually contribute to poor health.

In contrast to that rather vague role as a cardiovascular risk factor, however, an abundance of epidemiological research continues to underscore the “strong, independent and inverse association between physical activity and . . . mortality in apparently healthy individuals and diseased populations.” More recent studies suggest that, although physical exercise remains an important ingredient to sprinkle into any recipe for achieving cardiovascular health, the duration that one spends sitting is, by itself, a potentially lethal risk factor. In this editorial, I will first examine the influence of physical inactivity as a major, independent and lethal risk factor for heart disease and for mortality from any cause and then summarize some of the evidence and strategies for ameliorating its potentially harmful effects.

Physical Inactivity as an Independent Risk Factor for Heart Disease and Death

Too much sitting is a strong negative risk factor independent of physical activity. Even though we may consider a lack of physical activity as more or less equivalent to just sitting around, recent research shows that too much sitting is associated with negative health outcomes on its own demerits, that is, quite apart from the influence of physical activity. Research has established that prolonged periods of sitting is associated with significant detrimental metabolic effects that include abnormal glucose metabolism, obesity, and development of metabolic syndrome in addition to significantly higher cardiovascular morbidity, weight gain, and premature death.

For women over age 30, inactivity may be a greater risk factor for heart disease than smoking. In a study designed to measure the
relative contribution that the top 4 risk factors for cardiac disease in Australian women (high body mass index, smoking, high blood pressure, physical inactivity) make across a woman’s lifespan, researchers determined that the most detrimental risk factor did not remain constant, but changed over time. Until age 30, the highest risk for heart disease in this population of Australian women was associated with smoking. After age 30 and extending to age 90, the greatest risk for heart disease was distinctively attributable to physical inactivity, which outweighed all of the other risk factors. Researchers observed that physical inactivity rose steadily in these women from 48% to 81% over ages 22 to 90 years. Combining the prevalence and relative risk data, the research team noted that for women between the ages of 22 and 27 years, “low” and “no” physical activity accounted for 47% of heart disease, rising to 51% for women 31 to 36 years old, before declining to 23.5% in the eldest women aged 85 to 90 years, suggesting that the greatest threats posed by inactivity strike at women in the prime of life. Differences in local lifestyle, diet, and social customs may make it difficult to know the extent to which these results for Australian women are comparable and applicable to women living elsewhere, but the top risk factors and pattern of steadily increasing sedentism over one’s lifetime are undeniably familiar to women in many parts of the developed world.

In another large study of 334,161 European men and women followed for more than 12 years, Ekelund et al9 examined the relationship between physical activity and all-cause mortality, noting that physical inactivity has consistently been associated with an increased risk for all-cause mortality independent of obesity (defined by body mass index). For this study goal, the investigators found that when compared to obesity, inactivity was twice as lethal as a risk factor for premature deaths.

A third and very recent meta-analysis of 47 studies designed to determine the association between sedentary time and a range of variable outcomes in adults independent of physical activity (hospitalizations, all-cause mortality, cardiovascular disease, diabetes, and cancer), Biswas and associates10 in Toronto confirmed that prolonged sedentary time was independently associated with deleterious health outcomes regardless of physical activity. In that study, significant hazard ratio associations were found with all-cause mortality, cardiovascular mortality, cardiovascular disease incidence, as well as cancer mortality, cancer incidence, and type 2 diabetes incidence. As one might anticipate, hazard ratios associated with sedentary time and outcomes were generally more pronounced at lower compared to higher levels of physical activity, underscoring the inevitable outcome that the strong associations between sedentary behavior and all-cause mortality were greatest for those who exercised the least. As one might anticipate less, sedentary behavior was associated with chronic disorders and premature death even among those who exercised, further solidifying its stature as an undeniably persistent thorn that is not necessarily blunted by performing exercise.

As the stack of evidence attesting that sitting for prolonged periods can be hazardous to one’s health and longevity accumulates, our understanding of the mechanisms for why and how sedentism poses these threats is rudimentary.11 Ignoring or dismissing them will not make them go away, however, so finding strategies to mitigate the damage seems like a prudent next step.

Even Small Amounts of Physical Activity Offer Substantial Health Benefits

The Ekelund study9 not only looked at the association between physical activity and mortality, but also considered whether those negative effects on life expectancy might be mitigated by improvements in physical activity. In contrast to the Biswas report10 where exercise was not associated with improved health outcomes, Ekelund found that increasing physical activity via exercise—even by a fairly modest amount such as 20 minutes of walking daily—carries extremely effective health benefits. Although the impact of increasing physical activity was greatest for participants with normal body weight, whose all-cause mortality was reduced by 16% to 30%, beneficial effects were also enjoyed by those who were overweight. The authors projected that just adding a brisk, 20-minute walk to one’s daily routine would relocate that individual from the “completely inactive” group at high risk of death to the “moderately inactive group,” thereby cutting their risk of premature death.
Taking Breaks From Sedentary Behavior May Also Help

On the flip side of the physical activity/sedentary behavior coin, scientists who work with older adults disinclined to add rigorous exercise to their lives have approached the burdens related to sedentary living from an alternative perspective: rather than attempting to enjoin older adults to start performing physical exercises, aim at getting them to break up the duration of time they spend in sedentary behavior. A study of 215 adults between the ages of 54 and 94 years in Lisbon, Portugal, found a significant positive association between breaks in sedentary time and the person’s composite physical functioning, suggesting this as an alternative strategy that may be useful in supporting the person’s ability to maintain activities of daily living independently.12

For those who work with older patients about to be transferred or discharged (or family members, neighbors, and friends sitting too long at home), who may resist disruptions in their comfort or position, it is worthwhile to note that these breaks from sedentism need not be dramatic or particularly athletic—even fairly minor changes such as periodically standing up from a sitting or recumbent position, rocking back-and-forth from toes to heels, and alternately standing on tip-toes and returning to feet flat can all qualify as breaks from just sitting or lying still. The important aspect is that the breaks occur, preferably on a regular basis, for a few minutes every 30 minutes, during commercials in a television program, while talking on the telephone, or using some other trigger. Any activity that interrupts the sedentary posture should contribute to better health.

Taking a Walk in a Group Outside Can Help

A final strategy suggested for getting adults of all ages up and moving from their sedentary locations takes the form of walking groups. In their meta-analysis of 42 studies of outdoor walking groups representing 1843 participants, 76% of whom were women with a mean age of 58 years, Hanson and Jones13 found that walking groups offered a broad spectrum of health benefits to participants, including those who reported health disorders ranging from obesity and diabetes, to arthritis and fibromyalgia, as well as dementia and behavioral health problems. The analysis revealed that walking groups were associated with statistically significant improvements (reductions) in mean systolic blood pressure, diastolic blood pressure, resting heart rate, body fat, body mass index, total cholesterol, and depression together with statistically significant increases in VO2 max, the SF-36 (physical functioning) score, and 6-minute walk time. There were no notable adverse effects reported in any of the studies. In addition, the findings of this recent analysis were consistent with those from other meta-analyses on the efficacy of this program.

In addition to their obvious health benefits, walking groups were also credited with offering an attractive palette of enhanced features that make them especially attractive: low cost, accessible, high levels of adherence, low levels of participant attrition, low risk of negative side effects. Walking groups were also characterized by their participants as bestowing an array of social and psychological benefits such as social cohesion, which may encourage and sustain adherence as well as positive attitude toward physical activity, companionship, and shared experience.13

Closing

When it is time for education and discharge planning for your patients with cardiovascular health problems, and really for any patient in your care, make time to share this simple yet compelling recipe for better health and longevity:

• Sit less
• Stand more
• Strut your stuff longer and farther than you did yesterday
• Give yourself a better chance to live well and longer

And you do the same, critical care nurses, okay? CCN

JoAnn Grif Alspach, RN, MSN, EdD
Editor, Critical Care Nurse
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Prognostic Value of Initial Elevation in Cardiac Troponin I Level in Critically Ill Patients Without Acute Coronary Syndrome

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MERITA SHEHU, MD
EDMUND HERROLD, MD, PhD
HENRY COHEN, MS, PharmD, BCPP, CGP

BACKGROUND Cardiac troponin I levels are often obtained to help rule out acute coronary syndrome.

OBJECTIVES To determine if elevation of troponin level within 24 hours for patients without acute coronary syndrome admitted to the intensive care unit provides important prognostic information.

METHODS Patients without acute coronary syndrome admitted to the intensive care unit were prospectively divided into 2 groups according to highest serum level of cardiac troponin I within 24 hours of admission (elevated >0.049 ng/mL; control ≤0.049 ng/mL). Hospital mortality, incidence of intubation, and other parameters were compared between the 2 groups.

RESULTS Patients with elevated troponin level (n = 40) had higher mortality than did control patients (n = 50) (35% vs 12%; P = .01). Compared with control patients, patients with elevated levels were more likely to be intubated (41% vs 17%; P = .02).

CONCLUSIONS Critically ill patients without acute coronary syndrome with elevated levels of cardiac troponin I at admission had higher mortality and more intubations than did control patients. (Critical Care Nurse. 2015;35[2]:e1-e10)

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Training Forward Surgical Teams for Deployment: The US Army Trauma Training Center

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Since the late 1980s, the US Army has been deploying forward surgical teams to the most intense areas of conflict to care for personnel injured in combat. The forward surgical team is a 20-person medical team that is highly mobile, extremely agile, and has relatively little need of outside support to perform its surgical mission. In order to perform this mission, however, team training and trauma training are required. The large majority of these teams do not routinely train together to provide patient
care, and that training currently takes place at the US Army Trauma Training Center (ATTC). The training staff of the ATTC is a specially selected 10-person team made up of active duty personnel from the Army Medical Department assigned to the University of Miami/Jackson Memorial Hospital Ryder Trauma Center in Miami, Florida. The ATTC team of instructors trains as many as 11 forward surgical teams in 2-week rotations per year so that the teams are ready to perform their mission in a deployed setting. Since the first forward surgical team was trained at the ATTC in January 2002, more than 112 forward surgical teams and other similar-sized Department of Defense forward resuscitative and surgical units have rotated through trauma training at the Ryder Trauma Center in preparation for deployment overseas. (Critical Care Nurse. 2015;35[2]:e11-e17)

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Heart failure is a debilitating chronic condition that affects more than 5 million patients in the United States. The condition is complex and incurable, but multiple medications, procedures, and devices are available to treat it. Biventricular pacing, a therapy for some patients with heart failure, can improve quality of life and reduce the number of hospitalizations and mortality. In this article, I discuss selection of patients and devices, the procedure used to implant the pacemaker, potential complications, and assessment of the function of biventricular pacemakers. Nurses who provide care for patients with permanent pacemakers and biventricular pacemakers should be knowledgeable in the assessment of electrocardiographic (ECG) findings related to adequate functioning of biventricular pacemakers. In addition, I provide bedside critical care or telemetry nurses the information to determine if a biventricular pacemaker is functioning and when to contact a cardiologist to determine if further interrogation of the pacemaker or correction of timing is needed.

Indications for Biventricular Pacing in Heart Failure

Multiple indications exist for implanting a biventricular pacemaker in patients with heart failure, and the indications are continuously being reevaluated to include a broader range of patients with the diagnosis of heart failure. According to the Heart Failure Society of America, biventricular pacing is recommended for patients with sinus rhythm, a widened QRS interval greater than 120 ms, and a left
ventricular ejection fraction (LVEF) of 35% or less.\(^4\) Approximately one-third of patients with systolic heart failure have left bundle branch block with a QRS duration greater than 120 ms.\(^5\) Indications noted by the American Heart Association for biventricular pacing include LVEF of 35% or less, left bundle branch block with QRS duration 150 ms or greater, and heart failure greater than class II according to the New York Heart Association classification\(^6,7\) (Table 1). These criteria are dynamic, and selection of the device to be used and the decision to implant a device may depend on a patient’s signs and symptoms and decreasing functional status and local insurance-related criteria for reimbursement. Patients with New York Heart Association level I or level II heart failure may be eligible for insertion of a biventricular pacemaker if the ejection fraction is less than 30% and the QRS interval is 130 ms or greater.\(^6,8\)

Biventricular pacing may also be considered for patients with atrial fibrillation and a QRS interval greater than 120 ms and LVEF less than 35% with persistent moderate to severe heart failure.\(^3\) Biventricular pacing with defibrillation capability is recommended for patients who meet criteria for biventricular pacing who have also had cardiac arrest or who have evidence of ventricular tachycardia not due to a potentially reversible cause.\(^8\)

The decision to implant a biventricular pacemaker with defibrillation capability to prevent sudden cardiac death may also be made for other selected patients. Depending on the model of pacemaker chosen and pacemaker programming, inclusion of defibrillation capability is an elective option. Implanted devices with defibrillating capability are known as cardiac resynchronization therapy defibrillators (CRT-Ds).

### Ventricular Dyssynchrony in Heart Failure

A QRS duration greater than 120 ms in a patient with chronic heart failure may indicate ventricular dysynchrony (the left and right ventricular contractions do not occur simultaneously and result in impaired ejection). Left bundle branch block is a common cause of QRS duration greater than 120 ms. In left bundle branch block, the left ventricle is activated through the septum, but activation through the left ventricle is delayed, resulting in delayed contraction of the posterolateral left ventricular wall and delayed ejection from the left ventricle compared with the right ventricle. Doppler echocardiography may be used to show ventricular dyssynchrony, but 12-lead ECG evidence of prolonged QRS duration is the gold standard for indicating electromechanical ventricular delay.\(^3\)

When an intraventricular conduction delay is present, coordination in the timing of peak contraction within left ventricular segments is lacking, causing intraventricular dyssynchrony. Additionally, a lack of coordination between left and right ventricular systole, or intraventricular dyssynchrony, occurs. Furthermore, delayed systolic contraction of left ventricular segments results in reduced diastolic filling time with loss of atrial kick (responsible for 25% of ventricular filling). In patients with heart failure, this dyssynchrony may further impair the ability of the left ventricle to pump effectively.

#### Table 1: New York Heart Association heart failure classification\(^a\)

<table>
<thead>
<tr>
<th>Class</th>
<th>Signs and symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Cardiac disease, but no signs or symptoms (e.g., shortness of breath when walking, climbing stairs) and no limitation in ordinary physical activity</td>
</tr>
<tr>
<td>II</td>
<td>Mild signs or symptoms (e.g., mild shortness of breath and/or angina) and slight limitation during ordinary activity</td>
</tr>
<tr>
<td>III</td>
<td>Marked limitation in activity due to signs and symptoms, even during less-ordinary activity (e.g., walking short distances of 20-100 m), comfortable only at rest</td>
</tr>
<tr>
<td>IV</td>
<td>Severe limitations; experiences signs and symptoms even while at rest; mostly bed-bound patients</td>
</tr>
</tbody>
</table>

\(a\) Based on information from the Criteria Committee of the New York Heart Association.\(^7\)

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Mrs P, a 56-year-old woman, had heart failure after cardiac surgery for left coronary artery occlusion and ST-segment elevation myocardial infarction that could not be treated with percutaneous coronary intervention. Although she had completed a cardiac rehabilitation program and insisted that she followed a low-sodium diet and exercise program as instructed, shortness of breath, peripheral edema, and decreased exercise tolerance developed over a period of several months. Twice she was brought to the emergency department of her local hospital because of shortness of breath. During the first visit to the emergency department, she received diuretic therapy and was discharged home. On the second visit, she was admitted to the hospital and was examined by a consulting cardiologist. A 12-lead ECG revealed normal sinus rhythm with a right bundle branch block and QRS duration of 140 ms (Figure 1). A transthoracic echocardiogram indicated an LVEF of 25% and mild to moderate mitral regurgitation.

Implantation of a biventricular pacemaker was recommended to improve Mrs P’s functional status. She consented to the procedure, and a biventricular pacemaker was implanted. Figure 2 shows the results of a 12-lead ECG obtained after the implantation. Two weeks later, Mrs P had a follow-up visit with the cardiologist and stated that she was now able to perform all of her activities of daily living without shortness of breath or fatigue. Echocardiography during the visit indicated that LVEF had increased to 40% and that the mitral regurgitation had decreased. She has been followed up via a telephonic heart failure program and has had no further visits to the emergency department or rehospitalizations.

Figure 1 Electrocardiographic tracing before insertion of biventricular pacemaker.

Figure 2 Electrocardiographic tracing after insertion of biventricular pacemaker.
resulting in decreased cardiac output and stroke volume and an increase in mitral valve regurgitation, which further increases pulmonary venous congestion, resulting in increased backflow and pulmonary congestion. Mitral valve regurgitation in patients with heart failure has multiple causes, including deformation of the mitral valve leaflets due to remodeling, inefficiency of left ventricular contraction, and uncoordinated contraction of the left ventricle. In a study by Bader et al., intraventricular dyssynchrony was the most important independent variable in hospitalization for decompensated heart failure and mortality.

Biventricular Pacing

A biventricular pacemaker is used for CRT. Unlike traditional permanent pacemakers, which use 2 leads and electrodes to sense and pace the right ventricle, a biventricular pacemaker uses 3 leads and electrodes for pacemaker functions in both the right and the left ventricle (Table 2). Biventricular pacemakers may be CRT-P (pacemaker functions only) or CRT-D. In biventricular pacing, a specifically designed left ventricular lead is inserted through the coronary sinus and then advanced into a coronary sinus vein posteriorly to sense and pace the left ventricle (Figure 3). Benefits of biventricular pacing include increased left ventricular filling time, decreased septal dyskinesis, and reduced mitral regurgitation, although approximately one-third of patients do not have improvement in their cardiac conditions when treated with CRT.

Many studies have shown the effectiveness of biventricular pacing in improving quality of life and decreasing mortality in patients with heart failure. These studies include biventricular pacing both with and without implantable cardioverter defibrillators (Table 3).

Complications of Biventricular Pacemakers

Compared with implantation of traditional pacemakers, which have leads in the right atrium and right ventricle only, implantation of a biventricular pacemaker involves an additional lead in a coronary vein and thus an increased potential for complications (Table 4). Complications that may occur with implantation of traditional permanent pacemakers include pneumothorax (a complication associated with the insertion of any central venous catheter), bleeding, development of hematoma, and failure to pace or failure to sense appropriately. Late complications common to all permanent pacemakers include lead displacement, lead fracture, pocket infection, and systemic infection.

The most common causes of failure of biventricular pacing include loss of ventricular capture, implant failure, lead dislodgement, and atrial tachyarrhythmias. Unsuccessful implantation is the inability to implant...
the left ventricular lead because the lead cannot be threaded through the coronary sinus and into a coronary sinus vein. Placing the left ventricular lead is technically more difficult than placing the right ventricular lead and may be made more difficult if a patient has left ventricular enlargement, scarring, or atypical coronary sinus or coronary vein anatomy. Coronary sinus dissection or perforation may occur during implantation, and the signs and symptoms may not become evident immediately. Chest pain, shortness of breath, or cardiac tamponade may develop. Signs and symptoms of cardiac tamponade include widening of the mediastinum on chest radiography, jugular venous distension, chest pain, shortness of breath, pulsus paradoxus, and indications of shock. In most instances, loss of synchronization in biventricular pacing can be corrected by alterations in timing. The time delay between the right and the left ventricular stimulus (ie, atrioventricular delay) is programmed for each patient to optimize synchrony of left and right ventricular contraction.

### Optimizing Biventricular Function

In addition to ECG interpretation and pacemaker interrogation (the process for checking on the function

### Table 3  Studies on biventricular pacemakers

<table>
<thead>
<tr>
<th>Study</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>MADIT-CRT</td>
<td>Reduction in mortality for heart failure events and reduction in the risk of recurrent heart failure events</td>
</tr>
<tr>
<td>MIRACLE</td>
<td>Improvement in exercise tolerance and functional status and decrease in hospitalizations for heart failure</td>
</tr>
<tr>
<td>MUSTIC</td>
<td>Improvement in exercise tolerance, functional status, and quality of life and decrease in hospitalizations for heart failure</td>
</tr>
<tr>
<td>PATH CHF</td>
<td>Increase in exercise tolerance and quality of life</td>
</tr>
<tr>
<td>CONTAK CD</td>
<td>Increase in exercise tolerance and quality of life</td>
</tr>
<tr>
<td>COMPANION</td>
<td>Decrease in mortality and hospitalization for any cause</td>
</tr>
<tr>
<td>CARE HF</td>
<td>Decrease in hospitalizations for heart failure, improvement in functional status</td>
</tr>
</tbody>
</table>

Abbreviations: CARE HF, Cardiac Resynchronization-Heart Failure study; COMPANION, Comparison of Medical Therapy, Pacing, and Defibrillation in Heart Failure trial; CONTAK CD, CONTAK CD pacemaker study; MADIT CRT, Multicenter Automatic Defibrillator Implantation Trial with Cardiac Resynchronization Therapy; MIRACLE, Multicenter InSync Randomized Clinical Evaluation trial; MUSTIC, Multisite STimulation in Cardiomyopathy study; PATH CHF, Pacing Therapies for Congestive Heart Failure study.

### Table 4  Complications of biventricular pacemakers

<table>
<thead>
<tr>
<th>Complication</th>
<th>Signs and symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local infection at suture site</td>
<td>Fever, redness over pacemaker pocket site, purulent drainage, indications of sepsis (increased white blood cell count, hypotension, tachycardia)</td>
</tr>
<tr>
<td>Systemic infection/sepsis</td>
<td>Increased white blood cell count (&gt; 10.5 cells/μL), fever, hypotension, tachycardia</td>
</tr>
<tr>
<td>Hematoma</td>
<td>Swelling, red or purple discoloration, pain</td>
</tr>
<tr>
<td>Bleeding</td>
<td>Oozing at suture site, hematoma, tachycardia</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>Chest pain, shortness of breath, tachypnea, chest radiographic findings</td>
</tr>
<tr>
<td>Pocket infection</td>
<td>Swelling at insertion site, pain, erythema, ecchymosis, skin erosion</td>
</tr>
<tr>
<td>Lead displacement or fracture</td>
<td>Chest radiographic findings, electrocardiographic findings (failure to capture and failure to sense), chest pain, fatigue, decreased activity tolerance</td>
</tr>
<tr>
<td>Coronary sinus dissection or perforation</td>
<td>Hypotension, cardiac tamponade, chest radiographic findings</td>
</tr>
<tr>
<td>Implant failure</td>
<td>Failure to pace in the left ventricle, fatigue, activity intolerance, syncope</td>
</tr>
<tr>
<td>Cardiac tamponade</td>
<td>Jugular venous distension, narrowed pulse pressure, hypotension, chest radiographic findings, shortness of breath, chest pain</td>
</tr>
<tr>
<td>Venous occlusion</td>
<td>Arm swelling, pain, cyanosis</td>
</tr>
<tr>
<td>Electromagnetic interference</td>
<td>Palpitations, syncope, electrocardiographic changes including asynchronous pacing at preset rate</td>
</tr>
<tr>
<td>Phrenic nerve stimulation</td>
<td>Hiccups, abdominal pain, or cramps</td>
</tr>
</tbody>
</table>
of a pacemaker to make sure it is working properly and the batteries are in good condition), echocardiography is used to determine the functional effectiveness of biventricular pacemakers. Surface or transthoracic echocardiography is generally used to determine cardiac output and ejection fraction. Echocardiography is used to show optimization of left ventricular diastolic filling and ejection. It also indicates decreases in mitral regurgitation and the adequacy of the programmed atrioventricular delay.14

Pacemaker timing intervals, which are important in biventricular pacing, include atrioventricular delay, a parameter that starts with the atrial event and then is programmed to determine the time to ventricular response. Atrioventricular delay is programmed for each patient to optimize synchrony of left and right ventricular contraction. The atrioventricular delay may be programmed to be rate responsive to support a patient when his or her heart rate increases. Echocardiography indicates the cardiac output in relation to increases in heart rate to determine a patient’s ability to adapt to increases in heart rate when performing activities of daily living.

Assessment of Biventricular Pacemaker Function

Commonly, patients experience decreased exercise tolerance or fatigue when their biventricular pacemaker is not functioning optimally. They may be admitted to the hospital for shortness of breath or other signs and symptoms of heart failure, such as weight gain or lower extremity edema. If any question exists that the pacemaker is not functioning properly, a 12-lead ECG should be obtained, and a cardiologist should be contacted to review the ECG findings and determine if pacemaker interrogation is needed. In interrogation, a device is used to give information on lead integrity, battery life, and number of instances of atrial or ventricular tachyarrhythmia (Figure 4).

A 12-lead ECG is the most readily available method to determine if the pacemaker is functioning properly. Pacing spikes for both the right and the left ventricle should be evident and enable a nurse to determine if the device is pacing and capturing appropriately. When biventricular pacemakers were first implanted, it was not always evident that both right and left atrial chambers were being paced as there was no programmed delay between right and left atrial pacing. The left atrial pacing spikes and left ventricular pacing spikes were predominant in the 12-lead ECG. Now, most often data from both the right and the left ventricle are evident in the 12-lead ECG because cardiologists program the pacemaker to ensure a minimal delay that enables pacemaker spikes from both ventricles to be evident on the ECG. Data collected from the left and right ventricular leads of the pacemaker may be seen in ECG leads I and III, so monitoring in leads I and III may be beneficial to assess the function of a biventricular pacemaker.15(p252) During biventricular pacing, ECG lead V1 should show a tall R wave, and right axis deviation should be evident in the 12-lead ECG.16,17 A negative QRS complex in lead V1 in a patient with a biventricular pacemaker can occur if the V1 electrode is placed too high on the chest; other possible causes are failure of the left ventricular pacing lead, misplacement of the left ventricular lead, and delay due to scarring of myocardial tissue around the left ventricular electrode.16

When a patient with a biventricular pacemaker is admitted because of decompensated heart failure, the cause of the heart failure should be considered. The failure could be due to malfunctioning of the pacemaker, lack of adherence to medical therapy, or other causes such as infection. The patient should be asked if he or she has complied with dietary and medication therapies. A 12-lead ECG should be obtained and reviewed to determine pacemaker function. If a tall R wave and right-axis deviation are not present, a physician should be contacted.

If the patient has increased symptoms, obtain a 12-lead ECG or echocardiogram to determine biventricular pacemaker function.
because these findings may indicate the need for pacemaker interrogation to determine the function of the biventricular pacemaker and the need for further studies or pacemaker interrogation. Other determinations to be made include the following: Is the QRS interval greater than 120 ms duration, indicating ventricular activation of the impulse? Are pacemaker spikes present, and can the spikes be seen in all 3 chambers (right atrium, right ventricle, and left ventricle)?

Application of a magnet over the pacemaker should cause the biventricular device to pace at a programmed rate (an asynchronous ventricular rate). Patients with an implanted cardioverter-defibrillator have a different response to the magnet. Generally there is a single tone when defibrillation is not activated and a pulsed tone with the heart rate when defibrillation is activated. The magnet does not turn the pacemaker off permanently. In the case of death, the pacemaker must be programmed off. The preprogrammed rate depends on the manufacturer or model of the pacemaker, so the patient’s medical record should be checked to see if information on the pacemaker is available. If access to the information is not available but access to the patient’s device type and model is available on a wallet card (should be carried by every patient with a pacemaker of any type), the manufacturer can be contacted to obtain the needed information. Some pacemakers respond to application of a magnet by enabling access to stored information on the pacemaker’s function without initiating a preprogrammed pacing rate. The manufacturer can be contacted to determine if this feature of the pacemaker is the reason application of the magnet does not cause pacing at a preprogrammed rate.

Rhythm strips and a 12-lead ECG should be obtained during application of the magnet. If no pacemaker spikes are evident after magnet application, the battery may be depleted or fracture of a pacemaker lead may have occurred. Lead fracture or displacement may be evident on a chest radiograph (Figure 5). Displacement of the lead from the pacemaker may occur if the patient has experienced overextension of the left arm or trauma. ECG leads I and III should both be monitored. If the patient has an elevated body temperature or redness or drainage over the insertion site of the pacemaker generator, pocket infection or sepsis may have occurred. The hospital’s protocols for sepsis should be followed.

### Table 5  Assessment of biventricular pacemakers

<table>
<thead>
<tr>
<th>Method</th>
<th>Clinical Findings</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest radiography</td>
<td>Indications of lead dislodgement or fracture</td>
<td>Contact physician if radiographic findings suggest lead dislodgement or fracture</td>
</tr>
<tr>
<td>12-Lead electrocardiography</td>
<td>Pacemaker spikes in 3 chambers</td>
<td>Contact physician to obtain orders for pacemaker interrogation</td>
</tr>
<tr>
<td></td>
<td>Pacemaker spikes not evident in right atrium or either ventricle</td>
<td>Contact physician to obtain orders for pacemaker interrogation from manufacturer’s representative or cardiology consultation</td>
</tr>
<tr>
<td></td>
<td>Failure to pace at preset rate when magnet applied over pacemaker</td>
<td>Obtain orders for 12-lead electrocardiography with magnet</td>
</tr>
<tr>
<td>Telemetry or continuous</td>
<td>Pacemaker spikes not evident in lead I or lead III</td>
<td>Contact physician to inform of pacemaker malfunction and need to contact manufacturer for interrogation</td>
</tr>
<tr>
<td>electrocardiographic monitoring</td>
<td>Failure to pace at preset rate when magnet applied over pacemaker</td>
<td>May need to contact cardiologist for possible retiming or battery replacement</td>
</tr>
<tr>
<td>Physical assessment</td>
<td>Decreased activity tolerance, increased shortness of breath, increased indications of pulmonary congestion</td>
<td>Determine cause of increased indications of heart failure (device failure, compliance failure or other cause such as infection)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contact physician with clinical data such as electrocardiographic, chest radiographic, laboratory findings or physical findings such as fever, skin redness, or purulent drainage at pacemaker insertion site</td>
</tr>
</tbody>
</table>
Conclusion

Biventricular pacemakers are becoming increasingly common in the treatment of patients with heart failure. Critical care and telemetry nurses should be aware of the function of biventricular pacemakers and of assessment findings when the pacemakers malfunction to ensure that the nurses are able to communicate to a physician what additional diagnostic activities are needed to ensure appropriate patient care. Nurses who provide care for patients immediately after insertion of a biventricular pacemaker must also be aware of added complications associated with the implantation, such as coronary sinus vein dissection and cardiac tamponade. Assessment of the patient and of the functioning of the biventricular pacemaker is essential to ensure appropriate patient care. Online education on pacemakers is available (eg, www.medtronicacademy.com). CCN

Financial Disclosures

None reported.

References


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1. Which of the following are causes of intraventricular dyssynchrony?
   a. Timing of peak contraction of left ventricle
   b. Delayed systolic contraction of left ventricle
   c. Delayed activation of left ventricle
   d. All of the above

2. Which of the following is a complication specifically associated with biventricular pacemaker implantation?
   a. Coronary vein rupture
   b. Inappropriate timing
   c. Coronary sinus dissection
   d. Hematoma

3. Which of the following are involved in lead placement in biventricular pacing?
   a. Right atrium, right ventricle, and left ventricle
   b. Right ventricle, coronary sinus, and left ventricle
   c. Right atrium, right ventricle, and posterior cardiac vein
   d. Right atrium, left atrium, and left ventricle

4. Which of the following should be assessed to determine malfunction of biventricular pacing?
   a. Rhythm disturbance with onset of heart failure symptoms
   b. Impulse activation and presence of pacing spikes in the right atrium, right ventricle, and left ventricle
   c. Presence of left axis deviation and left bundle branch block (LBBB)
   d. Placement of pacing lead wires

5. According to the American Heart Association, indications for biventricular pacing include which of the following?
   a. Left ventricular ejection fraction (LVEF) <35%, right bundle branch block, QRS duration >130 ms, heart failure class II
   b. LVEF <35%, QRS duration >150 ms, heart failure class II
   c. LVEF <35%, LBBB, QRS duration >150 ms, heart failure greater than class II
   d. LVEF <35%, LBBB, QRS duration >120 ms, heart failure class III and IV

6. Ventricular dyssynchrony is an important variable in decompensated heart failure because it leads to which of the following?
   a. Mitral valve regurgitation
   b. Inappropriate timing of systole and diastole
   c. Impaired diastolic filling and loss of atrial kick
   d. Increased mortality in heart failure patients

7. A patient with a history of ventricular tachycardia develops class II heart failure. Echocardiogram shows LVEF of 30% with delayed contraction of the left ventricle. What form of pacemaker therapy would most benefit this patient?
   a. Biventricular pacemaker to synchronize left and right ventricular contraction
   b. Cardiac resynchronization therapy defibrillator
   c. Cardiac resynchronization therapy pacemaker
   d. Patient has class II heart failure and is ineligible for therapy

8. Benefits of biventricular pacemaker therapy include which of the following?
   a. Increased cardiac output and stroke volume
   b. Improved contraction of right and left ventricle
   c. Increase in left ventricular filling and decrease in septal dyskinesis
   d. Improved stroke volume and contraction of right ventricle

9. Which of the following leads to intraventricular dyssynchrony?
   a. Loss of atrial kick
   b. Decreased cardiac output
   c. Lack of coordination in left and right ventricular systole
   d. Lack of coordination in timing of peak contraction within left ventricular segments

10. Which of the following parameters is most integral to optimize synchronization of the left and right ventricle?
    a. Rate responsiveness
    b. AV delay
    c. Optimal left ventricular diastolic filling
    d. LVEF

Test answers: Mark only one box for your answer to each question. You may photocopy this form.

1. a 2. a 3. a 4. a 5. a 6. a 7. a 8. a 9. a 10. a

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Standards for Resuscitation After Cardiac Surgery

S. JILL LEY, RN, MS, CNS

Advanced Cardiac Life Support (ACLS) is the standard approach to management of cardiac arrest in the United States and guides patients’ resuscitation in a wide variety of clinical situations, but it has serious shortcomings after cardiac surgery. The European Resuscitation Council (ERC) has endorsed a new guideline specific to resuscitation after cardiac surgery that advises important, evidence-based deviations from ACLS and is under consideration in the United States. The ACLS and ERC recommendations for resuscitation of these patients are contrasted on the basis of the essential components of care. Key to this approach is the rapid elimination of reversible causes of arrest, followed by either defibrillation or pacing (as appropriate) before external cardiac compressions that can damage the sternotomy, cautious use of epinephrine owing to potential rebound hypertension, and prompt resternotomy (within 5 minutes) to promote optimal cerebral perfusion with internal massage, if prior interventions are unsuccessful. These techniques are relatively simple, reproducible, and easily mastered in Cardiac Surgical Unit–Advanced Life Support courses. Resuscitation of patients after heart surgery presents a unique opportunity to achieve high survival rates with key modifications to ACLS that warrant adoption in the United States. (Critical Care Nurse. 2015;35[2]:30-38)
up to 5000 US patients per year. Of critical importance is the rapid exclusion of reversible causes of cardiac arrest such as tension pneumothorax, endotracheal tube malpositioning, and infusion errors that can occur in this environment. If perfusion is inadequate in the absence of readily reversible causes, resternotomy within 5 minutes is the optimum strategy for neurologically intact recovery.1,2

Cardiac surgical patients present a unique opportunity for high survival thanks to optimal monitoring and immediate recognition of cardiac arrest from predictable causes, coupled with highly trained practitioners in an environment conducive to specialized interventions such as emergency resternotomy. In contrast to survival rates of 18% to 39% cited for in-hospital cardiac arrest,4,5 Dimopoulou et al6 reported that 79% (23/29) of their cardiac surgery patients who had a cardiac arrest survived to discharge, with 55% of these patients still alive at 4-year follow up. In the following pages, we contrast AHA and ERC recommendations for resuscitation of patients after cardiac surgical arrest, on the basis of essential components of care including cardiopulmonary resuscitation (CPR), defibrillation, management of asystole, use of epinephrine, and conduct of resternotomy.

Cardiopulmonary Resuscitation

Immediate external cardiac compressions (ECC) at a rate of 100/min and a depth of 2 inches (5 cm) are advocated by the AHA for virtually all adult cardiac arrests, but several important features of postoperative heart patients warrant consideration of a different approach. In contrast to ACLS strategies that advise compressions first, airway assessment and interventions can be performed rapidly in intubated ICU patients and may prove invaluable in quickly eliminating reversible causes of cardiac arrest. Manual ventilation of the patient with a bag-valve-mask device using 100% oxygen will determine appropriate endotracheal tube placement and the absence of pneumothorax or ventilator issues as reversible causes of cardiac arrest, while promoting optimal oxygenation. In addition, even brief external compressions can pose significant risks of cardiac damage shortly after heart surgery, as noted in multiple case reports of massive hemorrhage subsequent to CPR in these patients.7,8

ERC recommendations for resuscitation of patients after cardiac surgical arrest, on the basis of essential components of care including cardiopulmonary resuscitation (CPR), defibrillation, management of asystole, use of epinephrine, and conduct of resternotomy.

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A recent meta-analysis9 in noncardiac surgery patients receiving ECC identified a high rate of complications, including pericardial injury (8.9%), fractured sternum (15%), and rib fractures (32%), as well as additional
cases of chamber rupture, prosthetic valve dehiscence, vascular dissection, and more. After sternotomy, there is additional risk from displacement of the sternum with external compressions, as cardiac tissue or bypass grafts can be damaged or lacerated by bone edges or sternal wires. The actual incidence of these events is unknown, but they are potentially preventable and often fatal, warranting careful consideration before even brief compressions if other therapies offer benefit.

Finally, a short duration of CPR (1-3 minutes) before defibrillation of ventricular tachycardia or fibrillation (VT/VF) has not been shown to improve outcomes. The 2010 AHA guideline\textsuperscript{10} states: “With in-hospital SCA [sudden cardiac arrest], there is insufficient evidence to support or refute CPR before defibrillation.” In contrast, the ERC guideline\textsuperscript{1} states, during cardiac catheterization or in the early post-operative period following cardiac surgery (when chest compressions could disrupt vascular sutures), consider delivering up to 3-stacked shocks before starting chest compressions.

Given the potential for harm from even brief compressions, it is reasonable to defer ECC momentarily for more definitive therapies, as long as they are timely: In an arrest after cardiac surgery, external cardiac massage can be deferred until initial defibrillation or pacing (as appropriate) have been attempted provided this can be done in less than 1 minute.\textsuperscript{2}

The ERC guideline further recommends gauging the effectiveness of ECC by using the arterial pressure waveform, ensuring generation of a systolic blood pressure greater than 60 mm Hg for optimal cerebral perfusion.\textsuperscript{1} If external compressions fail to restore an adequate blood pressure, the chest should be reopened immediately, as this may indicate tamponade or extreme hypovolemia from internal bleeding.

Defibrillation

Immediate defibrillation of “shockable” rhythms is of unquestioned importance to survival and, once available, takes priority over all other therapies. When hospitalized patients with VT/VF, a majority of whom were in an ICU, were defibrillated within 2 minutes, survival nearly doubled from 22% to 39% ($P < .001$).\textsuperscript{4} Significantly higher
survival rates of 54% to 79% are achievable in patients undergoing cardiac operations, in part owing to prompt treatment of potentially reversible causes. Anthi et al cited acute destabilizing VT/VF as the cause of cardiac arrest in 45% of their patients, and 27% were attributed to mechanical events such as tamponade or pneumothorax. Half of these arrests occurred during the first 3 postoperative hours (almost 90% were within 12 hours) when patients typically are intubated with continuous electrocardiographic and hemodynamic monitoring and presumably are near manual defibrillators and personnel trained in their use.

The sequencing of defibrillation and ECC is of critical importance in these patients. Several detailed reviews have shown no benefit from CPR before defibrillation in out-of-hospital arrest when response times were 3 to 5 minutes or less, lending support to immediate defibrillation after heart surgery, where shorter response times should further negate the need for intervening compressions. Yet current ACLS algorithms advocate “a brief period” of ECC before defibrillation of VT/VF, with delivery of a single shock followed by a 2-minute cycle of CPR before repeating defibrillation attempts. In a recent large, randomized trial in patients who had experienced an out-of-hospital cardiac arrest, researchers investigated the optimum CPR duration (30-60 seconds vs 3 minutes) before rhythm analysis and shock by an automated external defibrillator, and they reported no significant differences but a trend toward better survival in the subset of VT/VF patients with shorter CPR duration.

Unfortunately, current ACLS algorithms are derived primarily from studies that used automated external defibrillators in out-of-hospital arrest, situations that are clearly different from a witnessed event in an intubated ICU patient after sternotomy. For inpatient cardiac arrest, the AHA acknowledges “the benefit of delaying defibrillation, to perform CPR before defibrillation, is unclear.” In contrast, the ERC advocates immediate delivery of 3 stacked shocks for VT/VF arrest after cardiac surgery or when a manual defibrillator is already connected.

Although there are no data supporting a 3-shock strategy in any of these circumstances, it is unlikely that chest compressions will improve the already very high chance of return of spontaneous circulation when defibrillation occurs early in the electrical phase, immediately after the onset of VF.

In ventricular fibrillation or pulseless ventricular tachycardia, 3 sequential shocks should be given without intervening CPR. In VF or pulseless VT, emergency resternotomy should be performed after 3 failed attempts at defibrillation.

When defibrillation occurs soon after the onset of VT/VF, neurological recovery is more likely regardless of diagnosis or subsequent revascularization, and defibrillation without delay is the accepted standard of care. Strategies that optimize electrical therapy for VT/VF prior to potential disruption of the sternotomy are reasonable for these patients. Additional recommendations by the AHA for in-hospital cardiac arrest that are appropriate after heart surgery include allowing nonphysicians to defibrillate and use of hands-free pads. These strategies offer important benefit both within and outside of the ICU that can significantly reduce time to defibrillation and potentially reduce mortality.

**Asystole**

Management of asystole or profound bradycardia is facilitated by the rapid institution of cardiac pacing, which is readily available after heart surgery. These rhythms may be transient or permanent and are more common following aortic valve or arrhythmia surgeries that are near the conduction system. Temporary single- or dual-chamber pacing wires are typically placed epicardially during most cardiac operations for management of bradyarrhythmias. When perfusion is inadequate because of a slow heart rate, ACLS algorithms call for immediate CPR followed by administration of epinephrine. After heart surgery, the presence of temporary pacing capabilities offers more definitive therapies that can be applied easily and without delay by staff trained in their use. The AHA generally endorses use of postoperative pacing wires to “reverse symptomatic bradycardia or asystole,” but the ERC offers additional directives:

For asystole or severe bradycardia, connect the epicardial pacing wires and set to DDD at 90 [beats per minute] at the maximum atrial and ventricular output voltages.
If the conduction system fails to respond to external pacing or chronotropic agents, the ERC guideline for a “nonshockable” rhythm recommends continuing ECC until prompt emergency resternotomy can be performed. However, it is essential to rapidly exclude the possibility of a shockable rhythm (ie, fine VF) masked behind non-capturing pacemaker spikes, to avoid delaying defibrillation in lieu of fruitless pacemaker adjustments. For any cardiac arrest with pulseless electrical activity where the temporary pacemaker is in use, this device should be paused briefly to exclude VF before reopening the patient’s chest.

Epinephrine

Use of epinephrine can cause catastrophic hypertension in postoperative heart patients, contributing to hemorrhage and the need for immediate reopening, which warrants extreme caution and modifications to standard administration. For pulselessness from any dysrhythmia, ACLS algorithms advocate administering 1 mg of epinephrine every 3 to 5 minutes, despite a lack of evidence that doing so improves survival, particularly in cardiac arrests of short duration. Cardiac surgery with cardiopulmonary bypass elicits a powerful hormonal response that triggers the release of endogenous catecholamines, and patients often receive additional inotropes or vasopressors for hemodynamic stabilization. Undesirable epinephrine effects of particular concern include increased myocardial oxygen demand and stimulation of dysrhythmias. After cardiac surgery, this “standard” epinephrine dosing can contribute to profound rebound hypertension with potential disruption of grafts and suture lines and subsequent hemorrhage. In reviewing the special circumstance of postoperative cardiac arrest, the AHA acknowledges the potential for vasopressor-induced bleeding, but cites insufficient evidence on epinephrine dose, antiarrhythmic use, and other routine pharmacological interventions to recommend deviating from standard resuscitation guidelines when cardiac arrest occurs after cardiac surgery.

A careful review of the ACLS guideline identifies that for VT/VF, an initial defibrillation attempt followed by 2 minutes of CPR should precede any epinephrine dosing. Therefore, the recommendation to initially withhold epinephrine in VT/VF arrest appears consistent with the European guideline: “Neither adrenalin nor vasopressin should be given during the cardiac arrest unless directed by a senior clinician experienced in their use.”

Although epinephrine is not indicated during cardiac arrest, it may be useful prior to cardiac arrest to support the circulation and distinguish patients who are inotrope responsive. In these situations, the ERC guideline advocates reduced doses of 100 μg or less, whenever epinephrine is used in a postoperative cardiac surgical patient. In addition, consideration should be given to discontinuing all infusions during an established cardiac arrest (with the possible exception of sedation) to exclude medication errors as an easily reversible cause of cardiac arrest.

Resternotomy

Key to the successful resuscitation of cardiac arrest in these patients is the need to perform emergency resternotomy early, especially in the context of tamponade or hemorrhage, where external chest compressions may be ineffective.

After promptly excluding reversible causes of arrest and performing defibrillation or pacing, as appropriate, immediate ECC is indicated (Figure 2). The team must then focus on achieving rapid resternotomy and internal massage by a skilled provider for restoration of optimal perfusion. Reopening the chest immediately in an ICU, rather than transporting to an operating room, allows earlier institution of internal cardiac compressions, which are often essential to neurological recovery. Hallmark studies have repeatedly demonstrated that external compressions are a poor substitute for internal massage, consistently delivering cerebral perfusion pressures that are 3- to 4-fold less than those of internal compressions and rarely exceed the 15 mm Hg end point required for neurological survival. Reexploration and direct visualization enable identification of potentially reversible causes of cardiac arrest such as hemorrhage, bypass graft abnormalities, or cardiac tamponade and can be used to rule out additional causes of profound cardiac failure.

Persistent bleeding from mediastinal chest tubes is the most frequent reason for reopening the chest postoperatively and occurs in 1% to 3% of patients. Bleeding can also precipitate cardiac tamponade, a rapidly fatal condition evidenced by inadequate cardiac filling resulting from blood and clot collections around the heart and great vessels, which often (but not always)
is accompanied by increasing intracardiac pressures that equilibrate and persistent hypotension despite fluids and medications. In the presence of significant bleeding or tamponade, ECC will be ineffective for mechanical reasons and rapid surgical correction is the standard of care. Improved survival is reported with prompt reoperation after cardiac surgical arrest: Mackay et al. reported a 48% survival rate when emergency resternotomy was performed within 10 minutes, as opposed to 12% when time to chest reopening was more prolonged.

Internal cardiac massage is superior to external cardiac massage. In patients with a recent sternotomy in whom resuscitative efforts are likely to last more than 5 to 10 minutes, emergency resternotomy is indicated in order to perform internal cardiac massage even if a reversible cause from resternotomy seems unlikely.

### Standardizing the Approach to Cardiac Surgical Arrests

The ERC guideline for management of postoperative cardiac arrest offers the most specific and appropriate evidence-based approach to these events that is currently available and should be adopted as the standard of care in the United States. The European Association for Cardio-Thoracic Surgery (EACTS) developed this guideline after an in-depth literature review and evidence grading by using standard criteria, followed by web-based surveys sent to surgeons internationally and refinement during the conduct of numerous resuscitation courses. The evidence-based guideline provided by Dunning et al. was the first to specifically address management of cardiac arrest after cardiac surgery and was promptly endorsed in the global ERC resuscitation standards following year. The EACTS and ERC currently recommend this approach in preference to standard resuscitation protocols for cardiac arrests after cardiac surgery.

In addition to the management principles identified here, the guideline by Dunning et al. provides a comprehensive approach to the personnel, practices, and equipment necessary to consistently perform emergency resternotomy within 5 minutes, eliminating wasted seconds that are nonbeneficial (Figures 1 and 2). Key to this approach is a readily available “mini” sternotomy set that includes only the essential instruments for reentry (large drape, scalpel, wire cutter, heavy needle holder, retractor, and suction) as well as staff preparation. Ongoing practice with the multidisciplinary team in simulated open chest resuscitations is strongly recommended to ensure that personnel working with these patients are familiar with specialized procedures to quickly and safely reopen a chest in the ICU. Institutional expectations during these “high-risk, low-volume” situations should be well defined and rehearsed to achieve rapid reopening with optimal survival rates. Hands-on practice with emergency carts, internal defibrillators, and possibly sternal saws (for “mini” or robotic approaches) allows
ICU nurses to be familiar with their use while maintaining sterile technique. This population may be well suited to “specialty-specific emergency response teams,” as advocated by the AHA for pediatrics and maternal-fetal cardiac arrests. Although most experienced US cardiac surgery programs are well aware of ACLS’ limitations and work around them, rarely are written protocols to guide a different approach available. Potential confusion and delays during these emergencies can occur in the absence of clear guidelines, which creates liability and limits our ability to attain the high survival rates that are achievable in these patients.

For the first time, a more appropriate algorithm for management of cardiac arrest after cardiac surgery exists that is evidence based and easily taught in a reproducible fashion. In collaboration with European guideline developers, courses in Cardiac Surgical Unit—Advanced Life Support are being offered through venues such as the American Association for Critical-Care Nurses’ National Teaching Institute to promote standardization, increase providers’ knowledge and comfort, and improve patients’ outcomes. These courses, currently certified by the ERC but not yet by any US governing body, offer a standardized approach to postoperative cardiac arrest that is gaining acceptance rapidly among US providers.

Summary

The AHA has called for research to improve our understanding of in-hospital cardiac arrest and reduce knowledge gaps; cardiac surgery is a good place to start. Dunning et al1 have generated a clearly defined, evidence-based protocol for cardiac surgical arrests that offers a much needed standard of care for these high-risk events. Additional research and new evidence are welcomed to further refine this guideline in the years ahead, but this is a tremendous first step in defining best practices in postoperative cardiac emergencies that produce optimal outcomes for patients. The avoidance of standard resuscitation techniques for these highly specialized situations is a critical concept that will save lives and shape our practice for years to come. CCN

Financial Disclosures
None reported.

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References
Facts

Advanced Cardiac Life Support is the standard approach to management of cardiac arrest in the United States and guides patients’ resuscitation in a wide variety of clinical situations, but it has serious shortcomings after cardiac surgery. This article reviews key differences and supporting evidence between Advanced Cardiac Life Support and guidelines recently adopted by the European Resuscitation Council (ERC), counterpart to our American Heart Association, that are specific to resuscitation after cardiac surgery (see Table).

The ERC guideline for management of postoperative cardiac arrest offers the most specific and appropriate evidence-based approach to these events that is currently available and should be adopted as the standard of care in the United States.

For the first time, a more appropriate algorithm for management of cardiac arrest after cardiac surgery exists that is evidence based and easily taught in a reproducible fashion. In collaboration with European guideline developers, courses in Cardiac Surgical Unit–Advanced Life Support are being offered through venues such as the American Association for Critical-Care Nurses’ National Teaching Institute to promote standardization, increase providers’ knowledge and comfort, and improve patients’ outcomes. These courses, currently certified by the ERC but not yet by any US governing body, offer a standardized approach to postoperative cardiac arrest that is gaining acceptance rapidly among US providers. CCN

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**Table** Recommendations for management of cardiac arrest: ACLS versus CSU-ALS

<table>
<thead>
<tr>
<th>ACLS recommendations for arrest</th>
<th>CSU-ALS recommendations for postoperative cardiac surgical arrest</th>
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<tbody>
<tr>
<td><strong>Ventricular fibrillation or pulseless ventricular tachycardia</strong></td>
<td></td>
</tr>
<tr>
<td>Immediate external cardiac massage</td>
<td>Defibrillate first if available within 1 minute</td>
</tr>
<tr>
<td>External cardiac massage → single shock → external cardiac massage × 2 minutes before repeating shock</td>
<td>Three stacked shocks before external cardiac massage</td>
</tr>
<tr>
<td><strong>Asystole or profound bradycardia</strong></td>
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<tr>
<td>External cardiac massage → vasopressor</td>
<td>DDD pacing at maximum outputs if available within 1 minute → external cardiac massage</td>
</tr>
<tr>
<td><strong>All pulseless cardiac arrests</strong></td>
<td></td>
</tr>
<tr>
<td>Epinephrine 1000 μg every 3-5 minutes; vasopressin 40 units may be used for first or second dose</td>
<td>No epinephrine or vasopressin during arrest</td>
</tr>
<tr>
<td>Use specific roles under direction of team leader</td>
<td>Reduce epinephrine dose to 100 μg prearrest</td>
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<tr>
<td></td>
<td>Use 6 key roles during arrest management</td>
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<tr>
<td></td>
<td>Rapid resternotomy (&lt;5 minutes) if no response to initial therapies</td>
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Abbreviations: ACLS, Advanced Cardiac Life Support; CSU-ALS, Cardiac Surgical Unit–Advanced Life Support.
CE Test

Test ID C152: Standards for Resuscitation After Cardiac Surgery


1. Which of the following reflects the current standard for managing cardiac arrest in postoperative cardiac surgery patients in the United States?
   a. Advanced Cardiac Life Support (ACLS) includes detailed guidelines for resuscitation after cardiac surgery.
   b. ACLS guidelines are consistent with those adopted by the European Resuscitation Council (ERC).
   c. ACLS has significant limitations when implemented in postoperative cardiac surgery patients.
   d. ACLS incorporates evidence-based recommendations for resuscitation of cardiac surgery patients.

2. Reversible causes of cardiac arrest that should be quickly assessed in postoperative cardiac surgical patients include all except which of the following?
   a. Tension pneumothorax
   b. Electrolyte imbalance
   c. Infusion errors
   d. Endotracheal tube malposition

3. Which of the following explains why airway assessment and interventions should precede compressions in cardiac arrest after cardiac surgery?
   a. Intubation can be performed quickly in this patient population.
   b. Hypoxia is the leading cause of arrest after cardiac surgery.
   c. Manually ventilating the patient can help identify reversible causes of the arrest.
   d. Promoting optimal oxygenation will increase the success of defibrillation.

4. Which of the following describes an additional risk to performing external cardiac compressions in patients after sternotomy?
   a. Cardiac tissue can be damaged by sternal wires
   b. Rib fractures can occur
   c. Valve dehiscence is more common
   d. Chamber rupture is likely

5. The ERC guidelines contain which of the following recommendations for the use of external cardiac compressions (ECCs) during cardiac arrest that occurs after cardiac surgery?
   a. ECC should be performed for 1-3 minutes before defibrillation to enhance the effectiveness of the shock.
   b. ECC should be evaluated by using the arterial pressure waveform to achieve a systolic blood pressure of greater than 60 mm Hg.
   c. ECC can be deferred until initial defibrillation has been attempted, if this can be accomplished within 3 minutes.
   d. ECC should be avoided and the chest should be reopened immediately to allow for internal cardiac massage.

6. Which of the following describes the ERC recommendation for the sequencing of defibrillation and cardiopulmonary resuscitation (CPR) in a cardiac surgery patient?
   a. Three sequential shocks should be delivered without intervening CPR.
   b. CPR should be administered for 1 minute, followed by 3 stacked shocks.
   c. A single shock should be delivered, followed by 2 minutes of CPR.
   d. One shock should be delivered, followed by emergency resternotomy if unsuccessful.

7. Which of the following is recommended by the ERC for management of asystole or symptomatic bradycardia in cardiac surgery patients with epicardial pacing wires?
   a. Chronotropic medications such as epinephrine should be used before initiating pacing.
   b. CPR should be performed immediately to restore adequate perfusion.
   c. Epicardial pacing should be initiated rapidly, with maximal atrial and ventricular outputs.
   d. Ventricular pacing should be initiated as soon as possible at a rate of 90 beats per minute.

8. Which of the following best describes the rationale for not routinely administering epinephrine in postoperative cardiac surgery patients who experience pulseless arrest?
   a. Epinephrine has been proven to improve survival only in cardiac arrests of short duration.
   b. Epinephrine use in cardiac surgery patients results in an increased incidence of tachycardia.
   c. Epinephrine contributes to hyperglycemia.
   d. Epinephrine-induced hypertension can disrupt grafts and suture lines, leading to hemorrhage.

9. Which of the following describes an advantage of performing early resternotomy in cardiac surgery patients who arrest?
   a. Reopening the chest increases right atrial pressure, which improves cerebral perfusion pressures.
   b. Direct visualization enables identification and treatment of potential causes of arrest such as hemorrhage or tamponade.
   c. External cardiac massage is more effective than internal cardiac massage in this patient population.
   d. Decreased survival is reported when emergency resternotomy is performed within the first 10 minutes of a cardiac arrest.

10. ACLS includes which of the following sequence of interventions for immediate treatment of cardiac arrest caused by ventricular fibrillation or pulseless ventricular tachycardia?
    a. 1 minute of external cardiac massage followed by 3 stacked shocks
    b. Immediate external cardiac massage followed by a single shock
    c. Immediate defibrillation with a single shock followed by 2 minutes of external cardiac massage
    d. Immediate defibrillation with three stacked shocks followed by 1 minute of external cardiac massage

11. The Cardiac Advanced Life Support-Surgical algorithm contains all except which of the following interventions?
    a. Deliver 3 stacked shocks before initiating external cardiac massage for ventricular fibrillation
    b. Perform rapid resternotomy (<5 minutes) if no response to initial therapies
    c. Administer a reduced dose of epinephrine (100 µg) during a pulseless arrest
    d. Initiate DDD pacing at maximal outputs for treatment of asystole

Test answers: Mark only one box for your answer to each question. You may photocopy this form.

1. [ ] a [ ] b [ ] c [ ] d
2. [ ] a [ ] b [ ] c [ ] d
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Test ID: C152 Form expires: April 1, 2018  Contact hours: 1.0  Pharma hours: 0.0  Fee: AACN members, $0; nonmembers, $10  Passing score: 8 correct (73%)

Synergy CERP Category A  Test writer: Joni L. Dirks, RN-BC, MS, CCRN

The American Association of Critical-Care Nurses is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center’s Commission on Accreditation. AACN has been approved as a provider of continuing education in nursing by the State Boards of Nursing of California (#01036) and Louisiana (#ABN12). AACN programming meets the standards for most other states requiring mandatory continuing education credit for relicensure.
Ensuring that we provide safe, evidence-based, cost-effective care to all patients is an assumption of today's health care system. All patients and health care providers should expect a health care system that is committed to preventing harm and improving patient care by having clinicians use evidence-based safe practices. The call for evidence-based practice (EBP) was made in the hallmark publication of the Institute of Medicine's report “To Err Is Human” more than a decade ago. Since this hallmark publication, efforts have been made by multiple organizations to encourage EBP. Organizations such as the Institute for Healthcare Improvement, The National Quality Forum, The Johns Hopkins Medicine Center for Innovation in Quality Care, the Agency for Healthcare Research and Quality, Joanna Briggs Institute, the American Association of Critical-Care Nurses, the...
Society of Critical Care Medicine,4 and the American College of Clinical Pharmacists,5 just to name a few, all provide best-practice documents and toolkits for how to implement EBP initiatives to improve patient outcomes. Yet, not all best-practice evidence is translated into daily practice, leaving some interventions, wedded in tradition, to remain part of practice.8,11 Similarly, not all interventions have strong research evidence to support them12,13; thus, clinicians must critically appraise the evidence that is available to guide practice.

To ensure that practice is based on current best evidence, critical care nurses must have a good understanding of what EBP is. Multiple definitions of EBP can be found in the literature. Regardless of which definition resonates best with your practice, all definitions have several key tenets. Essential elements of EBP include the integration of best research and other forms of evidence to guide practice, viewing clinical expertise as a component in care effectiveness, and consideration of patients’ preferences, values, and engagement in care decisions as essential to provide optimum evidence-based care to patients and their families.2,12-15 Embracing EBP as a practice norm requires critical care nurses to challenge traditional ways of providing care and move to practice interventions that apply current evidence to meet patient care needs better.

Although it is beyond the scope of this article to provide an in-depth discussion of EBP, a few critical points need to be made as we challenge practice interventions to be based on best evidence. The first point is that evidence is constantly evolving as we learn more about the effectiveness of care interventions. Thus, as critical care nurses, we must remain active learners throughout our career, gaining new knowledge to guide practice. Second, research evidence provides the foundation of care interventions, and EBP could not exist without well-done research.16 However, research evidence may not always be available to guide practice interventions, so nonresearch evidence should be examined critically to inform practice. Third, not all evidence provides clear answers to clinical questions; thus, the strength of evidence should be evaluated as to the risk or benefit of using the evidence to guide practice.17,18 Several tools exist to help clinicians critically evaluate and determine the strength of evidence (ie, level of evidence). AACN’s level of evidence provides criteria to help evaluate the strength of evidence to help clinicians evaluate use of that evidence to support practice.17 (Readers are referred to a recently published article in Critical Care Nurse that discusses the application of AACN levels of evidence to guide clinical practice for more information.) When research evidence is limited, critical evaluations of all forms of evidence (eg, nonexperimental evidence, national practice alerts, expert opinion, consensus statements, manufacturers’ guidelines) are necessary to guide practice.

This article is based on a presentation at the AACN’s 2014 National Teaching Institute that took place in Denver, Colorado. The presentation was the seventh of a series of presentations and articles that challenge critical care nurses to examine the evidence used to guide nursing practice interventions.19-23 In this most recent presentation, evidence for 4 critical care nursing practice interventions was examined: (1) weight-based medication administration, (2) chest tube patency maintenance interventions, (3) daily interruption of sedation, and (4) use of chest physiotherapy (CPT) in children. The evidence and implications for practice associated with each topic are discussed.

**Weight-Based Medication Practice**

Safe administration of medication often involves knowledge of the patient’s weight to determine the correct dosage. When medication dosage is based on the patient’s weight, the practice is referred to as weight-based medication dosing, as opposed to fixed dosing, which does not factor in weight.24 Numerous medications administered by critical care nurses use weight-based dosing: opioid, vasoactive, cardiac, corticosteroid, anti-convulsant, sedating, and anti-infective agents, to name a few. The clinical practice question that arises is which...
weight is the best patient weight to use in determining weight-based medication dosages? Pharmacokinetic considerations associated with weight-based dosing of chemotherapeutic and antithrombotic agents are not addressed here. Additionally, weight is influenced by the patient’s overall adiposity, which influences metabolic regulation.25 Multiple elements must be examined when looking at safe weight-based medication administration, including the medication’s hydrophilic or lipophilic properties and end-organ metabolism efficacy;25,26 these factors are not discussed here. Rather, this practice question focuses on exploring the evidence supporting best practice for communicating the patient’s weight for optimal decisions about administration of weight-based medications in intensive care units (ICUs).

Review of Current Evidence

Inaccurate weight-based drug calculations result in accidental underdosing or overdosing of patients.24,27 Two populations at greatest risk of inaccurate weight-based medication dosing are elderly patients and obese patients.24,27-30 Elderly patients are at risk of adverse drug reactions most frequently because of changes in renal function,28 and obese patients are at increased risk because of limited data guiding correct dosing in this population.24,26,27,30 Dosages for patients who are overweight are more likely to be too high or too low. Correct dosing in overweight patients is a concern because 68% of adults are overweight or obese, 6.7% are morbidly obese,31 and overweight individuals have a high number of hospital admissions, longer duration of mechanical ventilation, and longer hospital stays.32-35

Weight is a kinetic variable that reflects changes in volume of distribution for assessing the therapeutic effectiveness of a drug better than body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) does.24,26,36 Historically, pharmacokinetic properties of drug therapeutic effectiveness were studied within limited ranges, typically by using an average patient, often described as the “70-kg, 5-foot 5-inch healthy man.”24,17,38 Several weight measurements have been reported as appropriate for use in weight-based medication administration. Research supporting the different weight measurements is sparse; most researchers have explored specific weight metrics with certain medications. Critical care nurses should work closely with pharmacists in reviewing specific weight-based dosing strategies.

BMI has been explored as a metric for weight-based dosing. In a clinical review examining the state of the science and mathematical assumptions associated with weight-based medication administration, Pai24 addresses the concept that BMI is a metric developed to aid categorization of patients by weight and percentage of body fat. BMI was not developed to aid in drug dosing. Thus use of BMI as a standard metric for determining weight-based medication dosing should be avoided.24,27,27 However, knowing a patient’s BMI, specifically if they are in the obese (BMI 30-39.9) or extremely obese (BMI >40) categories, may be helpful in determining weight-based dosing. In a multicenter randomized cohort study evaluating the therapeutic effectiveness of vancomycin dosing, researchers reported that incorporating BMI was an important factor to consider as higher dosing was needed in patients who were obese to achieve therapeutic blood levels of the agent.

Ideal body weight (IBW) is a socially determined metric that incorporates height, sex, and age in determining an appropriate weight. Similar to BMI, this metric also was not developed for medication dosing.24,28-40 One instance in which IBW may be helpful with weight-based medication dosing is in the care of morbidly obese patients. To avoid underdosing or overdosing a morbidly obese patient (BMI >40), the clinician or pharmacist may use a formula in which the patient’s IBW is subtracted from the patient’s actual body weight (ABW) and multiplied by 0.4 to obtain an adjusted weight for dosing ([ABW - IBW] x 0.4 = dosing weight).24,26,36 Using an obese patient’s ABW to calculate a medication dosage will on average result in too high a dose, and using an obese patient’s IBW will on average result in a subtherapeutic dose for the patient.27,38

Dry weight is often a misused phrase in the ICU. Nurses may consider a patient’s admission weight to be the person’s dry weight; this is incorrect. Dry weight is a term used for patients with end-stage renal disease, and it is the weight of the patient after dialysis treatment.41 Dry weight is defined as the lowest tolerated postdialysis weight achieved by gradual change in postdialysis weight at which signs or symptoms of hypovolemia or hypervolemia are minimal.41 Dry weight is not a weight
to be used for weight-based medication dosing in patients who do not have end-stage renal failure.

Current evidence suggests that the patient’s ABW is the best weight to be communicated for decisions related to weight-based medication dosage. However, caution regarding the ABW needs to be exercised with obese patients. The critical care nurse is essential in obtaining, documenting, and communicating an accurate ABW on which care decisions will be based. Ideally the patient is weighed on admission to the ICU. Although it may not be practical to obtain the patient’s weight immediately upon admission, processes to ensure that the patient is weighed shortly after admission should be established. Actually weighing the patient is an important intervention, as research has shown that clinicians are not very good at “estimating” patients’ weight. Patient’s self-reported weights are more accurate than weight estimations by health care providers. Avoid guessing the patient’s weight for medication-dosing purposes. In a recent retrospective cohort study, researchers explored the efficacy of body weight and vasopressin therapy in patients with septic shock. The researchers found that adjusting vasopressin dosing on the basis of ABW resulted in improved vital signs.

Kane-Gill and colleagues conducted an observational study of “real world” dosing and adverse drug reactions. The researchers reported that most adverse drug reactions occurred in overweight patients. In a recent Cochrane review, Gillaizeau et al reported that embracing computerized advice on drug dosage decisions to include weight-based dosing was associated with an increase in serum concentrations of anti-infective agents, achievement of physiological effects of prescribed agents more consistently, and reduction in the number of medication errors. A critical element for maximizing computer-assisted weight-based dosing is the accurate entry of the patient’s ABW into the electronic health record. Frequently, this essential task is completed during the nurse’s admission process, and the accuracy of the admission weight will influence medication administration for that patient.

Obtain and use the patient’s actual body weight for weight-based medication administration. Critically evaluate medication therapeutic effectiveness and dosage accuracy in obese patients.

Implications for Practice

Admission weight, ABW, should be obtained, documented, and communicated for weight-based medication administration decisions throughout the patient’s ICU stay. Daily adjustments of the weight for dosing may result in medication errors. When patients have changes in weight because of fluid shifts, medication dosages should be adjusted to achieve the desired pharmacological response. Nurses working collaboratively with the provider and pharmacists may make weight-based decisions depending on the patient’s ABW, end-organ function, agent pharmacokinetics, and desired therapeutic effects. Finally, older patients and patients with higher BMIs require more vigilant monitoring by critical care nurses to evaluate the therapeutic effectiveness of medications, as these patients are at greatest risk for adverse drug reactions, including both underdosing and overdosing of medications.

Maintenance of Chest Tube Patency

Chest tubes are ubiquitous in cardiac and thoracic surgery. The chest tube serves as a drain for the removal of air, blood, and other fluids from the pleural and/or mediastinal spaces. Nurses must be knowledgeable and competent in the assessment and care of all things inserted into or attached to their patients. It is essential that the nurses caring for a patient with a chest tube know why and where the tube is placed, how to assess for proper functioning and troubleshoot improper functioning, when and how to measure drainage, what the expected drainage is, and how to assess for the presence of complications and maintain patency. A nurse’s failure to know and perform these important skills properly could cause serious harm to patients. The evidence supporting the management of chest tubes dates back to the early 1980s, yet some critical care nurses may still be managing chest tubes by using traditional practice interventions, such as stripping chest tubes, rather than practice based on best evidence.

Review of Current Evidence

The earliest method to maintain patency of chest tubes, primarily mediastinal tubes, was known as stripping. The clinician would grasp the drainage tube very close to the patient’s body and while collapsing the tube between the thumb and fingers, pull down the tube from the insertion site. The rationale for this procedure was
to increase the vacuum pressure in the tube to assist in the removal of the drainage within the chest and remove any clots that might be forming within the tube. When stripping was performed, clinicians (the author included) were taught, and probably taught others, that this was a very important procedure to maintain tube function and patency, and to prevent infection, pericardial tamponade and the need for emergent reoperation, and even cardiac arrest. A rolling device was sometimes employed to assist with the stripping procedure for clinicians who might not have the hand strength to ensure consistent pressure.

Nurses and other clinicians who routinely stripped chest tubes saw complications that might have been related to the procedure. Patients complained of pain, some tubes were dislodged and even pulled out, and typically there was more drainage after stripping. The clinical practice question arose as to whether the increase in chest tube drainage was assisted by the stripping or caused by the stripping. Once this question was asked, investigators started looking into whether the stripping or rolling was accomplishing the intended purposes or actually causing injury and harm to patients.

In 1982, Duncan and Erikson examined the effects of stripping chest tubes and reported that the intervention did increase negative pressure in the intrathoracic cavity. This finding brought the procedure into question. Practice evolved from stripping chest tubes to “milking” the tubes to maintain patency. The objective of milking was not to actually collapse the tube but to massage it to break up any clots, to avoid having any dependent loops that could fill up with fluid, and to ensure the tubing and drainage system stayed below the level of the insertion site. In 1986, Isaacson et al reported no difference in drainage quantities between milking and stripping in 211 cardiac surgery patients. Pierce et al validated this finding when they reported no difference between milking and stripping as far as drainage, complications, and vital sign changes. Although the research was limited, more than 2 decades ago, research demonstrated that both stripping and milking served no good purpose related to chest tube patency and probably caused harm. Yet to date this practice tradition may still be performed in the care of patients with chest tubes.

The clinical question to be answered was whether any intervention or procedure was necessary to maintain chest tube patency and avoid complications of chest tube drainage systems. Lim Levy et al compared stripping, milking, and no manipulation for 60 cardiac surgery patients and found no difference in tube occlusion when no manipulation was performed. Kirkwood authored an “Ask the Expert” column in Critical Care Nurse regarding stripping versus milking chest tubes and concluded that both interventions “should be avoided” because they do not improve chest tube patency and may cause an undesired increase in intrathoracic pressures.

In 2002, the Cochrane Database of Systematic Reviews published a review of the literature and evidence-based recommendations for the question of mediastinal chest drain clearance for cardiac surgery. It was updated in 2004. Nine hundred ninety-two papers were narrowed to 3 studies involving a total of 471 patients. The 3 studies did not provide common interventions or outcomes, so data pooling and meta-analysis could not be performed. However, based on “single studies,” the conclusion was that there was no difference in output, cardiac tamponade, or surgical re-entry between stripping, milking, and no manipulation.

Day and colleagues published a best evidence topic discussion to answer the question “Is manipulation of mediastinal chest drains useful or harmful after cardiac surgery?” The authors completed an extensive literature search and identified 681 papers, of which 4 papers provided the best evidence to answer the clinical question. The authors determined that chest drainage system manipulation with stripping or milking demonstrated no safety or efficacy benefits, slightly increased pressure, and risked tissue damage. Their conclusion was that no manipulation of drainage tubes should be done on a routine basis.

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Finally, the 6th edition of the AACN Procedure Manual for Critical Care echoes the recommendations offered by Day et al. The manual states, at level C evidence, that stripping and milking of closed chest drainage systems are contraindicated.

Implications for Practice

Although the quantity of research is small, the consistency of the findings is impressive. Chest drainage tubes serve an important function in the care and recovery of cardiothoracic surgery patients. No manipulation
of drainage tubes should be done on a routine basis. The management of these tubes should be based on the best evidence available. If current practice, unit protocols, or even physicians’ orders suggest stripping or milking chest tubes, which does not match the evidence-based practice recommendations, clinicians need to review the evidence and consider changing their practice. The research and evidence available on care of chest tubes clearly indicates that stripping and milking are not necessary to maintain chest tube patency and probably cause more harm than good.

Daily Interruption of Sedation

Administering sedation agents as part of patient care is common in the ICU, and use of sedation agents has been associated with prolonged mechanical ventilation. Sedation is used for a variety of reasons, including supplementing analgesic medications; decreasing anxiety, dyspnea, and delirium; facilitating patient care; reducing oxygen consumption; and producing a state of amnesia. The drawback to sedation is that it can accumulate in the body tissue and prolong the duration of mechanical ventilation. Providing sedation is a common practice in the management of critically ill patients, but the evidence supporting best practice for this intervention has recently been examined.

Related Beliefs and Evidence

The evidence guiding sedation administration practices has been evolving during the past decade. In the past, sedation was administered via continuous intravenous infusion without interruption until the prescriber decided it was time to wake the patient up. In the past few years, that philosophy has changed to one that is more patient focused, and sedation is tailored to the patient’s goals of care. The current recommended practice is to keep a patient more conscious by maintaining a light level of sedation and to use intermittent sedation versus continuous infusions. Both methods of delivery have their advantages and disadvantages. Continuous infusions of sedatives facilitate a steady state of sedation; however, continuous infusions promote the accumulation of the drug in body tissues and may extend the time it takes for the patient to wake up. Intermittent intravenous boluses of sedatives provide the least amount of sedation to achieve the desired effect; however, fluctuations in blood levels may be greater, resulting in peaks and troughs. During the peak, a patient may be over-sedated and during the trough undersedation may occur.

Another change in sedation administration practice is the incorporation of infusions that have a daily interruption of sedation (DIS). DIS is also referred to as daily awakening, sedation vacation, and a spontaneous awakening trial. During a DIS, all continuous infusions of sedatives being administered to a patient receiving mechanical ventilation are stopped and the patient is allowed to wake up to assess his/her level of consciousness and readiness for a spontaneous breathing trial. The anticipated outcomes from a DIS are to decrease the duration of mechanical ventilation and to decrease the ICU length of stay (LOS). The DIS has gained a lot of popularity; however, it is not for all patients. Patients who have been receiving mechanical ventilation for a prolonged period, have profound neurological deficits, or who may have life support withdrawn should not have a DIS.

Recent research indicates that although DIS reduces the duration of mechanical ventilation and ICU LOS in certain groups of patients, there are perceived barriers to its implementation. Tanios et al administered a web-based survey to 12,994 nurse, physician, and pharmacy members of the Society of Critical Care Medicine. Nine hundred four (904) responders identified their perceived barriers to the use of a DIS. The top 3 perceived barriers were the potential for respiratory compromise (26%), the lack of acceptance by nursing (22%), and the increased risk of patients’ removing devices (19%).

Evidence to support the use of a DIS to reduce the duration of mechanical ventilation is mixed. Two randomized controlled trials reported a significant decrease in the duration of mechanical ventilation. Similarly, in a performance improvement project, Jones et al reported that the duration of mechanical ventilation was shortened after the implementation of a spontaneous awakening trial and spontaneous breathing trial protocol was implemented. In contrast, researchers in 2 different studies reported no difference in the duration of mechanical ventilation, and in a third study, de Wit and colleagues reported that the group that received the DIS exhibited a longer duration of mechanical ventilation. Augustes and
Ho\textsuperscript{5} conducted a meta-analysis of randomized controlled trials on the use of a DIS, in isolation, in critically ill adult patients. Fourteen studies were identified; however, only 5 studies involving 699 critically ill adult patients were identified and included in the meta-analysis. The results of the meta-analysis indicated that a DIS in isolation does not decrease the mean duration of mechanical ventilation in critically ill adult patients ($P = .66$; 95% confidence interval, -2.49-3.92).

Research exploring the impact of a DIS on ICU LOS has yielded mixed results. Five studies\textsuperscript{62,64,65,68,69} were done to evaluate the effect of a DIS on ICU LOS. In 2 of the studies,\textsuperscript{64,65} a shorter ICU LOS was reported; in 2 studies,\textsuperscript{42,68} no difference was reported; and in 1 study,\textsuperscript{69} a longer ICU LOS in patients who received the DIS was reported.

One perceived barrier to the implementation of a DIS is the risk of the patient removing invasive catheters and tubes.\textsuperscript{66} Three studies\textsuperscript{62,64,65} were done to evaluate the effect of a DIS on self-extubation. One study\textsuperscript{64} showed an increased frequency of self-extubation without reintubation, and 2 studies\textsuperscript{62,65} showed no difference in the frequency of self-extubation. In the meta-analysis exploring the impact of a DIS, Augustes and Ho\textsuperscript{5} reported that a DIS does not increase the odds of self-extubation (odds ratio, 1.30; $P = .65$; 95% confidence interval, 0.41-4.10). Thus current evidence suggests that fear of patients’ self-extubation if sedation is discontinued has not been substantiated by research.

**Implications for Practice**

The practice of DIS, or sedation awakening, is based on limited scientific data\textsuperscript{62,64,65,68}; however, it has been implemented in many organizations along with EBP efforts to reduce oversedation of critically ill patients.\textsuperscript{61} The research evidence that supports this practice included patients in medical ICUs, with limited or no other patient populations studied. Based on the limited data available, it appears that DIS is safe in medical ICU patients.\textsuperscript{70} Further evidence is needed to determine the benefit of a DIS in other populations of patients. Nurses should continue to conduct and publish outcome evaluations to evaluate the positive effects of a DIS in more diverse patient populations and on the duration of mechanical ventilation, ICU LOS, and the incidence of self-extubation. A large randomized controlled trial in varied populations is needed to evaluate more effectively the safety and effectiveness of a DIS across all critical care practice settings. Additionally current practice evidence suggests that sedation should be used judiciously and that goals of sedation should be patient-specific to avoid overuse of sedating agents.\textsuperscript{61}

**Use of Chest Physiotherapy in Children**

CPT is a common sight in pediatric units. It is performed by nurses, respiratory therapists, physical therapists, and parents for children of all ages and diagnoses. CPT was first described in 1901 for treatment of bronchiectasis in adults.\textsuperscript{71} In the 1960s and into the 1970s, the use of CPT increased significantly in response to the criticism of positive-pressure breathing therapy.\textsuperscript{71} However, despite the increase in the use of CPT, evidence supporting this intervention is lacking.

CPT is the term commonly used to describe the manual percussion or chest clapping over both anterior and posterior lung fields. Percussion is thought to loosen secretions from the bronchial walls, enabling children to move secretions out of the airways with coughing.\textsuperscript{72} Loosening secretions aids in airway clearance, decreases the work of breathing, improves gas exchange, and decreases the duration of illness.\textsuperscript{73} The evidence regarding conventional CPT, involving percussion, postural drainage, and coughing in various common pediatric respiratory diagnoses is reviewed. Limitations in evaluating the evidence include the fact that early studies often used custom-made respiratory scores and subjective measures such as less coughing or improved oral intake\textsuperscript{73} making it difficult to compare study findings. Additionally, because of the active components of CPT, blinded trials are nearly impossible.

**Review of Current Evidence**

**Pneumonia.** The World Health Organization\textsuperscript{74} reports that pneumonia is the leading cause of death for children less than 5 years old. CPT has been used as an adjunct to decrease severity, length of illness, and improve outcomes of this serious disease. However, De Boeck and colleagues\textsuperscript{75} found little evidence to support use of CPT to treat pneumonia. Studies that supported the use of CPT to treat pneumonia did not have well-defined inclusion criteria and were published in the 1980s. Studies have not demonstrated improvement in signs and symptoms, decreased length of illness, decreased LOS,\textsuperscript{75,76} or reduction in duration of fever.\textsuperscript{77} Furthermore, pneumonia occurs in the peripheral airways; therefore, secretions are
not located in an area where CPT could facilitate movement of secretions out of the airways.\textsuperscript{73,74}

In a Cochrane database review, Chaves et al\textsuperscript{77} looked at CPT in the treatment of pneumonia in which the primary outcome criteria were mortality, LOS, and time to clinical resolution. The signs used for clinical resolution were absence of fever and work of breathing as evidenced by decreased retractions, nasal flaring, tachypnea, and normalized oxygen saturation levels. Three randomized clinical trials that involved 255 children from 29 days to 12 years old met study inclusion criteria. Researchers in 2 of the studies reported significant improvement in respiratory rate and oxygen saturation, but the third study failed to demonstrate a decrease in length of illness or LOS, and a meta-analysis could not be performed. The Cochrane review\textsuperscript{77} concluded that the evidence is insufficient to support the use of CPT in pneumonia. In another study,\textsuperscript{75} researchers randomized 72 hospitalized children 1 to 12 years old to receive standard respiratory care or CPT. No significant difference in severity of respiratory rate or duration of hospitalization was found between the 2 treatment groups. Additionally, the American Association of Respiratory Care does not recommend routine CPT in the treatment of pneumonia.\textsuperscript{72} Despite the widespread practice, the evidence does not support the use of CPT in the treatment of pediatric pneumonia.

**Bronchiolitis.** Bronchiolitis is a disease of the small airways of the lower respiratory tract, most commonly caused by viruses such as respiratory syncytial virus. It can cause significant symptoms of respiratory distress manifested by cough, tachypnea, retractions, and wheezing. The symptoms of bronchiolitis are a result of lower airway obstruction from the exudate and debris produced as a result of the necrosis of the epithelial layer of the airways.\textsuperscript{73} The goal of CPT is to relieve the airway obstruction and reduce the symptoms of respiratory distress. De Boeck and colleagues\textsuperscript{73} report the results of 3 randomized clinical trials of infants with bronchiolitis. CPT did not decrease LOS or need for supplemental oxygen and did not reduce illness severity. In another study\textsuperscript{78} of 601 children with lower respiratory infections admitted to 10 children’s hospitals, researchers compared use of CPT and length of illness. The use of CPT in these institutions varied from 45% to 71%, but the time to recovery did not differ.\textsuperscript{79} Thus CPT does not seem to shorten the course of illness.

Traditional passive CPT has been compared with forced passive exhalation as an adjunct to improve secretion clearance. Rochat and colleagues\textsuperscript{79} studied 98 infants less than 1 year old who had a diagnosis of bronchiolitis. The control group received routine supportive care with nasopharyngeal suctioning and oxygen. The experimental group received supportive care but also received 2 daily sessions of CPT consisting of bimanual compression over the chest and abdomen at the end of expiration. The researchers reported that this method of CPT did not demonstrate any benefit compared with nasopharyngeal suctioning alone. A 2012 Cochrane review\textsuperscript{80} updated the appraisal of evidence on the effectiveness of using CPT including passive forced exhalation to treat bronchiolitis. The researchers evaluated 9 clinical trials with 891 subjects and reported no decrease in length of illness, length of hospitalization, or severity of illness regardless of type of CPT used compared with no treatment. Some evidence suggests that there is a benefit of the forced exhalation technique, but additional research is needed.\textsuperscript{81} The current evidence does not support routine use of CPT to treat bronchiolitis in children.

**Asthma.** Asthma is a common pediatric diagnosis with exacerbations requiring hospitalization for 30% to 40% of children seen in emergency rooms.\textsuperscript{82} Asthma consists of airway narrowing and inflammation that can allow secretions to be trapped in the airways. A prospective trial included 40 children 4 to 18 years old who were hospitalized with asthma.\textsuperscript{83} Children were randomized to receive CPT. Measurements of oxygen saturations and work of breathing showed no difference between the control and experimental groups. In another study, hospitalized children 6 to 13 years old were randomized to either receiving CPT or receiving standard pharmacological therapy alone.\textsuperscript{84} No improvement in lung function was seen in the group receiving CPT compared with the group receiving only drug therapy.

The physiology of asthma can result in trapping of secretions that can further exacerbate air trapping. Many providers believe that CPT can facilitate the movement of secretions to larger airways to be expelled. DiDario et al\textsuperscript{85} surveyed pediatricians in the United States about how often they prescribe CPT for patients with asthma. They reported that 58% of pediatricians believed that CPT was beneficial in asthma treatment. Despite the belief that CPT may be a helpful treatment
for asthma, research evidence has not shown the therapy to affect patients’ outcomes.

Atelectasis. The transition from mechanical ventilation to spontaneous respiration in children can be challenging. The smaller diameter airways as well as the more compliant rib cage can result in airway collapse and atelectasis. In 1979, Finer and colleagues published the results of a study on routine CPT, positioning, and suctioning that demonstrated a significant decrease in postextubation atelectasis. Following this publication, routine postextubation CPT to prevent atelectasis and resultant respiratory failure became common practice. Historically, this study was done before the advent of surfactant therapy and the more advanced invasive and noninvasive ventilation techniques that are currently available. Bagley et al conducted a trial to reevaluate the effectiveness of routine CPT after extubation compared with positioning and routine suctioning in neonates. The presence of atelectasis was determined by evaluation by a radiologist who was blinded to the group assignment. Interim analysis was done after 177 infants owing to newly published concern for adverse effects linking CPT and intracranial abnormalities. The interim analysis showed no significant difference between the groups; therefore, the study was terminated early. A Cochrane review exploring the efficacy of a CPT intervention in infants requiring mechanical ventilator support concluded that there was no benefit to CPT in preventing postextubation atelectasis; however, the reintubation rate was lower in the patients who received CPT.

Postoperative atelectasis following mechanical ventilation is a concern for pediatric patients of all ages. CPT is routinely employed by clinicians to encourage deep breathing and coughing and prevent development of postextubation atelectasis. Reines and colleagues reported significantly more atelectasis in cardiac surgery patients who received prophylactic postoperative CPT compared with patients who did not have CPT. The American Association of Respiratory Care does not recommend CPT as a part of routine care but encourages early ambulation.

Implications for Practice

Traditional CPT has limited benefit in the management of children with pneumonia, bronchiolitis, and asthma or as a prophylactic therapy to prevent atelectasis following extubation. There may be some benefit for patients with neuromuscular disease, but cough assist is more effective. CPT is not without risk. Rib fractures, intraventricular hemorrhage, atelectasis development as well as increased pain and splinting have been reported in postoperative patients. Airway suctioning alone is effective in airway clearance. Patients’ tolerance of CPT must be considered as well as the best use of clinicians’ resources. It is important to evaluate each child’s signs and symptoms on an individual basis when considering CPT as a possible treatment intervention. However, little evidence suggests that CPT should be a routine practice.

Summary

Patients deserve to be provided care that is based on current best evidence. Yet barriers to consistent implementation of EBP continue to be reported. Common challenges for failing to implement practices that are based on best evidence consistently include lack of knowledge of current best evidence, perception that EBP is time consuming and burdensome, and resistance to
changing practice among coworkers and leaders.10,90,91 On the other hand, elements that foster effective translation of best evidence into daily practice are influenced by nurses’ understanding and believing that EBP improves patient care outcomes, clinical leaders’ modeling EBP in daily practice, and a culture that supports practice change based on best evidence.10,11 It is time to change the culture in our critical care units to one that embraces the translation of evidence into daily practice.

AACN honored Lucian Leape, MD, with the AACN Pioneering Spirit Award at the 2014 National Teaching Institute.12 Dr Leape helped author the Institute of Medicine’s report, “To Err Is Human” and has been foundational in the national patient safety movement. His commitment to improving patient outcomes by embracing EBP has helped to transform health care. Keeping with the pioneering spirit for which AACN honored Dr Leape, critical care nurses need to continually survey their individual practice, critically evaluate the evidence supporting practice interventions, and strive to provide safe, effective, EBP interventions as part of daily practice. CCN

Financial Disclosures
None reported.

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dotmore
To learn more about challenging practice habits, read “Examining the Evidence to Guide Practice: Challenging Practice Habits” by Makic et al in Critical Care Nurse, April 2014;34:28-45. Available at www.ccnonline.org.

References
Continuing to Challenge Practice to Be Evidence Based

Facts
Critical care nurses need to continually survey their practice, critically evaluate the evidence supporting practice interventions, and strive to provide safe, effective, evidence-based practice interventions as part of daily practice. Four common practice interventions are reviewed in this article.

Weight-Based Medication Practice
Admission weight, actual body weight, should be documented for weight-based medication administration decisions throughout the patient’s intensive care unit (ICU) stay. Daily adjustments of the weight for dosing may result in medication errors. When patients have changes in weight because of fluid shifts, medication dosages should be adjusted to achieve the desired pharmacological response. Nurses working with the provider and pharmacists may make weight-based decisions depending on the patient’s actual body weight, end-organ function, agent pharmacokinetics, and desired therapeutic effects. Older patients and patients with higher BMIs require more vigilant monitoring by critical care nurses to evaluate the therapeutic effectiveness of medications, as these patients are at greatest risk for adverse drug reactions.

Maintenance of Chest Tube Patency
Chest drainage tubes serve an important function in the care and recovery of cardiothoracic surgery patients. No manipulation of drainage tubes should be done on a routine basis. If current practice, unit protocols, or physicians’ orders suggest stripping or milking chest tubes, which does not match the evidence-based practice recommendations, clinicians need to review the evidence and consider changing their practice.

Daily Interruption of Sedation
Daily interruption of sedation (DIS) has been implemented in many organizations along with evidence-based practice efforts to reduce oversedation of critically ill patients. Based on the limited data available, it appears that DIS is safe in medical ICU patients. Nurses should continue to conduct and publish outcome evaluations to evaluate the positive effects of a DIS in more diverse patient populations and on the duration of mechanical ventilation, ICU length of stay, and the incidence of self-extubation. Additionally, current practice evidence suggests that sedation should be used judiciously and that goals of sedation should be patient-specific to avoid overuse of sedating agents.

Use of Chest Physiotherapy in Children
Traditional chest physiotherapy (CPT) has limited benefit in the management of children with pneumonia, bronchiolitis, and asthma or as a prophylactic therapy to prevent atelectasis following extubation. CPT is not without risk. Rib fractures, intraventricular hemorrhage, atelectasis development as well as increased pain and splinting have been reported in postoperative patients. Airway suctioning alone is effective in airway clearance. Patients’ tolerance of CPT must be considered as well as the best use of clinicians’ resources. It is important to evaluate each child’s signs and symptoms on an individual basis when considering CPT. However, little evidence suggests that CPT should be a routine practice.

Fecal Microbiota Transplant to Treat Recurrent *Clostridium difficile* Infections

MIRIAM L. BOYLE, RN, BSN
LISA A. RUTH-SAHD, RN, DED, MSN, CEN, CCRN
ZEHAO ZHOU, MLS, MED, PhD

The prevalence of recurrent or refractory *Clostridium difficile* infection has been steadily increasing since 2000. Consequently, alternative treatments to the standard antibiotic therapies are now being considered. One alternative treatment is fecal microbiota transplant. Although fecal microbiota transplant is relatively new—and not appealing to most people—it has been around for many years and has great promise as an inexpensive, safe, and efficient treatment of refractory and recurrent *C difficile* infection. With a better understanding of the intricacies of the colonic microbiome and its role in colonic physiology and pathophysiology, critical care nurses will recognize that fecal microbiota transplant has the potential to become the standard of care for treatment of recurrent or refractory *C difficile* infection. The American College of Gastroenterology and the Infectious Diseases Society of America provide the latest treatment guidelines for care of patients with these clostridial infections. (Critical Care Nurse. 2015;35[2]:51-65)

*Clostridium difficile* infections (CDIs) are some of the most common health care–associated infections in hospitalized patients\(^{14}\) and in patients residing in nursing homes.\(^{41}\) According to estimates, the diagnosis and treatment of CDIs cost more than $3.2 billion annually in the United States,\(^{2,4,11,12}\) with approximately 333,000 cases and 15,000 to 20,000 deaths per year.\(^{2,4,13-15}\) When the diarrhea associated with CDIs becomes severe and causes complications, the infections become life-threatening and are a marked cause of morbidity and death in hospitalized patients.\(^{1,4}\) The incidence of severe and recurrent CDIs (RCDIs) has increased because of a new hypervirulent strain of *C difficile* that is less responsive to traditional medications. Patients with RCDI often are treated in an intensive care unit. Fecal microbiota transplant (FMT), also called fecal bacteriotherapy, is an adjunctive, cost-effective treatment for patients with RCDI.\(^{3,12-13}\) Critical care nurses must understand the importance of a balanced gut microbiome\(^{20,21}\) and how CDIs disrupt that balance.\(^{22,25}\) Furthermore, the nurses must recognize the role of FMT in order to provide appropriate care, educate patients, and collaborate with health care professionals on the latest treatment options for patients with RCDI.

**CE Continuing Nursing Education**

This article has been designated for CE credit. A closed-book, multiple-choice examination follows this article, which tests your knowledge of the following objectives:

1. Identify patients at risk for developing *Clostridium difficile* infection (CDI)
2. Describe the role of the critical care nurse to ensure safety when caring for patients with recurrent CDI
3. Discuss the role of fecal microbiota transplant in the treatment of patients with recurrent CDI

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The Role of the Gut Flora

The gastrointestinal tract is complex and contains more than 500 species of microorganisms (intestinal microbiota), many of which are harmless in healthy individuals.20-25 Although microorganisms vary greatly from one person to the next, each person has the same basic bacterial types,20-25 which keep a harmonious balance in the gut to aid in protective, structural, and metabolic functions.4,20-25 (Table 2). The important role of the gut flora in colonization resistance or preventing potentially pathogenic organisms, such as Clostridium difficile, from establishing a colony within the gut has been recognized for a long time.

Recently, the Human Microbiome Project24,25 has emphasized the microbial components of the human genetic and metabolic landscape and how these components profoundly affect many diseases and conditions, from irritable bowel syndrome20 to mental health,26 immunity,20,27 cystic fibrosis,28 energy metabolism, and obesity.20,29

Definition and Transmission of CDI

Clostridium difficile, a gram-positive, rod-shaped, spore-forming bacterium spreads from person to person or surface to person via the fecal-oral route.20,30,31 When spores

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**Table 1** Time line for Dorothy’s course of illness

<table>
<thead>
<tr>
<th>Month in 2013</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>May</td>
<td>Dorothy went to her family medical doctor (FMD) because she had shortness of breath, fever, lethargy, and chills. Diagnosis: Pneumonia. Treatment: A “broad-spectrum antibiotic.”</td>
</tr>
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<td>Two weeks after Dorothy finished taking her antibiotic and the pneumonia had resolved, she started to have diarrhea and returned to her FMD. Diagnosis: Antibiotic-related diarrhea. Treatment: Probiotics.</td>
</tr>
<tr>
<td>July</td>
<td>Dorothy went back to her FMD and reported having diarrhea for 5 days despite taking probiotics. Diagnosis: A stool specimen was obtained, and Clostridium difficile infection due to broad-spectrum antibiotic therapy was confirmed. Treatment: Metronidazole 500 mg orally 3 times a day for 10 days.</td>
</tr>
<tr>
<td>August</td>
<td>Dorothy went back to FMD and reported continued diarrhea, abdominal cramping, decreased appetite, and a 5-pound (2.25 kg) weight loss. Diagnosis: Recurrent infection with C difficile. Treatment: Vancomycin 125 mg orally 4 times a day for 10 days.</td>
</tr>
<tr>
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<tr>
<td>November</td>
<td>Almost 3 months later, Dorothy was getting worse and her FMD encouraged her to go to the emergency department.</td>
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</table>

Dorothy, a 69-year-old woman who came to the emergency department, stated, “I have relentless diarrhea despite taking medication for 2 months and cannot deal with it any longer.” She reported that she had “not urinated in over a day.” Dorothy’s medical history included a bout of pneumonia and bronchitis that had been treated 5 months earlier with an antibiotic. Table 1 describes Dorothy’s time line of illness. Dorothy stated, “My bowels have not been the same since the pneumonia. I have been getting diarrhea on and off for months, but this time it is the worst ever.” She had no relevant surgical history. She was taking metronidazole 500 mg orally 3 times a day for the “bowel issues.”

Physical examination revealed a very pale appearance, flat neck veins, lethargy, and extreme fatigue. Other findings were oral temperature 100°F (37.8°C), heart rate

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**CASE REPORT**

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Dorothy, a 69-year-old woman who came to the emergency department, stated, “I have relentless diarrhea despite taking medication for 2 months and cannot deal with it any longer.” She reported that she had “not urinated in over a day.” Dorothy’s medical history included a bout of pneumonia and bronchitis that had been treated 5 months earlier with an antibiotic. Table 1 describes Dorothy’s time line of illness. Dorothy stated, “My bowels have not been the same since the pneumonia. I have been getting diarrhea on and off for months, but this time it is the worst ever.” She had no relevant surgical history. She was taking metronidazole 500 mg orally 3 times a day for the “bowel issues.”

Physical examination revealed a very pale appearance, flat neck veins, lethargy, and extreme fatigue. Other findings were oral temperature 100°F (37.8°C), heart rate
are ingested, they survive in the acidity of the stomach and enter the intestines, where they begin to germinate. Because of their durability and strength, spores germinate, and organisms rapidly outgrow the normal intestinal flora.\textsuperscript{1,3,8,12-17} Although \textit{C difficile} flourishes in anaerobic conditions such as the gut, it can survive on a variety of surfaces for more than 3 months.\textsuperscript{1-7,31} The spores are difficult to eradicate from surfaces, creating an easy way to
transmit infection from one person to another. In addition to transmission via the fecal-oral route, CDI may be a side effect of antimicrobial therapy. Physiological alterations associated with antimicrobial therapy cause perturbations in the intestinal microbiota that allow colonization.

**Pathophysiology**

*Clostridium difficile* produces 2 toxins that cause inflammation and disruption of the epithelial mucosal surface (see Figure), which lead to various degrees of diarrhea. Once the toxins get into the cell, they interfere with cellular function, resulting in apoptosis or cell death. Toxin A, an enterotoxin, causes increased intestinal permeability and fluid secretion. Toxin B, a cytotoxin, leads to intense colonic inflammation. The intestinal barrier function is lost, permeability increases, and granulocytes and fluids migrate into the intestines, resulting in diarrhea. Newer, more virulent strains of *C difficile*, such as the North American PFGE type 1 (NAP1/027) and PCR078, have highly mobile, mosaic genomes, a characteristic that enhances the drug resistance of the strains, making pharmacological treatment of CDIs caused by these strains more challenging than treatment of infections caused by less virulent strains of *C difficile*.

**Epidemiology**

According to the Centers for Disease Control and Prevention, the prevalence of CDIs has been markedly increasing since the early 2000s. Of more concern are the number of community-acquired cases and the number of cases resistant to metronidazole, the most common treatment for CDI. About half of the infections occur in patients less than 65 years old; however, patients more than 65 years old account for about 90% of the deaths due to CDI. The highest incidence of CDI is among elderly hospitalized patients (25% of all cases); the remaining 75% of cases occur in patients in nursing homes or in patients who recently visited doctors’ offices and clinics. Another increased rate has been noted in outpatients who are taking antibiotics (as Dorothy was) or proton pump inhibitors, children who are immunocompromised, patients who have had gastric bypass, and postpartum women.

**Clinical Manifestations of CDI**

The American College of Gastroenterology (ACG) classifies CDIs as mild, mild-to-moderate, severe, severe and complicated, and recurrent (Table 3). Signs and symptoms associated with CDI may appear shortly after
antibiotic therapy is started or weeks or months later. Although many patients with mild to moderate CDI are treated as outpatients, more patients, such as Dorothy, have severe CDI and require treatment in an acute care unit. Severe CDI is associated with abdominal distention and pain ranging from mild crampy feelings to severe diffuse pain, profuse diarrhea, leukocytosis, and hypoalbuminemia (< 3 g/dL). In severe and complicated CDI, at least one of the following is present or develops: hypotension, fever, leukocytosis, elevated serum lactate levels, any evidence of end-organ failure, and admission to an intensive care unit.2,3,12

Critical care nurses must recognize fulminant colitis, the most serious manifestation of CDI, which may lead to toxic megacolon, perforation of the colon, and death.3 Typical indications of fulminant colitis are severe abdominal pain, diarrhea, high fever, chills, leukocytosis, and abdominal distention.2,8,11 Some patients with fulminant colitis have minimal diarrhea because an ileus causes fluids to accumulate in the colon instead of being excreted.9 Recurrent CDI, as in Dorothy’s case, is defined by the ACG as a return of the signs and symptoms of CDI within 8 weeks of the completion of antibiotic therapy.2,10 Recurrence rates after 1 bout of CDI are reported to be 20% to 25% whereas recurrence rates after 2 or more bouts of CDI have been reported to be as high as 50% to 60%.7 Recognizing these classifications will help critical care nurses ensure timely therapy without overtreating or undertreating the patient.

Diagnostic Testing
Diagnostic testing for CDI includes laboratory and imaging studies. Laboratory tests include toxin enzyme immunoassays, toxigenic cultures, nucleic acid amplification tests, and the C difficile cytotoxin neutralization assay.2,4 The enzyme immunoassays are used to detect C difficile toxins A and B; however, the sensitivity and specificity of detection vary greatly among the commercially available assays.2,3 Toxigenic cultures have high sensitivities and specificities for detection of the organism but may take 2 to 5 days to produce results because of the incubation period required.2,3 Although toxigenic cultures are highly sensitive and specific, they can produce false-positives if a formed stool is sent for testing.2,3 The nucleic acid amplification tests are highly sensitive and specific but are only used in acute diseases because of concerns for false-positives. Finally, the C difficile cytotoxin neutralization assay produces results with 90%
sensitivities and specificities quickly and requires little hands-on time from a technologist.3,8 The ACG discourages repeat testing, stating that only a single sample needs to be assayed, and does not recommend testing for cure. Table 4 gives the sensitivities and specificities of the various tests.

Diagnostic colonoscopy and computed tomography of the abdomen and pelvis may be considered for complicated CDI.2-4,9 The results of these procedures help detect the severity and extent of the CDI and its effects, including thickening of the colonic wall, ascites, toxic megacolon, ileus, and perforation.2-9

**Traditional Pharmacological Interventions**

According to the Infectious Diseases Society of America2,4 and the ACG, traditional pharmacological treatment of CDI should be started only after testing for *C difficile* is completed. The exception is when a patient with suspected CDI is critically ill or has a rapidly worsening condition.2-4 The first-line treatment for mild CDI is oral metronidazole 500 mg 3 times daily for 10 to 14 days.2-4 Absorption of metronidazole occurs mostly in the upper part of the gastrointestinal tract, so this drug may be ineffective for infections due to some *C difficile* isolates.2,4 If patients are unable to tolerate oral metronidazole, the drug can be administered intravenously at 500 mg every 6 hours. Metronidazole should not be used long-term because of the risk for neurotoxic effects.2,4

For patients with moderate-to-severe signs and symptoms, such as Dorothy had, the drug of choice is oral vancomycin 125 to 500 mg 4 times daily for 10 days.2-4 In patients unable to take medications orally, or patients in whom oral agents cannot reach a segment of the colon (Hartman pouch, ileostomy, colon diversion), vancomycin can be administered via enema, colostomy, ileostomy, or nasogastric tube.2,4 Patients should be monitored for vancomycin resistance, which would be indicated by continuation of the diarrhea after vancomycin therapy was started. In such instances, fidaxomicin, a narrow-spectrum macrocyclic antibiotic, may be used at a dose of 200 mg orally twice a day. Compared with other CDI treatment options, administration of fidaxomicin is associated with lower rates of recurrence of the infection. Although fidaxomicin is quite expensive, if recurrences of CDI are prevented, the extra expense may be worthwhile.4,22

**Fecal Microbiota Transplant**

Approximately 20% of patients with CDI who are treated pharmacologically have a recurrence of the infection within 6 months after the antibiotic is discontinued.2,3,7,8,16 Treatment options for RCDIs are limited. The ACG recommends FMT after a third RCDI2,7,16 in order to reestablish the normal composition of the gut flora, restore the balance in metabolism, and stimulate both cellular and humoral immune responses in the gut mucosa.3,4,7,13,14,38 Although fecal transplants have been used since the 4th century in China, they are now becoming more widely accepted as a safe and effective method of treating RCDI.4,13,38-46 Table 5 provides facts related to FMT. The first FMT documented in the English literature was in 1958. Eiseman et al43 successfully used fecal enemas to treat 4 patients with pseudomembranous enterocolitis; all 4 had complete resolution of signs and symptoms.

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**Table 4** Microbiological testing for *Clostridium difficile*

<table>
<thead>
<tr>
<th>Testb</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Availability</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxin enzyme immunoassays</td>
<td>Low</td>
<td>High</td>
<td>Wide</td>
<td>Must detect toxins A and B</td>
</tr>
<tr>
<td>Toxigenic culture</td>
<td>High</td>
<td>High</td>
<td>Limited</td>
<td>Limited diagnostic use; epidemiological tool</td>
</tr>
<tr>
<td>Nucleic acid amplification tests (polymerase chain reaction assays, isothermal amplification tests)</td>
<td>High</td>
<td>High</td>
<td>Wide</td>
<td>Used only in acute disease</td>
</tr>
<tr>
<td><em>C difficile</em> cytotoxin neutralization assay</td>
<td>High</td>
<td>High</td>
<td>Limited</td>
<td>Limited diagnostic use; reference method</td>
</tr>
<tr>
<td><em>C difficile</em> culture</td>
<td>Low</td>
<td>Moderate</td>
<td>Limited</td>
<td>No diagnostic use</td>
</tr>
</tbody>
</table>

a Based on data from Surawicz et al,2 Kaseb and Novotne,3 and Cohen et al.4
b How quickly results of these tests are available depends on the hospital’s laboratory.

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Traditional pharmacological treatment of CDI should be started only after testing for *C difficile* is completed.
The first report of using FMT for treatment of RCDI was published in 1983; a woman had prompt and complete resolution of gastrointestinal problems after FMT. In 2010, Garborg et al reported the results of FMT in 70 patients with RCDI; the transplants were effective even in patients with CDI caused by the NAP1/BI/027 strain. By 2011, a total of 325 cases of RCDI had been treated with FMT worldwide, with a mean cure rate of 91%. Most recently, in 2012, Kelly et al reported the results of a retrospective, multicenter follow-up study of patients with RCDI who received FMT; the primary and secondary cure rates were 91% and 98%, respectively.

In FMT the stool (200-300 g) of a healthy donor is mixed with physiological saline or water to make a liquid slurry, filtered to remove larger particulate matter, and then instilled in the upper or lower part of the gastrointestinal tract of a patient with RCDI. Although early on the most common method of administration was retention enema, more recently the donor fecal material has been administered via nasogastric tube, nasoduodenal tube, colonoscopy, oral fecal capsules, and self-administered enemas. Instilling the fecal material via colonoscopy has many advantages. First, with this method, the stool can be infused throughout the length of the colon. Second, the colonic mucosa can be directly visualized and any abnormal findings can be documented. Third, patients are sedated and generally tolerate FMT well. Fourth, success rates range from 86% to 100% cure, whereas enema success rates are 81% to 100%. However, FMT via colonoscopy is associated with risks for perforation, infection, bleeding, and pain. Although the nasogastric method is least effective, with success rates of 73% to 83%, it is easier to perform than any other method, and poses lower risks to the patient.

The preferred donor source is someone who is intimate with the patient; however, donors may also include family members or other unrelated healthy donors. According to recent studies, the material from donors whose fecal specimens are frozen (up to 6 months) until needed is just as effective as fecal specimens from patient-identified donors. The advantage of using a donor who is known to the patient, or known to the gastroenterologist, is that some providers will then allow the donor to opt out of screening for CDI to save costs and allow the patient to receive FMT more quickly. Frozen stool can also be used quickly in emergent cases to save time. Fecal donors, like blood donors, are screened rigorously (Table 6).

Although minimal risks associated with FMT have been documented so far, critical care nurses must recognize that the biggest risks are transmission of undetected infectious bacterial agents and side effects such as headaches, sore throat, and various gastrointestinal...
complaints. One case of norovirus gastroenteritis was recently reported after FMT despite asymptomatic donors and lack of sick contacts. Uncertainty about the long-term safety of FMT is another factor to consider. In Dorothy’s case, no side effects were reported.

Role of Critical Care Nurses

Although most patients with RCDI may be treated as outpatients, patients with severe infections, such as Dorothy, and patients who have fulminant CDI colitis often require treatment in the critical care environment. Critical care nurses have many responsibilities to ensure patients’ safety, including recognizing when FMT may be a treatment option, identifying patients at risk for CDI, carrying out meticulous hand washing, promoting vigilant antibiotic stewardship, maintaining enteric contact isolation with attentive environmental cleaning, assessing and treating the patients’ underlying illnesses, promoting comfort, maintaining skin integrity, and developing clinical practice guidelines to ensure safe patient care. Teaching patients and their significant others is important in all areas when providing care to patients who may require an FMT.

Recognizing FMT As an Option for Patients With CDI

Critical care nurses must be aware of FMT as a treatment option for patients with RCDI. After stabilizing a patient’s hemodynamic status, maintaining accurate stool records, and carrying out regular abdominal assessments, nurses must be able to answer questions of the patient and the patient’s family members about the FMT procedure itself, know how to prepare the patient, and identify what to expect after the procedure.

Protocols for preparing patients differ depending on whether the route of administration is via the upper or the lower part of the gastrointestinal tract. For example, if FMT is performed via a nasogastric tube, a proton pump inhibitor is usually administered the night before the procedure, whereas, if the fecal material is transfused via a colonoscopy, a bowel preparation with polyethylene glycol orally may be administered the evening before the transplant. Other times loperamide may be administered either before or after FMT. All pharmacological therapy for CDI is discontinued 24 to 48 hours before FMT.

### Table 6 Exclusion criteria for donors of fecal microbiota

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute</td>
<td>Known human immunodeficiency virus (HIV), hepatitis B, or hepatitis C infection or known exposure to these within the past year, High-risk sexual behaviors, Use of illicit drugs, including intranasal cocaine, Tattoo or body piercing within past 6 months, Incarceration or history of incarceration, Current communicable disease, Risk factors for variant Creutzfeldt-Jacob disease, Travel within 6 months to areas where diarrheal illnesses are endemic, Malignant neoplasm</td>
</tr>
<tr>
<td>Gastrointestinal comorbid conditions</td>
<td>History of inflammatory bowel disease, irritable bowel syndrome, idiopathic chronic constipation, or chronic diarrhea, History of gastrointestinal cancer or known polyposis</td>
</tr>
<tr>
<td>Factors affecting the gastrointestinal microbiota</td>
<td>Antibiotics within the preceding 3 months, Major immunosuppressive medications, Systemic antineoplastic agents</td>
</tr>
<tr>
<td>Additional considerations</td>
<td>Recent ingestion of anything to which the recipient is allergic (eg, shellfish, nuts)</td>
</tr>
<tr>
<td>Relative</td>
<td>History of major gastrointestinal surgery (eg, gastric bypass), Metabolic syndrome, Systemic autoimmunity such as multiple sclerosis, connective tissue disease, Atopic diseases such as asthma and eczema, eosinophilic disorders of the gastrointestinal tract, Chronic pain syndromes such as chronic fatigue syndrome, fibromyalgia</td>
</tr>
</tbody>
</table>

*Many institutions use a donor questionnaire based on the Donor History Questionnaire prepared by the AABB Donor History Task Force to screen blood donors.*
Identifying Patients at Risk for CDI

The role of critical care nurses starts with patient rounds and identification of patients at high risk for CDI. A thorough history from patients who have diarrhea is the beginning step. Questions should include history of antibiotic use, recent hospitalization or stay in a nursing home, onset of signs and symptoms, employment as a health care provider, and whether or not diarrhea is the primary sign or if a causative agent of the diarrhea has been identified. Other factors to determine are whether the patient is immunocompromised, is elderly, or has a history of gastrointestinal disorders. The answers to these questions will help guide the clinician in ordering diagnostic tests. If CDI is suspected, a fecal specimen should be obtained along with specimens for other laboratory studies.

Meticulous Hand Washing

Meticulous hand washing with soap and running water is the most effective means of physically removing *Clostridium difficile* spores from the hands. Laboratory studies have shown that alcohol separates *C. difficile* organisms from stool specimens but is ineffective for eradication. Alcohol-based hand rubs mostly cause displacement of the spores over the skin surfaces. Health care providers must wash their hands for at least 15 to 20 seconds for maximal effectiveness.

Although much emphasis has been placed on ways to improve health care workers’ compliance with hand hygiene, little effort has been directed toward involving patients in the patients’ own hand hygiene. Evidence suggests that patients’ flora and the hospital environment are the primary source of many infections. Critical care nurses must educate and involve patients more directly in hand hygiene practices (e.g., not putting their hands in their mouth or putting contaminated items in their mouth) and use patient-centered safety initiatives to provide recommendations for patient hand hygiene protocols.

Vigilant Antibiotic Stewardship

One of the most important roles of critical care nurses is to be an advocate for the patient and to recognize that antibiotics are the primary risk factor for CDI. If antibiotics are the suspected cause of diarrhea, the drugs should be discontinued immediately and consideration given to the underlying reason the patient was started on the therapy. Rapid diagnosis and treatment and collaboration with gastroenterologists are essential for the well-being of patients.

Nurses must be sure that any antibiotics are administered correctly, with no missed doses, and ensure that the drugs are discontinued as indicated. The Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America recommend decreasing how often and for how long antibiotics are used and using the minimal number of antibiotics per patient. Nurses should be aware of these guidelines to establish institutional programs to enhance antibiotic stewardship.

Maintaining Enteric Contact Isolation and Vigilant Environmental Cleansing

Because *C. difficile* is so easily transmitted, critical care nurses must use personal protective equipment every time they enter the room of a patient with suspected or known CDI. Having to don personal protective equipment every time nurses enter a patient’s room may seem too burdensome; however, gowns and gloves are a necessity to prevent spreading *C. difficile* to other patients. Wearing gowns limits potential contamination, especially when nurses come in contact with bodily fluids, and inhibits cross-contamination to other patients and surfaces. After removing personal protective equipment, nurses must engage in thorough hand washing with soap and running water.

Vigilant environmental cleaning is necessary because *C. difficile* may thrive on frequently touched hospital surfaces like light switches, door knobs, call lights, television remote controls, and telephones. *Clostridium difficile* may thrive on frequently touched hospital surfaces such as light switches, door knobs, call lights, television remote controls, and telephones. These surfaces should be cleaned with a hypochlorite-based disinfectant or a dilute (1:10) solution of bleach.

Another key feature in preventing the spread of CDI is to have dedicated equipment for patients who are in isolation. Use of disposable blood pressure cuffs and thermometers can decrease rates of infection. If equipment must be shared, it must be disinfected according to hospital policy immediately after use and before it is used for another patient. Patients with CDI should be placed in private rooms with their own bathrooms if possible. If they are placed in a semiprivate room, they must
Critical care nurses must be cognizant of the emotional stress associated with being in isolation. A patient’s access to the television, telephone, and call bell system should be maintained so the patient knows he or she is not totally disconnected. Patients should also be assessed for depression and sadness due to social isolation.

Assessing and Treating CDI Patients’ Underlying Illnesses

CDI infections in patients who are hospitalized occur for many reasons. Critical care patients who have CDI require assessment and monitoring not only to determine the progress of their underlying illness but also to prevent complications of CDI, such as dehydration. Regular assessment of vital signs, hemodynamic status, intake, output, and daily weight is essential for rapid detection of dehydration.

Laboratory values such as serum levels of albumin, lactate, and electrolytes must be tracked. Serum lactate and albumin levels are assessed to differentiate the severity of the disease (see Table 3). Holistic assessment of all systems is also important to rapidly detect systemic manifestations.

Promoting Comfort and Maintaining Skin Integrity

Patients who have frequent loose stools, abdominal pain, and cramping are physically uncomfortable, especially if they are incontinent of stool. If a patient reports these findings, analgesics may be administered. Some patients may be extremely embarrassed if they are incontinent of feces; consequently, treating patients with dignity and respect is paramount to respectful compassionate nursing care.

In order to maintain skin integrity, patients should be cleaned promptly after each episode of incontinence and have skin creams or ointments applied to prevent breakdown. Nursing measures to prevent skin breakdown in patients with CDI are challenging because of the frequency, amounts, and characteristics of the stool. These patients require assessment by using a skin score and may require use of an indwelling bowel catheter system to divert the loose stool away from the skin to prevent excoriation and formation of pressure ulcers. Table 7 is a nursing care plan for patients with CDI.

Establishing Clinical Practice Guidelines

Because the risks associated with FMT are low and the outcomes are positive, including a better quality of life and fewer hospitalizations, critical care nurses must accept FMT as a treatment modality with promising outcomes. Although standards of care and nursing clinical practice guidelines for FMT are being developed, critical care nurses will play a pivotal role establishing these guidelines and in implementing the latest standards of the ACG and the Infectious Diseases Society of America to ensure safe, effective patient care.

Future Research

FMT has shown efficacy for RCDI, and research on the usefulness of this procedure for other conditions (eg, inflammatory bowel disease, irritable bowel syndrome, obesity, Parkinson disease, anxiety, schizophrenia, obsessive-compulsive disorders, autism) is under way. Future research depends on the outcomes of randomized control trials such as the Fecal Therapy to Eliminate Associated Long-standing Diarrhea trial and findings from the Human Microbiome Project. As more patients and health care providers learn to overcome the unpleasant thought of FMT and more patients with RCDI are treated with FMT, critical care nurses will learn from the outcomes and develop future research.

FMT has the potential to enhance resistance to infection and reduce inflammatory diseases. Further targeted manipulation of microbial populations is a growing focus of investigation. The most important manipulation, depending on the microbiota composition and the recipient’s genotype, could range from proinflammatory to anti-inflammatory effects. Although the impact of FMT on a recipient’s immune system is complex and unpredictable, ongoing discovery of commensal microbes and investigations of the effects of microbes on the host are important.

Summary

CDI continues to be a vexing health care problem for patients and clinicians alike. Because the prevalence of RCDIs is increasing, critical care nurses need to take further steps to be proactive in preventing CDI while at the same time remaining open-minded to alternative treatments such as FMT. Increasing evidence supports the role of FMT in the treatment of patients with RCDI. Critical care nurses must collaborate with hospitalists
### Nursing care plan for patients with diarrhea due to *Clostridium difficile* infection

<table>
<thead>
<tr>
<th>Nursing diagnosis</th>
<th>Nursing goals</th>
<th>Nursing interventions and rationales</th>
</tr>
</thead>
</table>
| **Diarrhea related to infection by *C difficile* as evidenced by >3 loose stools per day** | **Patient will have no diarrhea**                 | 1. Assess the frequency of defecation (consistency and color), body temperature, abdomen (inspect, auscultate, palpate, and percuss), and history of antibiotic use.  
**Rationale:** Diarrhea may be due to *C difficile* infection.  
2. Teach patient to keep a journal.  
**Rationale:** Information in the journal will help determine the treatment plan.  
3. Seek to identify the cause of diarrhea.  
**Rationale:** The cause determines course of treatment.  
4. Obtain stool specimens.  
**Rationale:** Results of laboratory tests can be used to rule out an infectious process.  
If *C difficile* infection is diagnosed, do NOT give medications that slow peristalsis.  
5. Use standard precautions and possibly contact isolation.  
**Rationale:** Measures are needed to prevent spread of infection from patient to patient or to the health care worker.  
6. Assess geriatric patients for the presence of impaction, ileus, and perforation.  
**Rationale:** Patients with an impaction have leakage of mucus or liquid stool around the impaction. |
| **Risk for ineffective tissue perfusion related to decreased intravascular volume due to diarrhea associated with infection by *C difficile*** | **Patient's blood pressure and heart rate will remain within baseline values** | 1. Monitor vital signs.  
**Rationale:** Decreased blood pressure and increased heart rate are signs of dehydration.  
2. Assess skin turgor.  
**Rationale:** Delayed skin turgor over sternum is a sign of dehydration.  
3. Measure stool amounts.  
**Rationale:** Diarrhea is defined as passing more than 300 g of loose stool in 24 hours. The amount of diarrhea should be decreasing as treatment measures are successful.  
4. Monitor for changes in urine output.  
**Rationale:** A decrease in urine output may signify dehydration and decreased renal perfusion.  
5. Monitor for changes in mental status, restlessness, dysrhythmias, tachycardia, and cyanosis.  
**Rationale:** These findings may indicate dehydration. |
| **Patient will be free of signs of malnutrition**                                   | **1. Monitor for signs of malnutrition** (bruises, dry pale skin, muscle wasting, and cheilosis).** | 1. Monitor for signs of malnutrition (bruises, dry pale skin, muscle wasting, and cheilosis).  
**Rationale:** Brittle hair, dry and pale skin, and muscle wasting are signs of malnutrition.  
2. Evaluate results of laboratory tests such as serum levels of albumin, total protein, prealbumin, transferrin, electrolytes, hemoglobin and hematocrit, and glucose.  
**Rationale:** Serum albumin level < 3.5 g/dL is considered an indicator of risk of poor nutritional status. All other noted laboratory results will be low.  
3. Track daily weights.  
**Rationale:** Tracking allows ready detection of weight trends and maintenance of a healthy body weight.  
4. Collaborate with dietary staff.  
**Rationale:** Collaboration allows a multidisciplinary approach to patient care.  
5. Note food intake and assess patient’s ability to eat.  
**Rationale:** Stressors such as being in an intensive care unit and anticipating a stool transplant may cause a decrease in appetite.  
**Rationale:** Stressors as noted earlier may cause bleeding. |
| **Anxiety related to change in health status and social isolation due to diarrhea** | **Patient will identify and verbalize symptoms of anxiety and report a decrease in anxiety** | 1. Assess the patient’s level of anxiety and physiological reactions to anxiety (eg, tachycardia, tachypnea, nonverbal expressions of anxiety).  
**Rationale:** Anxiety may cause deleterious effects on patient recovery.  
2. Encourage use of coping skills used successfully in the past.  
**Rationale:** Previously used coping skills for dealing with anxiety may help here.  
3. Explain and teach the patients interventions that may reduce anxiety.  
**Rationale:** When possible remove sources of anxiety.  
4. Decrease anxiety by using therapeutic touch.  
**Rationale:** Use therapeutic touch, and provide backrubs and massage.  
5. Determine if patients feel socially isolated.  
**Rationale:** Patients in contact isolation often feel this way. Be sure the patient has the call bell and knows how to use the television and telephone. |

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*a Based on information in Haugen and Galura.*
and gastroenterologists to provide patients with the most current treatment options. FMT is a promising inexpensive treatment for RCDI, with cure rates close to 100%. As FMT continues to develop, critical care nurses will play a unique role in helping patients with RCDIs find hope for healing.

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None reported.

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dotmore

To learn more about fecal transplant, read "Clostridium difficile Infection: Clinical Challenges and Management Strategies" by Walters and Zuckerbraun in Critical Care Nurse, August 2014;34:24-33. Available at www.ccnonline.org.

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Fecal Microbiota Transplant to Treat Recurrent Clostridium difficile Infections

**Facts**

Clostridium difficile infections (CDIs) are some of the most common health care–associated infections in hospitalized patients. The incidence of severe and recurrent CDIs (RCDIs) has increased because of a new hypervirulent strain C difficile that is less responsive to traditional medications. Patients with RCDI often are treated in an intensive care unit (ICU). Fecal microbiota transplant (FMT) is an adjunctive, cost-effective treatment for patients with RCDI.

- C difficile spreads from person to person via the fecal-oral route.
- Although C difficile flourishes in anaerobic conditions such as the gut, it can survive on a variety of surfaces for more than 3 months.
- CDI may be a side effect of antimicrobial therapy.
- About half of CDIs occur in patients less than 65 years old; however, patients more than 65 years old account for about 90% of the deaths due to CDI.
- In severe CDI, at least one of the following is present: hypotension, fever, leukocytosis, elevated serum lactate levels, any evidence of end-organ failure, and admission to an ICU.
- Typical indications of fulminant colitis, the most serious manifestation of CDI, are severe abdominal pain, diarrhea, high fever, chills, leukocytosis, and abdominal distention.
- Diagnostic testing for CDI includes laboratory and imaging studies. Laboratory tests include toxin enzyme immunoassays, toxigenic cultures, and nucleic acid amplification tests.
- The first-line treatment for mild CDI is oral metronidazole. For patients with moderate and severe signs and symptoms, the drug of choice is oral vancomycin.
- In patients unable to take medications orally, vancomycin can be administered via enema, colostomy, ileostomy, or nasogastric tube.
- In FMT the stool of a healthy donor is mixed with physiological saline or water and then instilled in the upper or lower part of the gastrointestinal tract of a patient with RCDI. The donor fecal material usually is administered via nasogastric tube, nasoduodenal tube, colonoscopy, oral fecal capsules, and self-administered enemas.
- The biggest risks associated with FMT are transmission of undetected infectious bacterial agents and side effects such as headaches, sore throat, and various gastrointestinal complaints.

**Role of Critical Care Nurses**

Patients with severe infections and patients who have fulminant CDI colitis often require treatment in the critical care environment. Critical care nurses have many responsibilities, including the following:

- Recognizing FMT as an option for patients with CDI
- Identifying patients at risk for CDI
- Meticulous hand washing
- Vigilant antibiotic stewardship
- Maintaining enteric contact isolation and vigilant environmental cleansing
- Treating CDI patients’ underlying illnesses
- Promoting comfort and maintaining skin integrity
- Establishing clinical practice guidelines
- Educating patients and their significant others
Learning objectives: 1. Identify patients at risk for developing *Clostridium difficile* infection (CDI) 2. Describe the role of the critical care nurse to ensure safety when caring for patients with recurrent CDI 3. Discuss the role of fecal microbiota transplant in the treatment of patients with recurrent CDI

1. Which of the following best explains the increased incidence of severe and recurrent *Clostridium difficile* infection (CDI)?
   a. A new hypervirulent strain of *C difficile*
   b. Ineffective cleaning regimens between patients
   c. Increased colonization rates among patients
   d. Poor hand hygiene in the hospital setting

2. Which of the following is the most common treatment for CDI?
   a. Nitazoxanide
   b. Fidaxomicin
   c. Metronidazole
   d. Vancomycin

3. The highest incidence of CDI is among which population of patients?
   a. Elderly hospitalized patients
   b. Nursing home residents
   c. Outpatients taking antibiotics
   d. Recent visitors to clinics

4. In severe and complicated CDI, which of the following is present?
   a. Dehydration
   b. Hypotension
   c. Leukopenia
   d. Proteinuria

5. Which of the following is a typical clinical finding of fulminant colitis?
   a. Periumbilical pain
   b. Hypotension
   c. Leukopenia
   d. Abdominal distention

6. Recurrent CDI is defined by the American College of Gastroenterology (ACG) as a return of the signs and symptoms of CDI within how many weeks of the completion of antibiotic therapy?
   a. 8
   b. 12
   c. 16
   d. 20

7. Which of the following is true regarding laboratory testing for CDI?
   a. Repeat testing is encouraged by the ACG.
   b. Only a single sample needs to be assayed.
   c. Testing for cure is recommended.
   d. Three negative tests negate the need for isolation.

8. When should traditional pharmacologic treatment for CDI be started?
   a. When patients report diarrhea with antibiotic therapy
   b. If the diarrhea results in hospitalization
   c. When diarrhea occurs with the third course of antibiotics
   d. After testing for *C difficile* has been completed

9. Who is the preferred donor source for a fecal microbiota transplant?
   a. Family members of the patient
   b. Someone known to the gastroenterologist
   c. Someone who is intimate with the patient
   d. Unrelated healthy donors

10. Which of the following was identified as a role of critical care nurses to ensure patient safety?
    a. Carrying out meticulous hand washing with an alcohol-based hand rub
    b. Immediately discontinuing antibiotics when diarrhea occurs
    c. Maintaining contact and droplet isolation
    d. Recognizing when fecal microbiota transplant may be a treatment option

11. Which of the following is the recommended test to assess the abdomen for the development of fulminant pseudomembranous colitis?
    a. Computed tomography
    b. Magnetic resonance imaging
    c. Radiograph
    d. Ultrasound

12. Which microbial test for *C difficile* has the highest sensitivity and specificity, widest availability, and quickest results?
    a. Cytotoxin neutralization assay
    b. Nucleic acid amplification test
    c. Toxigenic cultures
    d. Toxin enzyme immunoassay

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**Program evaluation**

Objective 1 was met
Objective 2 was met
Objective 3 was met
Content was relevant to my nursing practice
My expectations were met
This method of CNE is effective for this content
The level of difficulty of this test was:
1. easy  2. medium  3. difficult
To complete this program, it took me ______ hours/minutes.

---

Name ___________________________   Member # ____________
Address __________________________
City __________________________   State ______ ZIP ______
Country __________________________   Phone __________________________
E-mail __________________________
RN Lic. 1/St: ______________________   RN Lic. 2/St: ______________________
Payment by:   □ Visa   □ M/C   □ AMEX   □ Discover   □ Check
Card # __________________________   Expiration Date ______

Signature __________________________

The American Association of Critical-Care Nurses is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center’s Commission on Accreditation. AACN has been approved as a provider of continuing education in nursing by the State Boards of Nursing of California (#0036) and Louisiana (#ABN12). AACN programming meets the standards for most other states requiring mandatory continuing education credit for relicensure.
Improving patient safety is a top priority of all health care institutions. Of particular concern is the incidence of health care–associated infections (HAIs). In critical care, 2 common HAIs are ventilator-associated pneumonia (VAP) and central line (central catheter)–associated bloodstream infections (CLABSIs). Estimates of the costs of these HAIs are tremendous; VAPs contribute to 35,967 deaths per year and CLABSIs to 30,665 deaths.

Many factors in nurses’ work environment have been linked to patient safety. One important aspect of that environment is nurse-physician collaboration. Nurse-physician collaboration is defined as “nurses and physicians working together, sharing responsibilities for solving problems and making decisions to formulate and carry out plans for patient care.” In The Future of Nursing, the Institute of Medicine identified nurse-physician collaboration as 1 of 4 key priorities. According to the publication, nurses should strive to be full partners with physicians in redesigning health care in the United States.
Several barriers to achieving a full partnership with physicians have been recognized. First, nurses view collaboration as more positive and important than do physicians.5,7 Second, physicians do not seem to understand the role and scope of practice of nurses.5 To achieve full partnership, both nurses and physicians must recognize the unique contribution of each profession. Third, a disconnect exists in the perception of the quality of collaboration. Physicians rate the quality of collaboration significantly higher than do nurses.5,11 If members of both professions do not identify a problem, they will have little motivation to work toward a solution.

Nurses working in intensive care units (ICUs) with effective nurse-physician collaboration report greater overall job satisfaction than do nurses in other units. In a meta-analysis12 of nurses’ job satisfaction, nurse-physician collaboration was 1 of the top 3 most commonly noted variables predictive of job satisfaction, second only to job stress. Critical care nurses reported greater satisfaction with nurse-physician communication than did those nurses working in general care areas13; however, disparities remain in relation to perception of communication.14 Conflicts in the ICU are most often between nurses and physicians rather than between either nurses or physicians and members of other disciplines.15

Breakdown in communication and collaboration between nurses and physicians is related not only to unfavorable perceptions of the work environment14 but also to adverse patient outcomes. In an early study,17 researchers noted a significant inverse relationship between staff interaction and coordination and patient mortality: as staff interaction and coordination increased, patient mortality decreased. A similar relationship was noted between nurses’ reports of collaboration and patients’ outcomes. When adjustments were made for severity of illness, medical ICU nurses’ reports of collaboration were significantly predictive of improvement in patients’ outcomes.18 In another report,19 nurse-physician communication was examined in relation to medication errors, VAP, and catheter-associated sepsis. Nurse-physician communication was a significant predictor of medication errors but not of any other patient outcomes.

In this study, we address an important topic related to nurse-physician collaboration and adverse patient outcomes. The research question was as follows: What is the relationship between nurse-physician collaboration and 2 of the most common elements of patient care directly affected by nursing practice in critical care: VAPs and CLABSI? On the basis of a comprehensive review of the literature, we hypothesized that nurse-physician collaboration is inversely related to VAP and CLABSI.

### Methods

The theoretical framework for this study was Kanter’s theory of structural empowerment.20 In this theory, Kanter suggests that hierarchical structures contribute to behaviors and attitudes. Both the formal and the informal processes in place within a critical care setting and perceived power disparities may contribute to ineffective nurse-physician collaboration.

### Design

This longitudinal study was a secondary analysis of nurse perception data. In the original study,21 the Nurse Perception Survey was used once a year to measure nurses’ perception of the work environment during the 4.25-year study period. The survey was a compilation of 5 instruments used to measure various aspects of the work environment. During the study period, interventions to streamline nurses’ orientation and provide more staff education were implemented. Bundling practices recommended by the Institute for Healthcare Improvement22,23 were not fully implemented until the present study was completed.

### Sample and Setting

The original study21 was conducted in a 750-bed university-affiliated Magnet hospital in western New York. Four specialized ICUs (surgical, medical, burn-trauma, and cardiovascular) with 10 to 22 beds each were included in the study. The units were geographically isolated.
from each other. The research reported in this secondary analysis of data was approved by the appropriate university research review board.

Data on all nurses who participated in the original study were included in the secondary analysis. The Collaboration and Satisfaction About Care Decisions (CSACD) was 1 instrument embedded within the Nurse Perception Survey. A total of 671 nurse perception surveys were collected. The mean response rate for the entire study period was 96%.

Patient outcome data were collected on all patients (n = 3610) discharged from each of the 4 ICUs during the 4.25-year study period (January 1, 2005, to March 31, 2009). Discharge was defined as transfer to an alternative level of care, discharge home, or death. Demographic information was also obtained, including age, sex, length of stay, and comorbid conditions. This information was used to compute a Charlson Comorbidity Index to control for severity of illness. Specifically, data for all patients with CLABSI, VAP, or both were examined in the secondary analysis of data because these HAIs are the most common in critical care and contribute to marked morbidity and mortality.2

Measures

Nurse-physician collaboration was measured in the original study by using the CSACD, which is both reliable and valid. The Likert scale was adjusted from a 7-point scale to a 6-point scale when incorporated into the Nurse Perception Survey, with values of 1 (strongly disagree) to 6 (strongly agree). A mean collaboration score was calculated for all nurses. The CSACD has been used in many studies on nurse-physician collaboration and was created specifically for critical care units.

Dependent Variables

VAP was defined as pneumonia that occurred in a patient who had been treated with mechanical ventilation for more than 2 calendar days on the day the infection was diagnosed and was calculated as the number of VAPs times 1000 divided by the number of ventilator days for ICU patients per month. CLABSI was defined as laboratory confirmed bloodstream infection in which the central catheter had been in place for more than 2 calendar days on the day the infection was diagnosed and was calculated as the number of CLABSI times 1000 divided by number of central catheter days per month. Figures 1 and 2 illustrate CLABSI and VAP rates by unit for the entire period of the original study. Also included in the analysis were 3 unit-level variables related to patient outcomes in critical care. Nurses’ skill mix, nursing hours per patient day, and voluntary turnover were examined as covariates in the modeling procedures. These data were obtained from the nursing administrative database. Data on all variables were collected monthly and were aggregated at the unit level. Patient outcome data were obtained from the ICU clinical outcomes specialist.

Data Analysis

Data were cleaned and checked for errors and missing data before any analyses. SAS, version 9.3, software (SAS
Institute Inc) was used for data analysis. Data were expressed as mean and standard deviation. All statistical tests were 2-sided. P values less than .05 were considered significant. Evaluation of the nurse-physician collaboration was completed by examining data collected by using the CSACD from January 1, 2005, to March 31, 2009. Descriptive statistics were used.

The observations and analysis were at the unit level. In order to ensure a sufficient number of rare outcomes and a sufficient level of variability in patient outcomes, data were aggregated by unit by month except for nurse-level data, which were aggregated to the unit level by year. The total observations for these variables were 204 (4 units \(\times\) 12 months \(\times\) 4.25 years). Nurse-physician collaboration per unit was treated as constant within a year. As a result, the mean (per unit by year) was used as a proxy for job satisfaction for each month for each unit.

Mixed linear modeling with PROC MIXED (SAS, version 9.3) was used to examine the potential relationship between nurse-physician collaboration and HAIs. The intraclass correlation coefficient was calculated because of the hierarchical structure in the data. The coefficient is used to determine the degree to which observations within groups may be dependent because of the phenomenon of nesting. Intraclass correlation coefficients for VAP and CLABSI were 0.20 and 0.04, respectively. These moderately high values indicate that rates of VAP and CLABSI were unit dependent. Multilevel modeling\(^3\) was used to control for variability attributed to the effect of nesting of monthly data within units.

After confirmation that all assumptions of mixed linear modeling were met, multicollinearity among the independent variables was investigated. In order to choose the optimal predictors, the model was selected before the modeling was done. First, the primary predictor mean collaboration and the entire relevant nurse and patient levels’ covariates were included in the model, and the backward step was used to select the optimal variables for the final model. The following variables were chosen as in the final models: mean collaboration, unit, year, Charlson Comorbidity Index, nursing certification (CCRN), nurses skill mix, turnover, and nursing hours per patient day. Bias-corrected bootstrap methods were used to generate 95% CIs and \(P\) values for model parameters. These methods produce more accurate estimates in multilevel modeling when level 2 sample size is small or distributions deviate from normal.\(^3\)

**Results**

Tables 1 and 2 give the demographics associated with data on both the nurses and the patients used in this secondary analysis. Included in Table 1 are the mean rates for both CLABSI and VAP for the study period along with mean Charlson Comorbidity Index. This sample of nurses reported favorable perception of nurse-physician collaboration as measured by the CSACD instrument. Unit C consistently reported the highest satisfaction with nurse-physician collaboration, and unit D reported the lowest satisfaction. The 4 ICUs differed significantly in perception of nurse-physician collaboration (Table 3).

***Table 1*** Aggregated patient demographics by unit for entire study period (N = 3610)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of patients in unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient’s age, mean, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;21</td>
<td>6.8</td>
<td>0.3</td>
<td>1.4</td>
<td>0.5</td>
</tr>
<tr>
<td>21-30</td>
<td>14.8</td>
<td>2.3</td>
<td>3.5</td>
<td>3.6</td>
</tr>
<tr>
<td>31-40</td>
<td>14.3</td>
<td>5.3</td>
<td>6.7</td>
<td>3.7</td>
</tr>
<tr>
<td>41-50</td>
<td>17.0</td>
<td>11.0</td>
<td>15</td>
<td>13.8</td>
</tr>
<tr>
<td>51-60</td>
<td>17.3</td>
<td>17.4</td>
<td>18.8</td>
<td>31.0</td>
</tr>
<tr>
<td>61-70</td>
<td>12.0</td>
<td>25.3</td>
<td>18.6</td>
<td>23.8</td>
</tr>
<tr>
<td>71-80</td>
<td>9.6</td>
<td>23.6</td>
<td>20.5</td>
<td>12.9</td>
</tr>
<tr>
<td>&gt;80</td>
<td>8.2</td>
<td>14.8</td>
<td>15.5</td>
<td>10.7</td>
</tr>
<tr>
<td>Charlson Comorbidity Index</td>
<td>0.88 (0.33-2.08)</td>
<td>2.3 (0.5-4.22)</td>
<td>2.9 (1.6-4.9)</td>
<td>3.2 (1.5-5.0)</td>
</tr>
<tr>
<td>No. of CLABSi per month</td>
<td>2.4 (0-12)</td>
<td>1.3 (0-10)</td>
<td>1.1 (0-5)</td>
<td>2.2 (0-8)</td>
</tr>
<tr>
<td>CLABSI rate</td>
<td>5.7 (0-25.6)</td>
<td>3.0 (0-29.7)</td>
<td>3.3 (0-15.4)</td>
<td>5.9 (0-25.2)</td>
</tr>
<tr>
<td>No. of VAPs per month</td>
<td>1.1 (0-8)</td>
<td>0.4 (0-3)</td>
<td>0.3 (0-2)</td>
<td>0.6 (0-3)</td>
</tr>
<tr>
<td>VAP rate</td>
<td>3.7 (0-27.2)</td>
<td>1.6 (0-17.14)</td>
<td>1.0 (0-7.8)</td>
<td>1.6 (0-9.1)</td>
</tr>
</tbody>
</table>

Abbreviations: CLABSI, central catheter-associated bloodstream infection; VAP, ventilator-associated pneumonia.
Units with favorable perception of nurse-physician collaboration were associated with lower rates of both CLABSI and VAP. Table 4 illustrates the results of the 2-level model for CLABSI with controls for patient severity of illness. For every 0.5 unit increase in nurse-physician collaboration, the rate of CLABSI decreased by 2.98 (\( P = .005 \)). Additionally, those units with a higher proportion of certified nurses were associated with a 0.44 lower incidence of CLABSI (\( P = .02 \)). Neither nurses’ skill mix nor voluntary turnover was related to CLABSI, but nursing hours per patient day was a significant predictor of CLABSI for this sample. ICUs with increased nursing hours per patient day were associated with a 0.42 decrease in the rate of CLABSI (\( P = .05 \)).

Table 5 illustrates the results of the 2-level model for VAP with controls for severity of illness. For every 0.5 unit increase in nurse-physician collaboration, the rate of VAP decreased by 1.13 (\( P = .005 \)). Units with a higher proportion of certified nurses were associated with a 0.17 decrease in the rate of VAP (\( P = .01 \)). However, none of the unit-level variables (nurses’ skill mix, voluntary turnover, or nursing hours per patient day) was a significant predictor of VAP.
Discussion

Our findings support existing research that links nurse-physician collaboration and patient outcomes. Our results also add to the existing literature on nurse-physician collaboration and patient outcomes in 2 important ways. First, in many studies, only patient mortality was examined as an outcome measure. With recent policy changes by the Centers for Medicare and Medicaid Services related to nonreimbursement for HAIs, preventable conditions are now carefully scrutinized. Both CLABSI and VAP are associated with increased patient morbidity and mortality, and as health care providers, nurses need to better understand all aspects of the work environment that may affect HAIs. Second, the longitudinal data collection allowed us to examine trends over time, a situation that improves the validity of the findings. Additionally, we used mixed linear modeling for the data analysis, a step that allowed us to control for observations within groups that may be dependent because of the phenomenon of nesting. For example, patients in the cardiovascular ICU would have lower rates of VAP because they are typically not intubated for long periods postoperatively. Controlling for nesting in the data analysis is important to decrease error.

Another important finding is that units with a higher proportion of certified nurses were associated with lower incidences of both CLABSI and VAP. Certified nurses included nurses who completed certification such as those for CCRN, oncology nurse, and Advanced Trauma Life Support. Each of these additional certifications is above and beyond what is required by the hospital. In most research on patient outcomes and certification, the investigators looked specifically at CCRN certification. In previous multisite studies, no significant relationships were detected between certification and patient outcomes. Our findings are more consistent with expectations about the potential impact of certification on care delivery outcomes. For example, nurses who earn CCRN certification are held to a higher standard than are noncertified nurses: the CCRNs are required to earn more than 100 contact hours every 3 years, pass a difficult written examination, provide evidence of bedside nursing, and participate in disseminating evidence. Because of the extra effort required for certification, these nurses are expected to provide superior care, although the relationship between this enhanced care and improved outcomes has not been established.

Fortunately, rates of both CLABSI and VAP are decreasing, and some investigators have attributed this decrease to the implementation of new bundling practices. Embedded within the bundles is the need for effective communication. For example, during insertion of a central catheter, all members of the health care team must communicate effectively and collaborate with each other on sterile technique, use of personal protective equipment, and updates on the patient’s response to the procedure. According to our analysis, nurses rated overall nurse-physician collaboration as favorable, with significant differences between the 4 ICUs. At the unit level, those units with favorable nurse-physician collaboration were associated with decreased rates of both CLABSI and VAP.

Our findings have important implications. The first implication is the potential to improve patient safety through improved collaboration and communication. Several interventions have successfully improved nurse-physician collaboration. Multidisciplinary daily patient rounds can improve nurse-physician collaboration and communication. However, in 1 study, the physicians reported an improvement in nurse-physician collaboration, whereas the nurses reported no difference. This discrepancy in perception of collaboration is well-documented.

Kanter’s theory of structural empowerment may help explain the disparities. The hierarchical structures within the health care environment could potentially inflate physicians’ perceptions of collaboration because physicians administer the orders. Nurses, as the recipient of the orders, may find true collaboration difficult because of the inherent barriers related to the hierarchy within hospitals.

Other interventions that have improved nurse-physician collaboration include interprofessional education via both educational programs and patient simulations. Collaborative relationships improved after medical residents and nurses participated in both simulation training and formal education programs.

Limitations

Our study has several limitations. First, because the original study was conducted at a single institution,
generalizability of the findings is limited. Future research on nurse-physician collaboration and patient outcomes should be conducted at various institutions (with multiple units) to improve external validity. Additionally, we measured only nurses’ perceptions related to nurse-physician collaboration. For a more complete picture of the phenomenon, physicians’ perceptions should be included. Another limitation is that we did not include physician staffing in the models. The 4 ICUs varied in terms of use of midlevel providers, but the care of all ICU patients was managed by intensivists.

Despite these limitations, our results provide preliminary support for the relationship between nurse-physician collaboration and HAI in critical care. CCN

Financial Disclosures
This research was funded by a St John Fisher College faculty development grant.

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References


The majority of test-taking recommendations revolve around the acquisition and validation of knowledge and the dissection of questions. Another equally important tip would be to relax. I was recently listening to an interview of a retired hall-of-fame athlete answering questions about a young new star. When asked what advice he would offer, he spelled out R-E-L-A-X. He said of this young talented athlete, “He has it all, strong body, quick mind, full comprehension of the game, and talented team mates. He just needs to relax and show off his stuff.” This is good advice in competitive sports and also in test taking. To succeed, one must understand the game/concepts, put in the hours of practice, and learn from mistakes and from others. Come game day, get a good night’s sleep, eat, remember to breathe, relax, and arrive with your best stuff and show it.

Adult CCRN Practice Questions

1. While the nurse suctions an intubated patient, the monitor shows new-onset bradycardia with frequent premature ventricular contractions (PVCs). After stopping the suctionsing, the nurse’s first intervention is to do which of the following?

A. Instill air into the endotracheal tube (ETT) cuff
B. Administer amiodarone 300 mg intravenous (IV) push (bolus)
C. Administer atropine 0.5 mg IV push
D. Hyperoxygenate the patient with 100% oxygen (O₂)

Test plan topic: Pulmonary, 18% of the CCRN questions

2. A patient is being weaned from mechanical ventilation. The nurse is aware that the patient does not speak or understand English. The best method for the nurse to engage the patient in the weaning process is which of the following?

A. Have a translator explain the process to the patient in the patient’s language
B. Have a translator use a picture board with the patient to demonstrate the process
C. Give the patient written material (in the patient’s language) explaining the process
D. Call the patient’s family to translate for the nurse explaining the procedure

Test plan topic: Professional Caring and Ethical Practice, 20% of the CCRN questions

3. A postoperative patient receiving IV morphine via a patient-controlled analgesia (PCA)
pump is assessed by the nurse with the following findings:
- Arousal only to sternal rub
- Respiratory rate of 6 breaths per minute
- Oxygen saturation on pulse oximetry (Spo₂) 80% on room air

In addition to providing oxygen and stopping the PCA pump, the nurse’s best intervention is to administer which of the following?
- Acetylcysteine (NAC)
- Phystostigmine (Antilirium)
- Flumazenil (Romazicon)
- Naloxone (Narcan)

Test plan topic: Multisystem, 8% of the CCRN questions.

4. The nurse notes ST-segment elevations in leads II, III, and aVF on the electrocardiogram of a patient with chest pain. While preparing for transfer to the catheterization laboratory, the nurse will monitor closely for which of the following?
- Bradycardia and heart blocks
- Atrial dysrhythmias
- Rapid reentry rhythms
- Sick sinus syndrome

Test plan topic: Cardiovascular, 20% of the CCRN questions.

Correct Answers and Rationales for CCRN Practice Questions
1. Correct Answer: D
Rationale
Suctioning can cause changes in the patient’s cardiac rhythm because of a decrease in $\text{Pao}_2$. Hyperoxegenation before and between suctioning attempts assists in preventing low $\text{Pao}_2$ during the procedure. Amiodarone (B) is useful in treating ventricular arrhythmias and atropine (C) is given in bradycardic rhythms due to vagal stimulation or heart blocks, not for lower oxygen level due to suctioning. Deflation of the ETT cuff also is not the cause of the bradycardia.

Source

2. Correct Answer: B
Rationale
Clear and timely communication is imperative for the nurse to engage the patient in the process. A translator is best when explaining anything to a patient. A one-time explanation may not be enough for the weaning process, which occurs in stages over time. A picture board explained by the translator and then reinforced by the nursing staff (B) would allow objective and repeated communication. It is difficult for ventilator patients to read, and the reading level of a patient is not always known (C). A family member’s translation could not be verified by the nurse as accurate and appropriate (D).

Source

3. Correct Answer: D
Rationale
The patient’s assessment findings are indicative of respiratory depression due to opioid (morphine) administration. The best nursing intervention is to stop the infusion of morphine and give an opioid antagonist (Narcan). Acetylcysteine (A) is used as an antidote to acetaminophen, physostigmine (B) is given to counteract muscle relaxants, and flumazenil (Romazicon) is given for benzodiazepine overdose (C).

Source

4. Correct Answer: A
Rationale
The right coronary artery perfuses the inferior wall (II, III, aVF) and also the sinoatrial (SA) and atrioventricular (AV) nodes. A patient experiencing ischemia to the inferior wall might also have bradycardia and/or heart blocks develop.
5. Correct Answer: A

Rationale
Before moving the pulmonary artery catheter, the nurse needs to ascertain that the balloon is not inflated. Passive deflation is the safest method to remove air from the catheter's balloon. The catheter should be slowly pulled back only after the balloon has been assessed to ensure that it is not inflated or the pulmonic valve can be damaged (B). Active deflation is done by pulling the air out and could result in balloon damage (C). Use of the Trendelenburg or left-side position would not help to “float” the balloon from “wedge” position.

CSC Practice Questions

1. The arterial waveform of a patient who is 6 hours postoperative from coronary artery bypass graft (CABG) surgery has a significant decrease in amplitude with each inspiration and the amplitude increases during expiration. This assessment finding would be consistent with which of the following conditions?
   A. Atrial fibrillation
   B. Cardiac tamponade
   C. Acute coronary syndrome
   D. Pulmonary embolus

2. After mitral valve replacement, atrial fibrillation occurs in a patient who had been in normal sinus rhythm. The patient is receiving infusions of dobutamine at 7.5 μg/kg per minute, epinephrine at 5 μg/min, and is AAI paced at a rate of 90 beats per minute via temporary epicardial pacing wires. In addition to assessing the patient’s hemodynamic response to the rhythm change, the nurse should do which of the following?
   A. Administer amiodarone 150 mg and then start a continuous infusion
   B. Discontinue the epinephrine infusion and obtain a cardiac output
   C. Attempt rapid overdrive pacing by increasing the rate
   D. Decrease the pacemaker rate and assess the patient’s intrinsic rhythm

3. In the first hour after CABG and aortic valve replacement, the patient’s assessment reveals

<table>
<thead>
<tr>
<th>Variable</th>
<th>On Admission</th>
<th>1 Hour later</th>
<th>2 Hours later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure, mm Hg</td>
<td>100/60</td>
<td>75/50</td>
<td></td>
</tr>
<tr>
<td>Heart rate, beats per minute</td>
<td>100</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Central venous pressure, mm Hg</td>
<td>6</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Pulmonary artery pressure, mm Hg</td>
<td>20/8</td>
<td>25/18</td>
<td></td>
</tr>
<tr>
<td>Cardiac index</td>
<td>2.3</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Chest tube drainage, mL</td>
<td>230</td>
<td>230</td>
<td></td>
</tr>
</tbody>
</table>

*Calculated as cardiac output in liters per minute divided by body surface area in square meters.

The nurse should prepare for which of the following?
   A. Chest tube placement
   B. Thoracentesis
   C. An echocardiogram
   D. A chest computed tomography (CT) scan

4. Following mitral valve repair, the patient has greater than 200 mL/h chest tube drainage. Results of laboratory tests show a normal partial thromboplastin time (PTT), increased international normalized ratio (INR), decreased hemoglobin (Hgb), and decreased platelet count. To help correct the coagulopathy, the nurse should anticipate administering which of the following?
   A. Protamine sulfate, packed red blood cells (PRBCs), and cryoprecipitate
   B. PRBCs, fresh frozen plasma (FFP), and cryoprecipitate
   C. Protamine sulfate, FFP, and platelets
   D. FFP, PRBCs, and platelets

5. A patient is admitted following coronary artery bypass surgery. Vital signs are

<table>
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<tr>
<th>Variable</th>
<th>On Admission</th>
<th>1 Hour later</th>
<th>2 Hours later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure, mm Hg</td>
<td>100/60</td>
<td>98/60</td>
<td>95/55</td>
</tr>
<tr>
<td>Heart rate, beats per minute</td>
<td>90</td>
<td>100</td>
<td>110</td>
</tr>
<tr>
<td>Temperature, °C</td>
<td>35.5</td>
<td>35.8</td>
<td>37</td>
</tr>
<tr>
<td>Central venous pressure, mm Hg</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>
These assessment findings would be consistent with which of the following?

A. Heparin rebound  
B. Cardiac tamponade  
C. Protamine reaction  
D. Graft dislodgement

Correct Answers and Rationales for CSC Practice Questions

1. Correct Answer: B
Rationale
The arterial waveform shows signs of pulsus paradoxus, which may indicate cardiac tamponade. In pulsus paradoxus, there is a decrease in systolic pressure of at least 10 mm Hg during inspiration. The abnormalities in the arterial waveform seen in atrial fibrillation (A) are not related to respiration. Hypotension or hypertension might occur with acute coronary syndrome (ACS) or pulmonary embolism (PE) but again the abnormality would not be dependent on the respiratory pattern.

Source

2. Correct Answer: D
Rationale
The AAI mode of pacing is atrially paced, atrially sensed and inhibited. In atrial fibrillation (AFib), multiple foci stimulate the atria, making it difficult to pace a patient. The best thing to do in this situation would be to turn down the set pacing rate and assess the patient’s intrinsic rhythm and hemodynamic stability. If pacing is needed, a VVI mode would be more appropriate. Amiodarone (A) is given for atrial dysrhythmias, but the issue of stability and pacer/A Fib competition must be addressed first. Stopping the dose of epinephrine (B) might change the heart rate but not affect the AFib. Overdrive pacing (C) is not typically possible in AFib.

Source

3. Correct Answer: C
Rationale
Assessment reveals significant hypotension, tachycardia, increased central venous pressure (CVP), and decreased cardiac index. This assessment is consistent with a cardiac tamponade. The chest tube drainage has not changed in the first hour, suggesting that the drainage is blocked and collecting in the pericardial space, thus causing the pericardial tamponade. The fluid in the space is best visualized with an echocardiogram. A chest tube (A) and thoracentesis (B) could help remove fluid from the pleural space but not from the pericardial space. A chest CT scan (D) could help to diagnose the effusion, but the patient is unstable and the echocardiography can be done at the bedside.

Source

4. Correct Answer: D
Rationale
The PTT is normal, so protamine sulfate (A, C) would not be indicated. FFP would replace clotting factors to help to normalize the elevated INR, and platelet administration would help correct the deficit. PRBCs would increase the Hgb level. Cryoprecipitate (B) is indicated in the treatment of some coagulopathies. For a postoperative coagulopathy, the platelets would be given before the cryoprecipitate.

Source

5. Correct Answer: A
Rationale
Heparin rebound occurs when heparin reenters the bloodstream from the adipose tissue as the patient warms up. It is more commonly seen after inadequate reversal with protamine sulfate in obese patients. Treatment would be reversal with protamine sulfate. In a cardiac tamponade (B), the CVP would have increased and the chest drainage would have decreased. A protamine reaction (C) would cause an anaphylactic response. When a graft is dislodged (D), the hypovolemic shock assessment is immediate.

Source
AACN Certcorp publishes a study bibliography that identifies the sources from which items are validated. The document may be found in the AACN Certification exam handbook. The contributor of each question written for this column has listed the source used in developing each item. CCN
**Ask the Experts**

Discontinuing the Indwelling Catheter for a Critically Ill Patient With Spinal Cord Injury

**Q** Are there standards for when to start bladder training for patients with spinal cord injury in the critical care unit versus not clamping a urinary catheter because of the possibility of catheter-associated urinary tract infection? When the catheter is unclamped, what is the threshold for urine returned that would be of concern?

**A** Mikel Gray, PhD, FNP, PNP, CUNP, CCCN, replies:

Thanks for asking these timely and clinically relevant questions. Although nurses have historically advocated removal of indwelling catheters whenever feasible, the current focus on prevention of catheter-associated urinary tract infections has accelerated clinical decision making related to identifying the earliest possible time for removal. The Consortium for Spinal Cord Medicine has developed 2 clinical practice guidelines that address management of neurogenic bladder dysfunction following spinal cord injury.\(^1,2\) The Consortium is a multidisciplinary group whose members include the American Association of Spinal Cord Injury Nurses and the Association of Rehabilitation Nurses.

Both guidelines advocate insertion of an indwelling urinary catheter immediately following spinal injury (no later than the patient’s arrival in the emergency department) to manage the urinary retention associated with spinal shock and enable strict monitoring of urinary output. The decision to remove the indwelling catheter is based on 2 main considerations: restoration of hemodynamic stability and when strict monitoring of urinary output is no longer necessary. Strict monitoring of urinary output is strongly recommended for several reasons; spinal cord injury disrupts vasoconstriction and venous return, resulting in third spacing of fluids and oliguria, hypotension when upright, and ultimately polyuria when supine during sleep.\(^1\)

Because all patients with paralyzing spinal cord injury experience neurogenic bladder dysfunction with urinary retention during spinal shock, removal of the indwelling catheter is followed by institution of an intermittent catheterization program rather than expectation of a return to spontaneous voiding. Abnormalities in vasoconstriction and venous return impair fluid balance, and patients typically require more frequent catheterization, sometimes as often as every 1.5 to 2 hours. Urine production is often comparatively low during waking hours when the patient is upright and paradoxically higher during early morning hours after sleeping supine. Although evidence is insufficient to determine...
the optimal time for catheter removal, the catheter should be removed as soon as urinary output is adequately predictable to allow intermittent catheterization scheduled every 3 to 4 hours around the clock.

Because removal of the indwelling catheter in a patient with a new spinal cord injury is almost always associated with neurogenic bladder dysfunction, clamping and unclamping the indwelling catheter (sometimes referred to as bladder training) is not indicated. In addition, current best evidence suggests that regularly clamping and unclamping an indwelling catheter is not beneficial to able-bodied persons, as demonstrated in a recent randomized controlled trial in older men who had an indwelling catheter removed after experiencing acute urinary retention associated with benign prostatic enlargement.3 Rather than clamping and unclamping the catheter in an attempt to restore optimal bladder function following catheter removal in able-bodied patients, I recommend careful monitoring of intravesical volumes via bladder ultrasound during a trial of voiding to ensure that the able-bodied patient experiences successful micturition and does not experience urinary retention requiring catheter reinsertion.4

References

Financial Disclosures
None reported.
Permissive Hypoxemia Versus Normoxemia for Critically Ill Patients Receiving Mechanical Ventilation

Sabina González, RN, MS, CCRN

Review Question
Does permissive hypoxemia in critically ill patients receiving mechanical ventilation affect patient morbidity and mortality?

Relevance to Critical Care Nursing
The specific range of “normal” oxygen partial pressure (PaO₂) and oxygen hemoglobin saturation (SaO₂), as measured in an arterial blood gas sample, may vary slightly; however, there are variations in how clinicians interpret a patient’s response to hypoxemia. Hypoxemia is a common finding among critically ill patients and is treated with a combination of interventions aimed at normalizing arterial oxygenation to reduce morbidity and mortality. Unfortunately, these interventions are not without risk. For example, oxygen toxicity due to release of oxygen free radicals is associated with high or prolonged exposure to high inspired concentrations of oxygen (FiO₂) therapy, and this has been associated with patient harm.

Permissive hypoxemia is the concept of allowing lower than normal PaO₂ and SaO₂ levels in order to avoid the risk associated with high FiO₂ therapy. It may be beneficial to allow permissive hypoxemia in critically ill patients rather than chasing normal levels of oxygenation. The practice of allowing permissive hypoxemia is seldom described in the literature, and there is no specific threshold defined for its use. However, some evidence suggests that patients have survived extreme hypoxemia without morbidity. Permissive hypoxemia reduces harm by minimizing high FiO₂ therapy and exposure, and in some clinical contexts avoiding hyperoxemia has led to better outcomes, for example, in patients who have had a myocardial infarction, stroke, or cardiac arrest.

Cochrane Review Summary
A summary of findings from the Cochrane Library with implications for critical care nursing

Permissive Hypoxemia Versus Normoxemia for Critically Ill Patients Receiving Mechanical Ventilation

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Study Description and Results
This summary is based on a Cochrane systematic review that aimed to review the existing evidence supporting the use of permissive hypoxemia to improve outcomes in critically ill patients receiving mechanical ventilation. The reviewers searched for randomized control trials (RCTs) and quasi-RCTs that compared an intervention group of patients with hypoxemia relative to the control group and a control group of patients with either normoxemia or mild hypoxemia (not hyperoxemia). They did not specify the criteria or clinical parameters defining hypoxemia or the methods for achieving permissive hypoxemia. Their search included all patients, in any critical care setting, at least 1 year of age, excluding neonates and infants exposed to hypoxia in utero. The primary outcomes included mortality at the longest follow-up and overall 28-day mortality.

Secondary outcomes included the following:
1. Number of days of ventilation (invasive and noninvasive)
2. Ventilator-free days
3. Requirement for inotrope support
4. Resolution of multiorgan failure (according to different organ dysfunction scores)
5. Need for hemofiltration or dialysis
6. Improvement in neurological functioning of participant
7. Improvement in mean pulmonary arterial pressure
8. Length of stay in intensive care unit
9. Length of stay in hospital
10. Participant-reported outcome measures (quality of life)
11. Cost/benefit analyses

Summary of Main Results
The initial search yielded 1651 potential studies; however, no studies met the inclusion criteria. As this review was unable to uncover relevant studies to answer this research question, it cannot confirm or deny the clinical benefits of permissive hypoxemia or its safety as a treatment strategy. Because of the lack of evidence, the reviewers advise that any changes in clinical practice that include permissive hypoxemia as a treatment strategy be exercised with caution.

Nursing Implications
This review has revealed an important topic area that warrants further research. As preliminary evidence in clinical contexts suggests that avoiding hyperoxemia may lead to better outcomes for some patient populations, further research is necessary to validate these findings. This review concludes that research designs should carefully evaluate feasibility and safety, as well as address resource utilization, quality of life, and cost-effectiveness concerns. CCN

Financial Disclosures
None reported.

Reference
Incidence and characteristics of patient falls and fall prevention programs have been a topic of interest in the literature; however, few articles on fall reduction strategies written by staff nurses have been published. Falls in hospitalized patients are serious threats to patient safety. According to Morse, sequelae of falls are the second leading cause of death in the United States. Costs resulting from falls alone have been reported at between 0.85% and 1.5% of the total health care expenses within the United States, Australia, the European Union, and the United Kingdom. A fall is the most reported safety incident in inpatients and occurs in all adult clinical areas. Accidental falls are among the most common incidents reported in hospitals and occur in approximately 2% of all hospital stays. Growing evidence indicates that falls occurring in the hospital can be reduced with planning and intervention techniques.

Purpose and Goal of the Project

The purpose of our CSI project entitled “No Fall Zone” was to determine if improved education on the current falls policy, coupled with use of a falls contract and fall prevention signs above patients’ beds, decreased the overall total number of falls. The goal of this project was to decrease the total number of falls by 50% in 1 year to within NDNQI benchmarks. NDNQI defines a fall as
an unplanned descent to the floor (or extension of the floor, eg, trash can or other equipment) with or without injury of the patient: this includes falls that are result of physiological as well as environmental reasons. Falls include both assisted falls (when a staff member attempts to minimize impact of the fall) and unassisted falls. A fall that is reported to have been assisted by a family member or visitor counts as a fall.6

Fall rates are calculated as the total number of falls multiplied by 1000 and divided by the total number of patient days.

Action Plan
A 40-minute video was developed that reenacted a real-life fall of a patient that resulted in harm. The first part of the video reenacted the chain of events preceding the fall and the harmful consequences for the patient and the patient’s family. The second part of the video showed how the same scenario should have been handled. This video was shown to all of the staff on the unit through in-service training sessions during January 2013. The in-service training sessions also included staff education related to the falls policy, documentation requirements, and the Morse Fall Scale (MFS). A patient/family fall teaching contract was developed and implemented with all patients. New fall signage was designed and placed on the ceiling above the patients’ beds.

Results
Audits of practice after education and implementation of the new program began in March 2013. A total of 246 audits were completed by staff nurses and nursing leaders on all shifts on the following items: accurate completion of the MFS and the total fall risk score. We also assessed the following: Did the interventions implemented match the MFS? Was a bed alarm indicated? If so, was it on? Was the fall care plan implemented? Was the educational teaching contract completed? (See Table 1 for audit results.)

The total number of falls, the fall rate, and the cost of falls dramatically decreased after the implementation of these interventions (Table 2). The total number of falls decreased by more than 50%, and the fall rate is now below the NDNQI benchmark.

The fiscal impact associated with this project was $505,440 (cost of 2011 falls minus cost of 2013 falls).

Clinical Implications
This project shows that focusing on 2 specific interventions, combined with the fall bundle, provides the tipping point to have an impact on fall reduction. Our plan to maintain momentum includes quarterly “No Fall Zone” days, keeping fall data and providing updates in monthly staff meetings, continued representation by our unit on our Hospital-Wide Falls Action Team, and involving staff council and the clinical nurse specialist from our unit in maintaining best-practice initiatives related to patients’ falls.

Table 1 Documentation audit results

<table>
<thead>
<tr>
<th>Documentation</th>
<th>Audit result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morse Fall Scale completed</td>
<td>95%</td>
</tr>
<tr>
<td>Mean fall risk score</td>
<td>56.7</td>
</tr>
<tr>
<td>Median fall risk score</td>
<td>55 (majority of patients at risk for falling)</td>
</tr>
<tr>
<td>Fall interventions match Morse score</td>
<td>90%</td>
</tr>
<tr>
<td>Bed alarm indicated and used properly</td>
<td>77% (23% of time not used and should have been)</td>
</tr>
<tr>
<td>Bed/Chair alarm not indicated</td>
<td>33%</td>
</tr>
<tr>
<td>Fall care plan implemented appropriately</td>
<td>75%</td>
</tr>
<tr>
<td>Educational fall contract completed</td>
<td>45%</td>
</tr>
</tbody>
</table>

Table 2 Falls data

<table>
<thead>
<tr>
<th>Variable</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total No. of falls</td>
<td>37</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>Progressive care unit fall rate</td>
<td>3.92</td>
<td>2.42</td>
<td>1.84</td>
</tr>
<tr>
<td>National Database for Nursing Quality Indicators benchmark</td>
<td>3.37</td>
<td>2.68</td>
<td>3.20</td>
</tr>
<tr>
<td>Costs associated with fall</td>
<td>$719,280a</td>
<td>$447,130</td>
<td>$213,840</td>
</tr>
</tbody>
</table>

a Mean cost of a fall was $19,440.
Further work is needed to assist nurses in prioritizing fall interventions on the basis of patient-specific needs to identify clearly what will affect each patient in the most effective way. Because of the successful outcome of these strategies on this unit, the same process will be replicated and disseminated to other units within the hospital.

For more information on this project, please visit the AACN CSI Database at www.aacn.org/csi.

Financial Disclosures
None reported.

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Concise yet thorough guidance on how to safely and competently care for adult critically ill and progressive care patients.

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Fundamentals of Geriatric Pharmacotherapy, 2nd edition


Reviewed by Linda Bell, RN, MSN

Fundamentals of Geriatric Pharmacotherapy is not your typical “drug book”—it assumes knowledge of disease-specific pathophysiology and pharmacotherapy and adds to that knowledge by focusing on a specific population, older adults.

There are 2 sections in the book. The first section sets the stage by discussing the social, ethical, and economic issues of aging, including one chapter on challenges in geriatric care and and one chapter on the ethical and socioeconomic considerations of aging. These 2 chapters provide a platform upon which the rest of the text builds.

The second section focuses on the body systems and diseases, and additional content includes geriatric assessment, adverse drug events, and palliative and hospice care. The introductory chapter for this section covers biomedical effects of aging, addressing issues such as age-related changes in medication sensitivity.

Each chapter in the second section includes the etiology; epidemiology; presentation of particular diseases, conditions, or situations in older adults; discussion of the standard treatment in adult populations with added treatment recommendations for the older adult; and any barriers to appropriate treatment. For example, the discussion of hypertension outlines the literature and current recommendations for blood pressure management in adults. The treatment recommendations address the studies that included older adults and provide discussion about target goals for blood pressure in comparison to the JNC 7 and other organizational guidelines for later decades of life.

Each chapter starts with objectives and includes key terms and definitions for the particular topics, which is helpful to understanding context. Additionally, each chapter calls out key points and concludes with a case presentation with plan and rationale, clinical pearls, chapter summary, and self-assessment questions. Each chapter has an exhaustive reference list as well as multiple charts, tables, and assessment tools.

The value of this book may be for the advanced practice nurse who has prescriptive authority. However, the content goes beyond how to prescribe for older adults. The case presentations discuss patients in different settings (eg, acute care, outpatient clinic, and long-term care) to avoid the stereotypical thinking that all older adults end up in a facility and to remind us that multiple conditions may exist in the same patient and that all must be accounted for in managing this population.

The numbers of older adults are increasing and people are living longer. It is essential for caregivers of older adults to have age-specific knowledge and competencies. Books like Fundamentals will help to ensure that we all provide evidence-based, age-appropriate care.

Linda Bell is a clinical practice specialist at the American Association of Critical-Care Nurses in Aliso Viejo, California.

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For those of us not working in a high-risk perinatal unit, the announcement that a pregnant woman is being admitted to the intensive care unit for any reason creates a high level of anxiety. Obstetric Intensive Care Manual provides essential information to assess, diagnose, and treat pregnant patients emergently admitted to the intensive care unit. The first chapter provides practical understanding of the basic hemodynamic changes that occur during pregnancy and how other conditions may affect or be affected, such as shock, preeclampsia, or valve disease. Consecutive chapters address conditions such as obesity, cardiac disease, respiratory disease, and even psychiatric emergencies. Multiple charts and tables provide support for the content.


This book begins by introducing the “12 Critical Concepts,” providing a foundation for the learning in the rest of the book. It is a great self-paced learning with large figures that help make interpretation easy. 12-Lead EKG Confidence starts with a basic review and builds the knowledge throughout the chapter. In addition, each chapter has worksheets with instructions and the answers are provided in the back. A great benefit of this book is that other than in the common clinical arrhythmias all the worksheets are 12 lead rather than rhythm strips, even when you are just being asked to calculate rate and intervals.

Wallach’s Interpretation of Diagnostic Tests: Pathways to Arriving at a Clinical Diagnosis, 10th edition

Rather than just providing laboratory tests and results, Wallach’s focuses on assessment and interpretation of patient symptoms and then appropriate laboratory tests and results. The true value of this book is its facilitation of understanding the results of tests. The introduction reviews the factors affecting laboratory tests to remind the reader that the numbers may not always be accurate and what to look for if there is a suspected error. This volume is accompanied by access to an interactive eBook edition that offers tablet, smartphone, or online access to the content. CCN

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**Missoula**

12th Annual Critical Care Symposium

*Date:* May 4, 2015. *Place:* Providence St. Patrick Hospital Broadway Building Conference Center. *Address:* 500 W Broadway, Missoula, MT. *Keynote Speaker:* Mary Kay Bader. *Sponsor:* Bitterroot Chapter of AACN. *Contact:* Nicole Marks, *E-mail:* marksn2303@gmail.com

**PENNSYLVANIA**

**Camp Hill**

Acute and Critical Care Issues Across the Lifespan

*Date:* April 17, 2015. *Place:* Giant Community Room. *Address:* Trindle Road, Camp Hill, PA. *Sponsor:* Susquehanna Valley Chapter of AACN. *Contact:* Lori Cox, *E-mail:* lorinp@comcast.net. *Fee:* $20, members (fee refunded at door); $30, nonmembers

**TENNESSEE**

**Memphis**

Spring Seminar: Focus the Flame

*Date:* April 10, 2015. *Place:* Baptist Memorial Hospital, Memphis Seminar Rooms, Memphis, TN. *Keynote Speaker:* Teri Lynn Kiss. *Sponsor:* Greater Memphis Area Chapter of AACN. *Contact:* Janet F. Mulroy. *Phone:* (901) 682-5478. *Fax:* (901) 344-2699. *E-mail:* jfmulroy@comcast.net

**TEXAS**

**Dallas**

Advanced Critical Care & Emergency Nursing


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Critical Care Summit


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**CriticalCareNurse**

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Why did you become a nurse?
My mother was in the intensive care unit (ICU) in a vegetative state after a cardiac arrest. Her wish was to discontinue all lifesaving measures, but when I approached the physician with her advance directives he screamed that I was killing my mother. A nurse informed the physician that he would immediately remove himself from “her ICU” or she would call security. She was an angel in the midst of chaos and despair. I promised myself I would be just like her: I would protect my patients and families, and I would honor their wishes as she had done for me.

What about your job as a nurse makes you happy?
Everything! I love that each day brings a new promise of adventure, camaraderie, compassion, and miracles. I love that each patient is a challenge in a unique way. But I am happiest teaching nurses about the ICU and all its wonders.

Tell us about an extraordinary experience you’ve had as a critical care nurse.
A few years ago I cared for a 22-year-old man who had been severely injured in a motor vehicle accident. For 6 hours 6 to 8 nurses fought to save his life. Although he was intubated, he was alert and awake because his blood pressure was so low that we were unable to give him pain or sedation medication. His family stayed at his bedside while we pushed liter after liter of fluid and unit after unit of blood products. Finally, the trauma surgeon spoke with the family. They agreed to stop all measures. The mother told her son how much she loved him and how happy and proud they were of the man he had become. With his final breath of life, he signed the phrase “I love you all.” It was the most beautiful thing I have ever witnessed.

What are the challenges you encounter and how do you overcome them?
The biggest challenge is working without the resources that larger facilities have at their disposal. I am so proud of our nurses as they figure out how to overcome this lack of resources. The challenges are many but seem few because I am surrounded by extraordinary nurses.

What has your journey as a nurse been like?
It has not always been easy but it’s always been rewarding. I believe that now more than ever nurses have the opportunity to be powerful and innovative leaders in this ever changing world of health care.

At the end of a busy day, how do you find balance in your life?
I enjoy listening to music, reading a good book, and spending time with my family. I usually regenerate on my days off with surfing, hiking, or kayaking.

What would we be surprised to know about you?
Despite all my years of experience, I am terrified to take the CCRN exam. However, it is my next goal.

How has AACN played a role in your career?
AACN has been a continuous source of resources, encouragement, and inspiration. Every year when I have attended NTI, I have never left without being fully rejuvenated and inspired to come back and share the knowledge I have gained.
VAP is a threat to our patients on mechanical ventilation.¹,²

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