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This issue is the second part of a two-part series that discusses the pharmacology of adverse drug reactions important to the emergency physician. Part I covered angiotensin-converting enzyme inhibitors and angioedema, gastrointestinal bleeding associated with non-steroidal anti-inflammatory drugs, anti-convulsant hypersensitivity syndrome, drug-induced Stevens-Johnson syndrome and toxic epidermal necrolysis, and drugs associated with the prolonged QT interval syndrome.

Adverse Drug Reactions for the Emergency Physician: Part II

Authors: **Larissa I. Velez, MD**, Department of Emergency Medicine, University of Texas Southwestern, Dallas; **Javier Caldera, MD**, Department of Emergency Medicine, University of Texas Southwestern, Dallas; **Sing-Yi Feng, MD,** Department of Emergency Medicine, University of Texas Southwestern, Dallas; and **Ellen O'Connell, MD**, Department of Emergency Medicine, University of Texas Southwestern, Dallas.

Peer Reviewers: **Frank LoVecchio, DO, MPH, FACEP**, Research Director, Maricopa Medical Center; Medical Director, Banner Poison Center, Phoenix, AZ; and **Barry H. Rumack, MD**, Director Emeritus, Rocky Mountain Poison and Drug Center, Clinical Professor of Pediatrics, University of Colorado Health Sciences Center, Denver.

An important principle throughout this series is the real potential for adverse drug interactions with drugs used or started from the ED. One very helpful habit is to have an accurate list of all medications the patient is currently taking or has taken within the past two weeks, including prescription, over-the-counter, and herbals. This list should be consulted before using or initiating any medication during an ED visit. The principle of accurately and completely identifying all patient medications is so

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important, that it has been identified as Goal 8 of the 2006 National Patient Safety Goals: "Accurately and completely reconcile medications across the continuum of care." This medication reconciliation process is required for all patients who access the hospital system—emergency department, outpatient, and inpatient—and will be assessed by JCAHO during their inspection visits. So, in addition to being a good thing to do to minimize adverse drug interactions, medication reconciliation now is a regulatory requirement.

—J. Stephan Stapczynski, MD, Editor

Warfarin

Warfarin (Coumadin) is the most commonly used oral anticoagulant. It was synthesized by and named after the Wisconsin Alumni Research Foundation in 1948. Warfarin is administered as a racemic mixture, with the S-enantiomer being the active form. Warfarin is metabolized mostly by cytochrome P450 2C9 (CYP2C9).[1] Its mechanism of action is interfering with the vitamin K-dependent clotting factors (II, VII, IX, X). Warfarin has a narrow therapeutic window and, due to its metabolism through the P450 system, warfarin has many interactions. Individual metabolism, foods, and other drugs can either induce or inhibit the enzymes, which results in either failure of therapy or excessive anticoagulation.[1]

Table 1. Drug Interactions with Warfarin

Potentiates warfarin effect (increased risk of bleeding)	Cimetidine, erythromycin, fluconazole, ciprofloxacin (Cipro), levofloxacin (Levaquin), metronidazole (Flagyl), phenytoin, tetracycline (Sumycin), kava kava, gingko biloba, ginseng, grapefruit juice
Decreases warfarin effect (increased risk of clotting)	St. John's Wort, carbamazepine(Tegretol, Carbatrol, Epitol), chlodiazepoxide (Librium), rifampin, green leafy vegetables, green tea, oral contraceptives

Emergency physicians must know the most common interactions of warfarin. Whenever a patient using warfarin comes to the ED, a good drug history must be obtained. The history should include the use of antibiotics, anticonvulsants, and herbal remedies. Of the herbal remedies, St. John's Wort, commonly used as an over-the-counter antidepressant, can be particularly problematic. It is known to cause induction of CYP2C9, thus increasing the metabolism of warfarin.[2,3] Ginkgo biloba, used for memory enhancement, and ginseng, used for fatigue and anxiety, are both known to increase the risk of bleeding in patients taking warfarin.[4] Antifungal drugs (such as miconazole [Monistat-Derm, Micatin, Lotrimin, Micozole] and fluconazole [Diflucan]) and the quinolone antibiotics are potent inhibitors of CYP2C9, thus they increase availability of warfarin and increase the risk of bleeding.[5-7] Cimetidine (Tagamet) with some of the selective serotonin reuptake inhibitors (SSRIs) has a similar effect. On the contrary, CYP2C9 inducers such as phenobarbital and rifampin (Rifadin, Rimactane, Rofact) may decrease the effects of warfarin, resulting in an increased risk of thromboembolic events.[8] Table 1 summarizes common drug interactions with warfarin and their effect on clotting.

Serotonin Syndrome

Serotonin syndrome (SS) is an iatrogenic drug-induced "toxidrome" that results from[9] the overstimulation of the 5-HT_{1A} receptors in the central grey nuclei and the medulla, with perhaps some overstimulation of the 5-HT_2 receptors.[10] This overstimulation may be due to excess precursors of serotonin or its receptor agonists, lower reuptake of serotonin from the synaptic cleft, or slowdown of serotonin metabolism.[10,11]

The diagnosis of SS includes a history of use of a serotonergic agent(s), the presence of recognized signs and symptoms, and the exclusion of other conditions. Since it may be hard to distinguish from neuroleptic malignant syndrome, the diagnosis of SS often includes the lack of use of a neuroleptic agent. The syndrome mainly affects the autonomic, GI, and neurological systems. The

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Table 2. Sternbach Criteria for the Diagnosis of Serotonin Syndrome

- Recent addition or increase of a known serotonergic agent
- Absence of other possible causes (such as infection)
- No recent use of a neuroleptic agent
- At least 3 of the following:
  - Mental status changes (i.e., agitation, confusion)
  - Myoclonus (greater in lower extremities)
  - Hyperreflexia (greater in lower extremities)
  - Diaphoresis
  - Shivering
  - Tremor (greater in lower extremities)
  - Diarrhea
  - Incoordination
  - Fever

onset of symptoms is sudden, and it usually manifests itself less than 24 hours after treatment initiation or overdose.[10] It seems that the more powerful the serotonergic agent and the higher the dose, the more pronounced are the SS symptoms.[12] The diagnosis of SS is guided by the Sternbach criteria, listed in Table 2, although other less utilized diagnostic criteria exist.[13-15]

There is no specific test to diagnose the serotonin syndrome—elevation of total creatine kinase and leukocyte count, elevated transaminases, and lower bicarbonate levels have been used, but lack accuracy. Disseminated intravascular coagulation, kidney failure, metabolic acidosis, and adult respiratory distress syndrome (ARDS) are reported complications.[10]

Meticulous supportive management is the mainstay of care. All serotonergic agents must be discontinued. Isotonic crystalloids should be administered to optimize urine output and avoid renal failure from myoglobin deposition in the kidneys. Benzodiazepines should be given to treat agitation. Although their effectiveness has not been demonstrated in prospective studies, cyproheptadine (Periactin), chlorpromazine (Thorazine), and methylsergide (Sansert) have been described as possible antidotal therapies for SS.[16-18]

Cyproheptadine (4 mg po q2-4h up to 0.5 mg/kg/d) is a histamine-1 receptor antagonist with anticholinergic and antiserotonergic characteristics. Chlorpromazine (25 mg IM) is a neuroleptic with 5-HT_{1A} and 5-HT_2 receptor antagonism that also has anticholinergic effects. One case of partial improvement has been reported with the use of propranolol (20 mg po q8h).[19]

Neuroleptic Malignant Syndrome

Neuroleptic malignant syndrome (NMS) is an uncommon but life-threatening condition with a reported mortality of 30-50%.[20] It was first described in the 1960s by Delay.[21] NMS is an idiosyncratic condition that is thought to occur in 1% of the patients receiving neuroleptics.[22] The syndrome usually occurs 3-9 days after the neuroleptic therapy is initiated. NMS is associated more frequently with the high potency neuroleptics haloperidol and thiothixene.[22] However, most of the newer antipsychotics also have been reported to cause NMS.[23-26]

NMS has been associated with reduced signaling in the dopaminergic pathways due to sudden withdrawal of dopaminergic drugs (such as Parkinson's disease drugs) and drugs that block dopamine signaling.[27] In both of these scenarios, the culprit is thought to be dopaminergic blockade in the basal ganglia and in the hypothalamus.[22]

Table 3. Levenson's Criteria for NMS

Major	• Fever (> 38°C), rigidity, elevated creatinine kinase
Minor	• Tachycardia, labile blood pressure, altered consciousness, diaphoresis, leukocytosis

The clinical features of NMS include alteration in mental status, autonomic instability, hyperthermia, and rigidity.[28] The primary motor component is the lead pipe rigidity. The patient's mental status can range from delirium to coma. The cardiovascular instability results in labile blood pressure, diaphoresis, tachycardia, and tachydysrhythmias. Hyperthermia is key to the diagnosis, although isolated case reports describe the syndrome without elevated temperatures.[27,28]

The diagnosis is made on clinical grounds in a patient with the signs and symptoms described above and who is using a neuroleptic agent. The most widely accepted diagnostic criteria were published by Levenson in 1985.[29] (See *Table 3.*)

Though not diagnostic, laboratory abnormalities that can be seen include leukocytosis with a left shift, and an elevated creatinine kinase due to rhabdomyolysis from muscle rigidity.[22] Myoglobinuria may also be present and renal function may be compromised due to the rhabdomyolysis. Electrolyte imbalances, such as hyperkalemia and a low bicarbonate, also may be found.

NMS can be misdiagnosed as sepsis. For this reason, it is important to consider other causes for the patient's signs and symptoms, such as meningitis or encephalitis. A head computerized tomography (CT) scan and lumbar puncture should be performed, and empiric treatment with antibiotics should be considered. The syndrome also is difficult to differentiate from SS.[30]

As with the most adverse drug reactions (ADRs), the mainstay of treatment consists of aggressive supportive measures and discontinuing the offending agent. Patients should be hydrated aggressively to maintain an adequate urine output. Hyperthermic patients must be cooled. Intravenous benzodiazepines should be used to decrease muscle rigidity and to control the agitation. Antipyretics generally are not beneficial, since the hyperthermia is due to excessive muscle contractions, not hypothalamic disturbances.

In addition to the above-mentioned interventions, some pharmacologic agents can be used. Dantrolene sodium (Dantrium), bromocriptine (Parlodel), and L-dopa (Dopar, Larodopar) are the most common agents used.[20,27,30,31] Dantrolene sodium causes muscle relaxation via inhibition of the release of calcium from the sarcoplasmic reticulum and is the classic antidote for malignant hyperthermia.[27,32] The recommended dose of dantrolene sodium is 3-5 mg/kg/day IV divided in 3-4 doses.[22] Bromocriptine, a central dopamine agonist, also has been used successfully. It should be administered orally or by nasogastric tube at 5 mg every 6 hours. In severe cases, patients may need to be paralyzed with non-depo-

larizing agents and intubated. Electroconvulsive therapy is cited in various articles as an alternative treatment.[22,27,28] The time to recovery from NMS has been reported to be 9-15 days.[27]

Malignant Hyperthermia (MH)

MH is a rare autosomal dominant disorder of the skeletal muscle, specifically at the ryanodine receptor complex.[33] This receptor controls calcium release from the sarcoplasmic reticulum. When triggered, there is an excessive release of calcium from the sarcoplasmic reticulum in the skeletal muscle and increased permeability of the cell membranes.[33,34] Its incidence is estimated to be between 1 in 50,000 to 1 in 100,000 people.[33] MH is associated with the use of halogenated anesthetic gases such as halothane (Fluothane) and succynylcholine (Suxamethonium, Anectine), and as such, it generally occurs in the intraoperative setting.[33] The condition is characterized by rapid onset of fever, changes in blood pressure, and hyperkalemia followed by a metabolic acidosis and hypercarbia.[28,34,35] Masseter muscle rigidity is one of the most common findings.[36] Treatment consists of immediate cessation of the exposure to the offending agent and the use of dantrolene sodium.[30] Dantrolene inhibits the ryanodine receptor, and its introduction resulted in a significantly decreased mortality rates, from 80% to less than 10%.[32]

Extrapyramidal Symptoms (EPS)

Drug-induced movement disorders, also called extrapyramidal symptoms (EPS), usually are associated with a blockage of the dopamine receptor, with an unopposed cholinergic tone.[28,37] Dystonia and akathisia will be discussed, since these are the most likely EPSs encountered by emergency physicians.

Dystonia

Dystonia is an idiosyncratic reaction defined as a tonic muscular contraction localized to one or several groups of muscles. It usually involves the mouth and/or the neck.[38] The clinical effects are oculogyric crisis, jaw fixation, torticollis, and even opisthotonus.[37] Although not life-threatening, the symptoms are distressing to the patient. Dystonias usually occur during the first week of treatment with an antipsychotic.[37] It is estimated that 2-3% of the patients on an antipsychotic medication may develop a dystonic reaction. The acute treatment of a dystonic reaction includes the use of IV anticholinergic agents such as diphenhydramine (1mg/kg IV or IM) or benztropine (Cogentin, Bensylate) (2 mg IM or PO) followed with by oral doses of the medications for up to a week.[28] The patients should not resume the use of the offending agent.

Akathisia

The term akathisia refers to the sensation of restlessness, usually in the lower extremities, that causes patients to feel an urge to move around.[38,39] Akathisia is caused by dopamine receptor blockers such as the antipsychotics and antiemetics but also has been reported with the use of selective serotonin reuptake inhibitors (SSRIs).[40] It is estimated to occur in 20-30% of patient treated with neuroleptics, although the number varies widely in the literature.[41] It usually occurs in patient within the first week of treatment with these medications.[37] Anticholinergic drugs such as benztropine 1-2 mg/day have been used as treatment, but there are no prospective studies addressing their efficacy.[42]

Disulfiram-Like Reactions

Disulfiram (tetraethylthiuram disulfide) (Antabuse) has been used as an aid to treat alcohol dependence for more than 40 years.[43] It acts by inhibiting the hepatic aldehyde dehydrogenase, resulting in an elevation of acetaldehyde in the blood when alcohol is ingested.[44] The clinical effects of this disulfiram-ethanol reaction include nausea, vomiting, headache, flushing, and palpitations.[44,45] In severe instances this can cause myocardial infarctions, respiratory failure, congestive heart failure, respiratory depression, and even death.[43] There are multiple substances known to cause disulfiram-like reactions: mushrooms (*Coprinus atramentarius*), sulfonylureas, industrial solvents (tricholorethylene), scombroid toxicity, and antimicrobial agents such as trimethroprim-sulfamethoxazole (Bactrim, Septra, Sulfatrim), cephalosporins, and metronidazole (Flagyl).[44,45]

There are no specific tests to diagnose disulfiram-like reactions. The mainstay of treatment consists of supportive measures. IV crystalloids will treat the hypotension and fluid loss due to the vomiting. Rarely, vasopressors may be needed.[46] Hypoglycemia should be treated with D50W. Thiamine and folate should be repleted in the malnourished patient. Antihistamines can be used to treat the flushing and pruritus.[47]

Contrast-Induced Nephropathy

While not exactly an adverse therapeutic drug reaction, contrast-induced nephropathy (CIN) is an adverse event due to contrast-requiring studies, which frequently are a part of the ED patient work-up.

CIN usually is defined as a rise in serum creatinine of 0.5 mg/dL or a 25% increase above baseline, which usually occurs within 2-3 days after receiving parenteral radiographic contrast for a study, and for which there is no alternative explanation.[48,49] The exact mechanism of the nephropathy is unknown. Etiologies that have been postulated are a direct reduction in renal perfusion caused by the contrast medium, and direct toxicity to renal tubular cells.[48]

The exact incidence of CIN is unknown. In a group of patients undergoing cardiac angiography, Rudnick found that an increase in serum creatinine of 0.5 mg/dL in 8% of patients with a baseline creatinine of less than 1.5. None of these patients had an increase greater than 1 mg/dL.[50] However the incidence of CIN in patients with baseline renal impairment has been found to be 12-27% and may actually be higher.[48]

There are several identified risk factors for developing CIN. From the contrast standpoint, factors are the amount of contrast used and the type of contrast. There is a statistically significant increased incidence of CIN in patients receiving ionic vs. non-ionic contrast medium.[50] Also, high-osmolar contrast is worse than low osmolar contrast.[48]

Multiple patient factors contribute to an increased risk for CIN. The patients at highest risk are those with pre-existing renal insufficiency alone or in combination with diabetes.[50] Other con-

Table 4. Other Adverse Reactions

ADR	SIGNS/SYMPTOMS	COMMON CAUSES	TREATMENT
Heparin-induced thrombocytopenia	Thrombocytopenia Large vessel thrombosis Rash	Heparin (Hepalean)	Stop the use of heparin
Warfarin-induced skin necrosis	Skin necrosis	Warfarin	Stop the use of warfarin
Purple digit syndrome	Vascular thrombosis in an acral distribution	Warfarin, possibly in patients with protein C deficiency	Stop the use of warfarin
Methemoblobinemia	Hypoxia, cyanosis	Nitrates, benzocaine	IV methylene blue (Urolene blue)
Lactic acidosis	Anion gap acidosis	Metformin (Glucophage), HIV drugs (ddI [Didanosine,] d4T [Stavudine,] AZT [Zidovudine])	Stop the offending agent Supportive care, hemodialysis if severe
Hyperglycemia	High glucose concentration	Clozapine (Clozaril) Olanzapine (Zyprexa, Zydis) Risperidone (Risperdal) Quetiapine (Seroquel)	Stop the offending agent
Pancreatitis	Mid-epigastric pain, vomiting	Protease inhibitors	Supportive care, NPO or clear liquids
Anaphylaxis	Respiratory distress, hypotension, urticaria	Food allergies, antibiotics, hymenoptera stings, multiple	Respiratory support, Epinephrine 1:1000 3cc subcutaneous, IV steroids, IV antihistamines
Hemolysis	Symptomatic anemia, elevated total bilirubin, schistocytes on smear	Multiple drugs, G6PD + sulfas	Removal of offending agent, supportive care, transfusion if necessary
Rhabdomyolysis	Muscle pains Elevated creatinine kinase	HMG-CoA reductase inhibitors (statins)	Stop the offending agent Hydration
Kidney stones	Flank pain, hematuria	Indinavir (Crixivan, IDV)	Stop the offending agent, supportive care

ditions that put patients at risk are diabetes alone, hypertension, age older than 70 years, heart failure, dehydration, NSAID use, and aminoglycoside use.[48,49] Particular caution must be taken with diabetics who are using biguanides such as metformin, as a slight decrease in renal function due to contrast use may bring about a severe, potentially fatal metabolic (lactic) acidosis.[49]

Prevention of CIN has provoked much study. However in general, there remains no clear strategy for prevention. Using a non-ionic, low- or iso-osmolar contrast medium is a first step. Maintaining adequate hydration is a generally accepted prevention measure.[49] Recently there has been great excitement over the use of IV sodium bicarbonate (NaHCO3) to prevent CIN. A 2004 study compared IV NaCl to IV NaHCO3 as pretreatment, given from 1 hour prior to the use of the contrast until 6 hours after. The majority of patients (110/119) were undergoing cardiac catheterization. In the NaHCO3 group, 1/60 developed CIN, whereas 8/59 in NaCl group did.[51]

Another described prevention strategy is the use of N-acetylcysteine (NAC) pre- and post-treatment. NAC is thought to function as a vasodilator and free radical scavenger.[49]

In the past, forced diuresis with mannitol (Osmitrol, Resectisol) or furosemide (Lasix) had been recommended. However, these treatments have proven only to exacerbate dehydration, thus worsening the situation and should be avoided.[48]

The primary treatment for CIN is prevention. Usually, most elevations in serum creatinine are transient, peaking at 3-4 days post procedure, and returning to baseline in 1-2 weeks.[48,49] Rarely is hemodialysis necessary, and it remains the only true treatment for CIN. Hydration remains the mainstay, as well as using least-toxic media in the smallest amounts necessary. NaHCO3 pre-

Table 5. Adverse Drug Reaction Resources

Canada's Adverse Drug Reaction Database	www.cbc.ca/news/adr/database/
Drug Information Databases	www.drugs.com/ www.medscape.com/druginfo
Drug Interaction Databases	www.drugdigest.org/DD/Interaction/ChooseDrugs
Adverse reactions and drug interactions to herbal medicines	www.intellihealth.com/IH/ihtIH/WSIHW000/8513/31402.html www.drugdigest.org/DD/Interaction/ChooseDrugs
Adverse drug reaction bulletins	www.who.int/druginformation/
MedWatch: The FDA Medical Products Reporting Program	www.fda.gov/medwatch
American Association of Poison Control Centers	www.aapcc.org/director2.htm 1-800-222-1222
Information on drugs that affect the QT interval	www.qtdrugs.org

and post-treatment, and/or NAC also may be helpful. However, more data are needed before either strategy can be recommended routinely as prevention for CIN. Monitoring post-procedure for a rise in serum creatinine or symptoms of decreased renal function is recommended for patients most at risk for CIN, particularly those with preexisting renal insufficiency or diabetes.

Conclusions

ED patients are at risk of adverse drug events. Some of the risk factors for this are multiple medical problems, advanced age, polypharmacy, and the frequent use of herbal products and over-the-counter medications not reported to the physician.[8,52,53-55] Emergency physicians should be aware of the most common ADRs and must know how to prevent and manage them. In the ED, a careful history of the patient's medical conditions, a complete list of medicines and herbal remedies might help reduce the risk for ADRs. However, in the hectic environment of the ED physicians sometimes might overlook potentially dangerous drug interactions.

Prescription errors that may result in ADRs might be reduced by hospital protocols to track ADRs.[56] Having a dedicated ED pharmacist has been proven to reduce medication errors by having someone dedicated to analyzing physicians' orders and the patients' lists of medications.[57] Other useful resources to recognize potential drug interactions and ADRs in the ED are computer programs, PDAs, and the Internet.[58,59] Computerized order entries can help not only in making orders understandable and thus reducing errors, but also can be used to help identify potential drug interactions.[60]

Another way to reduce ADRs is to report all events encountered in clinical practice. Wood and Stein suggest that a drug safety and ADR reporting program independent from the FDA might be useful.[61] Finally Vinay in 2005 lists a number of different web sites that are available to report and read about ADRs associated with different drugs.[62]

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Physician CME Questions

1. An adult female uses an SSRI for depression. She receives meperidine in the ED for pain. Subsequently, the patient develops diaphoresis, fever, resting tremors, and agitation. She does not have rigidity. What are your next steps in the treatment of this patient?
   A. Rule out other conditions.
   B. Provide adequate fluid hydration and supportive measures.
   C. Avoid any further serotonergic drugs.

D. All of the above are correct.

2. A patient with newly diagnosed schizophrenia receives haloperidol. She is not receiving any other medications. She develops confusion, hypertension, fever 41°C, and lead pipe rigidity. What is the most likely diagnosis?
   A. Extrapyramidal syndrome.
   B. Malignant hyperthermia
   C. Akathisia
   D. Neuroleptic malignant syndrome

3. A 62-year-old patient who uses warfarin comes to the ED due to multiple ecchymoses without any trauma. Her INR is 10. Which of the following medications is the culprit in this drug interaction?
   A. Albuterol
   B. Pantoprazole
   C. Levofloxacin
   D. Verapamil

4. Which of the following choices is the most appropriate treatment for serotonin syndrome?
   A. Benzodiazepines for agitation
   B. Intravenous fluids to maintain euvolemia
   C. Removal of the serotonergic agent
   D. All of the above

5. Which medication has been associated with pancreatitis?
   A. Acyclovir
   B. Trimethoprim/sulfamethoxazole
   C. Protease inhibitors
   D. Fluconazole

6. Which intervention has been used for the prevention of contrast-induced nephropathy?
   A. N-acetylcysteine
   B. Sodium bicarbonate
   C. Adequate hydration
   D. All of the above

7. What is the most appropriate treatment for a dystonic reaction?
   A. Diphenhydramine and cimetidine
   B. Steroids
   C. Benztropine and diphenhydramine
   D. Cyproheptadine

8. Which of the following increases the risk of bleeding with warfarin?
   A. Ciprofloxacin
   B. St. John's wort
   C. Oral contraceptives
   D. Rifampin

9. Which of the following increases the risk of clotting with warfarin?
   A. Grapefruit juice
   B. Carbamazepine
   C. Tetracycline
   D. Ginseng

10. The specific test used to diagnose serotonin syndrome is the Sternbach Test.
   A. True
   B. False

CME Answer Key

1. D; 2. D; 3. C; 4. D; 5. C; 6. D; 7. C; 8. A; 9. B; 10. B

In Future Issues: **Congestive Heart Failure**

Emergency Medicine Reports CME Objectives

To help physicians:

- quickly recognize or increase index of suspicion for specific conditions;
- understand the epidemiology, etiology, pathophysiology, and clinical features of the entity discussed;
- apply state-of-the-art diagnostic and therapeutic techniques (including the implications of pharmaceutical therapy discussed) to patients with the particular medical problems discussed;
- understand the differential diagnosis of the entity discussed;
- understand both likely and rare complications that may occur.

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Physicians participate in this continuing medical education program by reading the article, using the provided references for further research, and studying the questions at the end of the article. Participants should select what they believe to be the correct answers, then refer to the list of correct answers to evaluate their knowledge. To clarify confusion surrounding any questions answered incorrectly, please consult the source material. *After completing this activity, you must complete the evaluation form that will be provided at the end of the semester and return it in the reply envelope provided to receive a certificate of completion.* When your evaluation is received, a certificate will be mailed to you.

Emergency Medicine Reports®
The Practical Journal for Emergency Physicians

Adverse Drug Reactions, Part II

Other Adverse Reactions

ADR	SIGNS/SYMPTOMS	COMMON CAUSES	TREATMENT
Heparin-induced thrombocytopenia	Thrombocytopenia Large vessel thrombosis Rash	Heparin (Hepalean)	Stop the use of heparin
Warfarin-induced skin necrosis	Skin necrosis	Warfarin	Stop the use of warfarin
Purple digit syndrome	Vascular thrombosis in an acral distribution	Warfarin, possibly in patients with protein C deficiency	Stop the use of warfarin
Methemoblobinemia	Hypoxia, cyanosis	Nitrates, benzocaine	IV methylene blue (Urolene blue)
Lactic acidosis	Anion gap acidosis	Metformin (Glucophage), HIV drugs (ddI [Didanosine,] d4T [Stavudine,] AZT [Zidovudine])	Stop the offending agent Supportive care, hemodialysis if severe
Hyperglycemia	High glucose concentration	Clozapine (Clozaril) Olanzapine (Zyprexa, Zydis) Risperidone (Risperdal) Quetiapine (Seroquel)	Stop the offending agent
Pancreatitis	Mid-epigastric pain, vomiting	Protease inhibitors	Supportive care, NPO or clear liquids
Anaphylaxis	Respiratory distress, hypotension, urticaria	Food allergies, antibiotics, hymenoptera stings, multiple	Respiratory support, Epinephrine 1:1000 3cc subcutaneous, IV steroids, IV antihistamines
Hemolysis	Symptomatic anemia, elevated total bilirubin, schistocytes on smear	Multiple drugs, G6PD + sulfas	Removal of offending agent, supportive care, transfusion if necessary
Rhabdomyolysis	Muscle pains Elevated creatinine kinase	HMG-CoA reductase inhibitors (statins)	Stop the offending agent Hydration
Kidney stones	Flank pain, hematuria	Indinavir (Crixivan, IDV)	Stop the offending agent, supportive care

Drug Interactions with Warfarin

Potentiates warfarin effect (increased risk of bleeding)	Cimetidine, erythromycin, fluconazole, ciprofloxacin (Cipro), levofloxacin (Levaquin), metronidazole (Flagyl), phenytoin, tetracycline (Sumycin), kava kava, gingko biloba, ginseng, grapefruit juice
Decreases warfarin effect (increased risk of clotting)	St. John's Wort, carbamazepine(Tegretol, Carbatrol, Epitol), chlodiazepoxide (Librium), rifampin, green leafy vegetables, green tea, oral contraceptives

Sternbach Criteria for the Diagnosis of Serotonin Syndrome

- Recent addition or increase of a known serotonergic agent
- Absence of other possible causes (such as infection)
- No recent use of a neuroleptic agent
- At least 3 of the following:
  - Mental status changes (i.e., agitation, confusion)
  - Myoclonus (greater in lower extremities)
  - Hyperreflexia (greater in lower extremities)
  - Diaphoresis
  - Shivering
  - Tremor (greater in lower extremities)
  - Diarrhea
  - Incoordination
  - Fever

Adverse Drug Reaction Resources

Canada's Adverse Drug Reaction Database	www.cbc.ca/news/adr/database/
Drug Information Databases	www.drugs.com/ www.medscape.com/druginfo
Drug Interaction Databases	www.drugdigest.org/DD/Interaction/ChooseDrugs
Adverse reactions and drug interactions to herbal medicines	www.intellihealth.com/IH/ihtIH/WSIHW000/8513/31402.html www.drugdigest.org/DD/Interaction/ChooseDrugs
Adverse drug reaction bulletins	www.who.int/druginformation/
MedWatch: The FDA Medical Products Reporting Program	www.fda.gov/medwatch
American Association of Poison Control Centers	www.aapcc.org/director2.htm 1-800-222-1222
Information on drugs that affect the QT interval	www.qtdrugs.org

Levenson's Criteria for NMS

Major • Fever (> 38°C), rigidity, elevated creatinine kinase
Minor • Tachycardia, labile blood pressure, altered consciousness, diaphoresis, leukocytosis

Supplement to *Emergency Medicine Reports*, June 26, 2006: "Adverse Drug Reactions for the Emergency Physician, Part II."
Authors: **Larissa I. Velez, MD**, Department of Emergency Medicine, University of Texas Southwestern, Dallas; **Javier Caldera, MD**, Department of Emergency Medicine, University of Texas Southwestern, Dallas; **Sing-Yi Feng, MD**, Department of Emergency Medicine, University of Texas Southwestern, Dallas; and **Ellen O'Connell, MD**, Department of Emergency Medicine, University of Texas Southwestern, Dallas.

Thomson American Health Consultants
Building Six, Suite 400
3525 Piedmont Road NE
Atlanta, Georgia 30305-1515
Tel (404) 262-7436 Fax (404) 262-7837
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Sincerely,

Brenda L. Mooney

Brenda Mooney
Vice-President/Group Publisher
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Emergency Medicine Specialty Reports

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Patient Safety in Emergency Care Transitions

Authors: **Zachary F. Meisel MD, MPH,** Assistant Professor, Department of Emergency Medicine, Pennsylvania Hospital, University of Pennsylvania School of Medicine, Philadelphia; and **Charles V. Pollack, MD, MA, FAAEM, FACEP**, Chairman, Department of Emergency Medicine, Pennsylvania Hospital, Associate Professor of Emergency Medicine, University of Pennsylvania School of Medicine, Philadelphia.

Peer Reviewer: **Shawna J. Perry, MD, FACEP**, Associate Professor, Assistant Chair, Director of Clinical Operations, Department of Emergency Medicine, University of Florida Health Science Center, Jacksonville.

Case Study

A 75-year-old woman with a chief complaint of chest pain is brought to a university emergency department (ED) by a city-run emergency medical systems (EMS) service. The paramedic gives a verbal bedside report to the ED nurse, noting in the history that the patient's family stated that she had been at bed rest for the previous five days after straining her back. Her chest pain—a new symptom—started two hours ago. The paramedics return to their station-house where they complete the prehospital record. It includes notations of a pulse rate of 120 beats per minute and a pulse oximetry reading of 91%. The prehospital record does not arrive at the receiving hospital until the following day. Meanwhile, back in the ED, the nurse records a normal set of vital signs and a chief complaint of chest pain, but fails to note the recent history of decreased mobility. The patient, Mrs. Smith, is evaluated by a medical house officer who notes a story of new exertional chest pain with shortness of breath, and also notes from the patient's old records the additional history of an abnormal cardiac stress test in the past year. The resident presents the case to the ED attending. They review the patient's electrocardiogram together and note new nonspecific T wave abnormalities in the anterior and inferior leads. The physicians order aspirin, beta blockers, nitroglycerine paste, a chest radiograph, and cardiac biomarkers, and decide to admit the patient for inpatient care. As an admission diagnosis, the resident enters "chest pain, rule out acute coronary syndrome." The patient is taken to radiology by hospital transport. When she returns, she is placed in a different room in the ED and she is not placed back on a cardiac monitor, despite a recurrence of her tachycardia. At nursing change-of-shift, Mrs. Smith's nurse gives verbal report to the oncoming nurse who will be taking the assignment. It is noisy and busy during this time, as many nurses are performing similar sign-outs in the same area. Nursing sign-out is interrupted twice by a patient requesting a cup of ice. At the same time, the resident presents the patient as a moderate risk cardiac chest pain to the admitting house officer on the telephone, and the ED attending calls the hospitalist and reports the admission of a chest pain patient and a plan of action including evaluation for possible coronary angiography the following day. As there are no monitored beds available in the hospital, Mrs. Smith boards as an inpatient in the ED for the night. The admitting resident notes some transient tachypnea while evaluating the patient and plans to discuss it when she rounds with the hospitalist attending, but does not mention this to the ED attending. A new ED attending arrives, and the first attending provides his replacement with a

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verbal summary of all the patients under his care at the whiteboard in the center of the ED. They almost skip Mrs. Smith because she had been moved once again to another new ED room and is now an inpatient. On his way out, the first attending turns back and states: "Oh yeah, Mrs. Smith is a rule-out MI who has already been admitted." The next day, the patient is still in the ED. Three sets of cardiac markers are negative. The house team decides to discharge the patient home from the ED after scheduling a follow-up cardiac stress test. She has to wait an additional two hours for her son to borrow a neighbor's van in which to drive her home. During that time, she asks the nurse if she can have any pain medications for her back, but is told that she has been discharged and that she can take acetaminophen or ibuprofen at home. She is taken home with discharge papers and placed back in bed, complaining to her family that her chest is "OK" but that her upper back has "really started to hurt" again. The next morning she returns to the same ED, by ambulance in cardiac arrest, found at autopsy to be secondary to a massive pulmonary embolism.

Introduction

Transitions among providers and site of service are commonplace in contemporary medical care. They involve the transfer of information, responsibility, and authority, even though these exchanges may not be explicitly recognized by the caregivers involved. By definition, transitions involve an interruption of continuity of care. These gaps commonly are viewed as significant sources for medical error.[1]

As exemplified in the clinical scenario presented, poorly coordinated or ineffective transitions may negatively impact patient safety and quality of care. In particular, certain aspects of patient-related transitions have earned recent scrutiny and focus within the patient safety movement. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) added to its patient safety goals for 2006 an explicit direction to improve handoff communications.[2]

The Institute of Medicine (IOM) in its 1999 report "To Err is Human" cited the ED as the hospital location with the highest proportion of negligent adverse events.[3] Emergency medical care, in particular, routinely involves multiple transitions in care for any given patient. EDs are designed as transfer stations for patients who ultimately are bound for hospital admission, transfer to yet another health care facility, or discharge back home. In addition, nearly all EDs are staffed with personnel, including physicians, who work in shifts. Therefore, responsibility and information related to patient care routinely are passed, internally and externally, from one health care provider to another during emergency medical care.

The weak links that these transitions represent in the continuum of care largely have been studied outside of emergency medicine environments. Many of the insights and lessons from this growing body of literature, however, can inform the practice of emergency medicine. In addition, certain aspects of transitions are unique to emergency care, not least of which is the sheer number of transitions through which any given ED patient must pass. Also complicating emergency transitions are the staggered timing of shift changes and the infrequency of multi-disciplinary signouts. The purpose of this review is multifold. First, it will examine what currently is known about care transitions in non-emergency care environments. Second, this article will examine transitions within EDs, exploring what makes emergency care transitions unique. Last, it will identify tools and strategies—and the evidence behind these efforts—that may be used to improve patient safety during ED transitions.

Communication

Among studies that evaluate patient care across transitions, the quality with which information is transferred has received the greatest scrutiny by far. Communication in health care occurs via verbal, electronic, and written means. One of the most widely used but least understood methods in communication is the sign over for the transition of care. Alternately called the sign-out, the handoff, handover, or report, this routine allows providers to transfer patient information, responsibility, and authority to their colleagues. Information that is transferred during transitions may include specific patient data, status of the health delivery system (i.e., no ICU beds available), and specific tasks that need to be completed. Responsibility is the assumption of accountability for the work that needs to be done for the patient and is paired with the authority to act as a caretaker and advocate for the patient.

Nurses, attending physicians, and resident physicians classically perform the handoff with similar types of caregivers. However, in the ED, this transfer of information can cross disciplines: for example a paramedic will handoff a patient to a physician, or an ED resident may give report to a hospitalist attending physician. The handoff is used to bridge the natural gaps or discontinuities that arise when a new provider assumes care of the patient.[1] It is also a process that can result in adverse events when

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clinical information is not communicated properly.

Failures of communication are considered to be among the most common factors contributing to adverse events in all medical settings.[4-6] Eighty-four percent of root causes of sentinel events reported to the JCAHO from multiple health care settings in 2002 were deemed at least in part due to a "breakdown in communication."[7]

Missing clinical information has been shown to be common at all levels of care. Up to 14% of all primary care visits involve missing clinical information: verbal, electronic, and written.[8] One study surveyed Ohio family physicians, finding that 15% of all reported errors in primary care were associated with missing clinical information at the time of primary care evaluation.[9] Similarly, multiple studies have shown that important clinical information—such as medication lists, test results, and follow-up plans—routinely is lost at the time of discharge from various inpatient settings.[10-12] Lack of clinical information at the time of patient evaluation in an ED has been shown to be a particularly pervasive problem. One study evaluated 1002 ED visits and found information gaps in 29% of the documented care. The missing information was deemed to be essential to care in 47% of the patients.[13]

Within the health care setting, most studies of nursing signovers have been performed in intensive care unit (ICU) settings. Handoffs among medical and surgical residents who cover admitted patients for each other at night also have been studied. In addition, handovers in the ED have been subject to limited but insightful analyses. Finally, handoffs have been studied closely in non-health related occupations. These investigations and their conclusions will be discussed later in this review.

Handoffs in Non-Health Care Related Domains

High-risk transitions are not unique to health care. Exchanges of information, responsibility, and authority occur in many twenty-four hour operational industries outside of health care. Workers in the aerospace, nuclear power, and marine transportation industries routinely participate in such procedures. Lardner conducted an extensive review of shift changeovers in high-risk industrial processes in which multiple adverse events (some leading to human injury) were evaluated for miscommunication at the shift handoff.[14] Both effective communication of poor information and ineffective communication of good information were found to be root causes of these incidents. Larder makes four recommendations that could be used to improve the quality of the handover and limit adverse outcomes secondary to communication errors. Handovers should:

- be conducted face to face;
- be a two-way exchange, with both participants taking joint responsibility for ensuring accurate communication;
- use verbal and written means of communication; and
- be given as much time as necessary to ensure accurate communication.

When these best practices are applied to high-risk industrial shift handovers, the incidence of errors and of injuries are significantly reduced.[14]

In a study of NASA Space Shuttle mission control shift change handoffs, Patterson et al identified and explored the consequences of three problems that potentially afflict the receiver of information at the shift turnover: failing to be told, misunderstanding the information, or forgetting information during the switch.[15] The costs of these errors were significant and included:

- being unaware of significant data;
- being unprepared to deal with the impact of previous events;
- failing to anticipate future events;
- dropping or redoing activities that are in progress; and
- creating unwarranted shifts in goals, decisions, and plans.

The authors conducted a follow-up study in which shift handovers in nuclear power plants and in ambulance and railroad dispatching centers also were observed. They identified specific strategies that routinely are used by these high-risk industries to limit error.[15] The potential role for these tools in emergency care transitions will be discussed later.

Inpatient Nursing Handoffs

Observations of nursing handovers have been published since at least the 1970s. These investigations far outnumber studies of physician signovers and have been more comprehensive in their scope. Written and verbal reports are routine for most inpatient nursing handoffs.[16] In addition to communicating medical information, researchers have established that nursing handovers have ritual significance (for example, some nurses wait to receive a verbal report before beginning work), organizational functionality, and team-building functions.[17]

Researchers have identified certain problematic aspects of the traditional nursing handover. One study noted that nearly half of the content of the average handover was specifically unrelated to any nursing needs.[18] In addition, of a cohort of handovers assessed, researchers found that these reports tended to underplay the significance of certain clinical features, giving the oncoming nurse a falsely reassuring bias about the condition of the patient.[19]

A unique aspect of the nursing signover is the high degree of socialization incorporated into this activity. Nurses may use the handover process to assess each other's work.[16] This may put pressure on them to perform and can affect the content of the presentation. One study found that nursing handovers in elderly care were rapid, formulaic, and highly jargonized. In addition, the documentation at handover did not always reflect the content of the verbal handoff.[16] Problems in nursing handovers can lead to adverse events, most commonly related to the administration of medications. Nursing change of shift was identified as contributing to nearly half of the adverse drug events (ADEs) in a retrospective study at a large Texas hospital.[20]

Despite the potential problems associated with nursing handovers, ethnographic studies of these turnovers have shown that, for the most part, these rituals are efficient, comprehensive, effective, and performed with relative ease.[21] A study of the handoff in a busy ICU found that they were fluid, patient-focused, and seamless processes in which the extent and detail of the reports addressed the specific nursing needs for each individual patient.[22] A British study evaluated six nursing shift handovers on a general medical ward and found that, in addition to exchanging patient information, nurs-

es used the ritual to engage in team building and to reinforce cohesiveness within the team.[23] In summary, nursing handovers are an essential, complex, and highly ritualized practice that, most often, meet the needs for the oncoming nurse to take care of his or her patient. However, even under the best of circumstances, the handover also is a process that is vulnerable to interruptions, inconsistencies, and subjectivity. A poor handoff has direct patient safety consequences and particular relevance to emergency care situations.

Resident Sign-Out

Increased scrutiny on house-staff work hours has resulted in changes in the division of labor for resident physicians taking care of patients. To comply with American Council on Graduate Medical Education (ACGME) regulations that limit the total and consecutive hours of hospital duty, many training programs have adopted a type of shift work model in which certain physicians take care of patients during the day and then sign out the patient in the evening to a night-float team. The sign-out involves the transfer of both patient care information and responsibility to another physician.[24,25] Because residents have been moving toward a shift-work model that is not unlike what has long been done in EDs, data from studies that evaluate transitions for house-staff can help inform understanding of similar processes in EDs, including departments that do not utilize residents.

Resident sign-out is divided into two general categories. Cross-coverage is a temporary place-holding procedure in which a resident who has primary responsibility for the patient temporarily transfers patient care to another resident, with the plan that the original resident will resume active care of the patient when he or she returns to the hospital, often the following morning. Sign-over is a process that occurs when a new resident takes over the primary and active care for a patient, usually from a night-float admitting resident. The increased use of these procedures over the past 10 years among hospital-based house staff has provided observers with the opportunity to conduct natural experiments in process-improvement and patient-safety evaluation. These studies have yielded interesting findings.[26,27]

Handoffs among residents have been identified as common root causes of preventable adverse events. When 821 residents from multiple training programs at the Massachusetts General Hospital were surveyed on adverse events and their causes, 15% identified "problems with the handoff" as the leading factor perceived to contribute to mistakes in patient care.[28]

Cross coverage, in particular, has been shown to be strongly associated with preventable adverse medical events. Petersen et al conducted a case-control study of more than 3,000 nonsurgical patients. In a multivariate analysis of 32 candidate variables, cross-coverage was one of only three factors that independently correlated with preventable adverse events (odds ratio 6.1).[29] In another study of internal medicine house staff cross coverage, omitted content (such as medications, problem lists, and pending tests), as well as poor process execution (such as lack of face-to-face sign-out) were identified as major causes of failed communication.[30] Another study noted that cross-covering residents in a community internal medicine program often made medical decisions without using or reviewing the patients' charts.[31] Finally, in a study of night-float admitting residents, Lofgren et al noted that when patient care is transferred to another resident on the day after admission, patients had significantly more tests ordered and experienced slightly longer inpatient stays.[32]

Despite the known problems with these transfers of care for admitted patients, resident sign outs often are informal and unstructured. They may take place over the telephone, via face-to-face conversation, or by checklists pinned to a bulletin board in a call-room.[33] Various interventions to improve communication at the point of resident sign-out have been studied. In one study of surgical resident sign-out, a computerized system was developed to download patient information such as laboratory and radiographic results automatically, producing standardized lists for rounding and transfer of care. The tool was accepted and deemed successful by most of the house-staff using the system.[34] Other studies have shown increased resident satisfaction with sign-outs after the implementation of computerized and standardized sign-out processes.[35]

In a more rigorous study, Petersen et al developed a computerized sign-out program to standardize the process. Included in the program were summaries of the patients' current medical status, resuscitation status, recent laboratory values, medication allergies, an active problem list, and a to-do list for the oncoming physician. After the computerized sign-out intervention was implemented, total preventable adverse events dropped from 1.7% to 1.2%, and the odds ratio (OR) for a patient suffering an adverse preventable event during the cross coverage period decreased from 5.2 to 1.5 (CI 0.2-9.0).[36]

Based on these and other studies on resident handovers, regulatory and graduate medical education monitors and advocates have joined forces to implement best practice procedures for the hand-over. The British National Patient Safety Agency and the Royal College of Physicians have recommended the following guides to handovers for clinicians.[37] Handovers should:

- be multidisciplinary;
- occur at a fixed time and be of sufficient length;
- be free from distraction;
- have access to lab results, clinical information and communication devices;
- have a clear delineation of roles and responsibilities;
- include check lists of tasks to be done; and
- be a two-way process with questions and clarifications made routine;

These suggestions could be applicable to ED transitions as well.

Transitions in the ED

Emergency care settings differ from other hospital settings in many ways. EDs have a unique culture and pace. Emergency physicians and nurses interact with each other in particular ways to accomplish highly specific, specialized patient care goals. Transitions in the ED also have unique status. At the most basic level, EDs represent an environment in which transitions in patient care are exceedingly common and are incorporated into the culture of care. As outlined in the introduction, a single patient typically will

endure several transitions in care during the course of his ED stay.

Although limited, specific studies have examined transitions in the ED. One study conducted observations of transitions in five EDs in the United States and Canada. Physician and nurse handovers were observed from an ethnographic perspective. Although there was large variation in the way many of the handovers were conducted, certain features were consistent. The investigators found nearly all the handovers to: be two-way dialogues; include discussions about the "status of the entire work unit," as opposed to being limited to specific patients; be conducted in a standardized order; and expand and contract according to the volume and acuity of the ED patients.[38]

Investigators from the same study audiotaped doctor and nursing signovers in the ED and found that nearly all transitions have four phases: pre-turnover (preparation), arrival of the replacement, exchange, and post-turnover. In addition, the investigators noted that:

- the medical record was seldom used by either doctors or nurses in the handover;
- physicians and nurses performed their handovers separately;
- the location of the signovers varied—taking place at the bedside or at a patient name board—but they tended not to be in a quiet or distraction-free area.[39]

Nursing care transitions in the ED also have been evaluated specifically. One study surveyed 48 ED nurses on the quality of handovers and found 50% and 45% of them cited missing information and distractions, respectively, as common problems in the handover process. The majority of nursing handovers occurred in the busiest and loudest part of the ED.[40]

Only one published study to date has examined the ED physician to admitting physician handover.[41] This observational study at two hospitals demonstrated the structure of these handovers was highly variable; some occurred in person, some occurred by telephone. The intermittent use of admitting residents for a subset of the patients who needed to be hospitalized added more variation and less organization to the handover process. The authors observed that the length and detail of the admission handover was determined more by certain characteristics of the physicians who were performing the transition than by acuity or other patient characteristics.

Pitfalls in ED Transitions

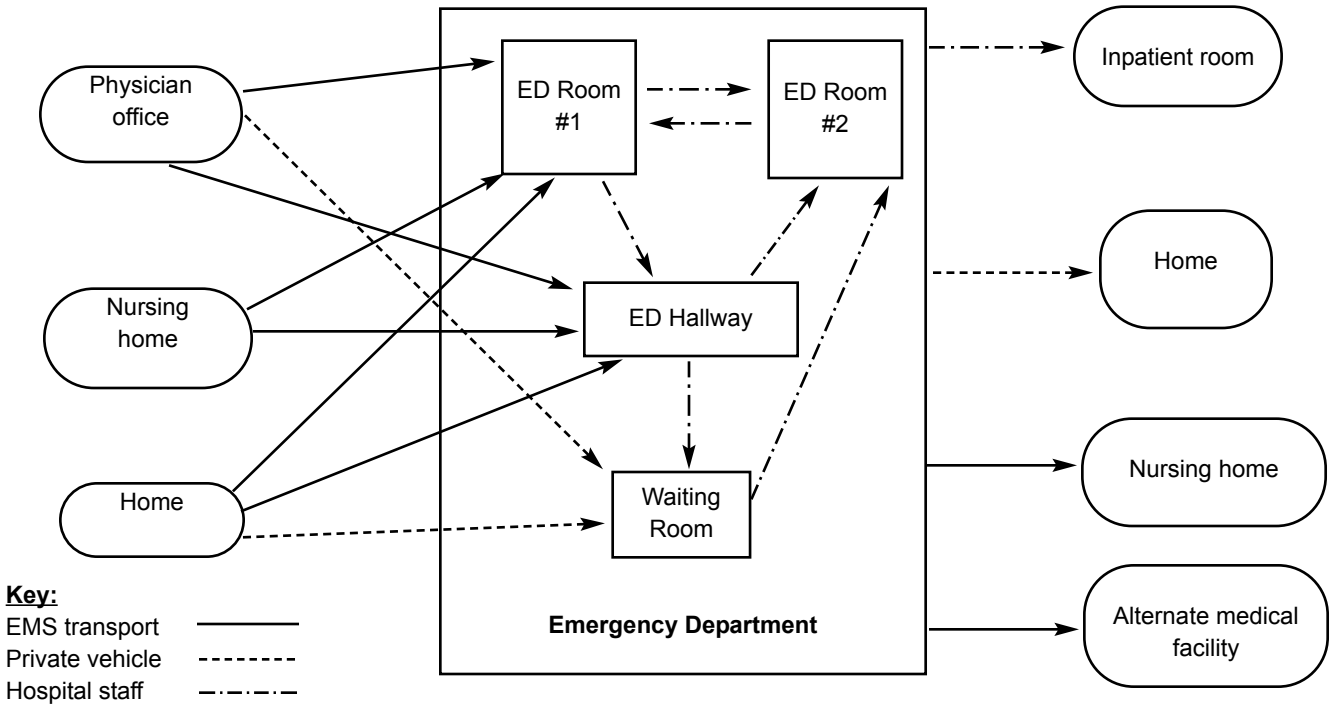
Many of the problems that have been identified in inpatient nursing and physician handoffs are potentially exacerbated in the ED setting. For example, multiple studies have demonstrated the presence of excess noise in the ED.[42,43] Patient flow and acuity tend to be higher in the ED than on the floors as well. Thus, the prevalence of distractions and interruptions—which has been noted to be a problem in inpatient settings—is likely greater in the ED. This has been validated by a study that demonstrated the high prevalence of overlapping conversations, interruptions, and heavy "communication loads" on physicians and nurses in an Australian ED.[44] Similarly, asynchronous shift changes among residents, attending physicians, and nurses in the ED can be obstacles to multi-disciplinary transitions. Variability in style or training among attendings also will potentially limit the standardization or uniformity of sign-outs: ED attendings, out of professional courtesy, may be less willing to criticize each other than are residents or nurses, if they are unhappy with the quality of the handoff.[45,46] In EDs, temporal variability of the signover in relation to where the patient is in the course of his or her care may exacerbate communication failures. If a patient arrives just prior to shift changeover, the content of the transition will be different than if the patient is deep into the medical work-up at the time of signout.

Patient transitions in emergency care settings may also be inherently more complex than in inpatient settings. In the ED, the three types of patient transitions—information, responsibility, and authority—can become unbundled during a change in status or location of the patient. For an inpatient, all components of the transition will occur simultaneously with the physical movement of the patient. This is not always so in the ED. Overcrowding has dramatically increased the prevalence of boarders.[47,48] In such situations, change in location and nursing assignment lags behind the transfer of physician responsibility and the authority to treat. These delays can have the effect of two physician teams caring for a single patient, which in turn may lead to uncertainty in caretaking roles and lost clinical data. (*See Figure 1.*)

Unlike many inpatient hospital units in which the staff-to-patient ratios are fixed, EDs often pare their staff at times when patient volume is anticipated to be lower. In general, this translates into fewer nurses, physicians, and ancillary staff covering the ED at night. An outgoing nurse may transfer half of his patients to one nurse and half of his patients to another. Similarly, the overnight physician may take over patient care from multiple providers. This funnel effect of patient coverage is unique to the ED and adds particular complexity to the role of nursing and physician sign-outs. For example, a single caretaker may double or triple the number of patients for whom he is responsible within a span of five minutes.

Another example of increased complexity in emergency care transitions occurs when paramedics and EMTs deliver patients to the ED. In some states, written prehospital records are not mandated to be available until 24 hours after the patient received EMS care.[49] In these cases, there is a disconnect in information flow caused by the transfer of responsibility and location of patients before the transfer of potentially important written information. Despite the use of prehospital bedside reports, three problems remain. First, these verbal-only reports are given simultaneously with actual physical movement of the patient from the ambulance gurney to the hospital bed. During the transfer of particularly critical patients, emergency care providers routinely engage in attaching lines and monitoring and evaluating the patient at the same time as they are engaged in the signover. Second, a bedside report often is a one-way transfer of information from paramedic or EMT to nurse. This process often excludes other caregivers, particularly physicians. Third, an EMS report may be obscured by cross-talk, often at loud decibels in small, noisy rooms. Thakore et al surveyed medical and ambulance staff on the perceived quality of patient handover by ambulance staff during resuscitations. While both staffs were, in general, satisfied with the quality of the handoffs, there was a notable lack of satisfaction with pediatric

Figure 1. Movement of Emergency Patients



Frequent changes in patient status and location can unbundle transitions in information, responsibility, and authority.

handovers. In addition, during critical transfers, ambulance staff felt that the ED staff did not listen well, and medical staff noted that ambulance crews did not give a thorough report—often omitting vital signs.[50] The potential for lost information at the point of transfer from prehospital to ED is great.

Similar to the unique challenges posed by transfers from the prehospital environment, transitions out of the ED to ambulatory settings can be particularly challenging. Studies have shown high rates of error associated with discontinuity of care from inpatient to outpatient settings.[12,51] Such discontinuities may be even more problematic in ED discharges to home. Hastings, in a literature review, notes that older patients discharged home from the ED suffer high rates of adverse outcomes-including death.[52,53] Pitfalls in emergency care transitions are summarized in Table 1.

Improving the Emergency Transition: Concepts and Strategies

The Institute of Medicine in its report "Crossing the Quality Chasm" explicitly identified the need to improve "coordination and integration of care … to manage smooth transitions from one setting to another."[54] From this report and other calls for improved transitions, many health researchers and policy analysts have articulated the goals of smooth, robust, and error-limited transitions. Most of the suggested approaches, not surprisingly, come from non-ED settings.

One study identified 21 successful strategies used at shift turn-over in high-risk, non-medical settings and applied them to the ED handover.[15] The authors suggest these tools for improving patient safety at the point of ED transitions:

- Use face-to-face reports only;
- Limit interruptions;
- Provide a written summary of the handoff;
- Provide unambiguous transfer of responsibility;
- Make it clear to others at a glance which personnel are responsible for which duties at a particular time; and
- Delay transfer of responsibility during critical activities.

The MedTeams Research Consortium evaluated 54 adverse events in EDs that were deemed to be preventable by improved teamwork. Employing teamwork or "crew resource management" (CRM) techniques culled from aviation safety programs, the authors identify how teams can improve various aspects of patient care, including transitions. Less hierarchy, sharing of tasks, cross-checking, and improved information sharing are the backbone of team approaches to patient safety.[55,56] (When directed towards emergency transitions, team processes include: call out requests for information input; check-back processes to verify communication; systematic and standardized handover processes; and interdisciplinary/team signouts.)

Broadly recognized strategies for general patient safety may have indirect application to transitions. Despite limited evidence for many of these ideas, Leape et al argue that rigorous studies are not always needed to identify ways to improve patient safety.[57] Thus, simplification, standardization, teamwork, and a culture of safety are concepts that may improve overall approaches to transitions of patient care and need to be tailored to meet specific clinical settings.[58,59] The utility of computerized sign-out systems for

Table 1. Potential Pitfalls in Emergency Transitions

- Noise, distractions, and interruptions
- Unclear delineation of patient care responsibility at time of transfer
- Delays in prehospital documentation
- Handoffs during reduced staffing periods (funnel effect)
- Information transfers while simultaneously performing patient care
- Risks to elderly and uninsured at discharge
- Unwillingness to question an already established plan or diagnosis

inpatient cross coverage has already been discussed. Other standardized systems, such as templates, have also been shown to be helpful for hospitalists who must sign-out to each other.[60] Mandatory checklists in trauma settings to prevent omissions at the time of patient transfer have been proposed.[61] However, as has been discussed, EDs are highly unique, and no one intervention likely will achieve these goals. Many of these interventions have yet to be scrutinized; however, some researchers have noted that mechanizing this process risks neutralizing the effectiveness of the organic aspects of the personalized verbal sign-out.[38]

Barriers to implementing any of these strategies are formidable. Improving processes that cross multiple health care disciplines and segments requires a willingness among participants to alter routines and culture. However, both the promotion of improved communication and the culture of safety are movements that have gained considerable traction in the past few years. Momentum invariably will carry some of these concepts forward.

Conclusions

Transitions of care are common, complex, and high-risk processes in EDs. Presently, there is little uniformity in their structure and content, and most participants in the transfers of patient care believe that the processes remain problematic and could be improved. Understanding the complicated and interacting ways in which patient care is transferred in, out, and around emergency settings is the first step to improving ED transitions, limiting adverse events, and enhancing patient care and satisfaction.

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Physician CME Questions

1. The JCAHO 2006 Patient Safety Goals include which of the following directives?
   A. Reduce medical errors at the time of patient care transitions.
   B. Improve handoff communications.
   C. Standardize signout procedures.
   D. Increase use of electronic medical records during health care transitions.

2. Transitions in emergency departments are:
   A. rare events.
   B. incorporated into the culture of care.
   C. often performed with nurses and physicians together.
   D. protected from interruptions and distractions.

3. Signovers do not necessarily include the transfer of:
   A. authority.
   B. location.
   C. responsibility.
   D. information.

4. The funnel effect:
   A. occurs during most health care transitions.
   B. disproportionately impacts physicians over nurses.
   C. is exacerbated by ED overcrowding.
   D. may involve the rapid assumption of care from multiple sources.

5. Most participants in ED transitions:
   A. limit interruptions while performing the signout.
   B. use the medical record to facilitate the process.
   C. don't prioritize the signout as an important task.
   D. adjust the process to meet the volume and acuity of the department.

CME Answer Key

1. B; 2. B; 3. B; 4. D; 5. D

Emergency Medicine Specialty Reports
CME Objectives

Upon completing this program, participants should be able to:

• Understand the roles of various health care providers in the transfer of patient care process;

• Define the unique elements involved in the transfer of patient care by emergency medicine providers; and

• Identify tools and strategies that allow for a safer transfer of patient care by emergency department providers.

Thomson American Health Consultants
Building Six, Suite 400
3525 Piedmont Road NE
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Tel (404) 262-7436 Fax (404) 262-7837
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- Define the unique elements involved in the transfer of patient care by emergency medicine providers;
- Identify tools and strategies that allow for a safer transfer of patient care by emergency department providers.

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