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Neonatal Cardiac Emergencies: Management Strategies

By P. Syamasundar Rao, MD

INTRODUCTION

Emergencies of life-threatening nature involving the cardiovascular system in the neonate are many and complex. Successful management depends upon prompt and accurate diagnosis of the problem in order to institute appropriate therapeutic measures and referral to a specialized treatment center, if necessary. These situations may manifest themselves as severe cyanosis, heart failure, lethargy and lack of spontaneous movement or arrhythmia (Table I). The purpose of this presentation is to draw attention to cardiac emergencies in neonates and to discuss their management.

GENERAL MANAGEMENT

During the process of identification and work-up, prevention of hypothermia, maintenance of neutral thermal environment, monitoring for and prompt treatment of hypoglycemia and hypocalcaemia, monitoring acid-base status and treatment of metabolic acidosis with sodium bicarbonate ($NaHCO_3$) and management of respiratory acidosis with suction, intubation, assisted ventilation as deemed necessary, are important and should be diligently undertaken in all patients. In most cyanotic heart defects FIO_2 of no more than 40% is necessary because of fixed intracardiac shunting. In certain cyanotic heart defects (CHDs), for example, Hypoplastic Left Heart Syndrome, 100% FIO_2 may be detrimental to the patient by increasing the pulmonary flow at the expense of systemic perfusion. Specific measures depend on the diagnosis and will discussed here-under.

Table I. List of Cardiac Emergencies in the Neonate

1. Cyanosis in the newborn
2. Congestive heart failure
3. Lethargy and lack of spontaneous movement
4. Arrhythmias

NEONATAL CYANOSIS

Cyanosis is an important manifestation of severe CHD in the neonate, as has been alluded to by a number of cardiologists [1-5]. Central cyanosis is manifested by bluish discoloration of mucous membranes and is generally more difficult to identify in the neonate than in older subjects. The ready availability of pulse oxymeters makes the confirmation of cyanosis easier than obtaining blood gas analysis. The methods to distinguish cardiac from non-cardiac cyanosis and steps used to formulate a cardiac diagnosis are discussed elsewhere [5] and are beyond the scope of this presentation, except to state that evaluation of pulmonary blood flow by chest X-ray is useful in categorization of CHD babies, especially prior to echocardiographic and/or angiographic studies.

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Decreased Pulmonary Vascular Markings

Neonates with severe cyanosis and decreased pulmonary vascular markings on chest roentgenogram are likely to have severe right ventricular outflow tract obstruction and may have ductal dependant pulmonary circulation (Table II-A). The ductus may be kept open by an infusion of prostaglandin E_1 (PGE_1). Various cardiac defects with ductal-dependent pulmonary blood flow in which prostaglandin is useful are listed in Table II-A. The current recommendations are for infusion of PGE_1 at a dose of 0.05 to 0.1 mcg/kg/min intravenously. Although PGE_1 has been used in infants beyond the first month of life, it is most likely to be effective the earlier in life it is begun. It appears that a small ductus can be dilated, but an already closed ductus may be difficult to reopen. Side effects include apnea (10%), elevation of temperature (10%), muscular twitching, and severe flushing. The side effects have not posed substantial management problems; however, the infant should be watched for apnea. Once the O_2 saturations improve, the PGE_1 dose should be weaned down to 0.025 to 0.03 mcg/Kg/min; this is particularly useful in preventing apnea and need for endotrachial ventilation. The major benefit of prostaglandin use lies in its keeping infants in a reasonable condition while the infant is being transferred to a tertiary care institution. Also, well-planned catheterization and angiography, as well as palliative or corrective surgery, can be performed with relative safety because of higher PO_2 and correction of metabolic acidosis. No more than 40% of humidified oxygen is necessary in infants with cyanotic congenital heart disease since they have fixed intracardiac right to left shunt. Once the diagnosis is established by echo-Doppler and/or cardiac catheterization studies, a permanent way to provide pulmonary blood flow should be considered. In patients whose cardiac defect could not be corrected in the neonatal period, a Blalock-Taussig shunt [6] is performed; most surgeons perform a modified Blalock-Taussig shunt [7] using an interposition Gore-Tex graft between right or left subclavian arteries to the ipsilateral pulmonary artery. An alternative approach is to keep the ductus open by placing a stent in it [8-11]. Based on our experience and that of others [8-12], implantation of stent into the ductus is technically demanding but a feasible procedure. Stenting the ductus arteriosus [8-12] is an attractive non-surgical option, but because of limited experience, it is not currently a first-line therapeutic option.

Table II. Ductal-dependent Cardiac Defects

A. Ductal-dependent pulmonary flow

- Pulmonary atresia or critical stenosis with intact ventricular septum
- Pulmonary atresia with ventricular septal defect
- Severe Tetralogy of Fallot
- Tricuspid atresia
- Complex cyanotic heart disease with pulmonary atresia or severe stenosis
- Ebstein's anomaly of the tricuspid valve
- Hypoplastic right ventricle

B. Ductal-dependent systemic flow

- Hypoplastic Left Heart Syndrome
- Severe coarctation of the aorta
- Interrupted aortic arch

If the cause of cyanosis is secondary to pulmonary atresia with intact ventricular septum or critical pulmonary stenosis, transcatheter radiofrequency perforation of the atretic pulmonary valve [8,13-15] or balloon pulmonary valvuloplasty [16-20], respectively may be undertaken.

Increased Pulmonary Vascular Markings

Cyanotic neonates with increased pulmonary flow may have transposition of the great arteries, Hypoplastic Left Heart Syndrome, coarctation of the aorta and multiple left-to-right shunts.

In infants with severe cyanosis and increased pulmonary blood flow on chest X-ray, the cause of cyanosis is likely to be transposition of the great arteries. Initially starting PGE1 to open the ductus to improve mixing may be undertaken followed by balloon atrial septostomy [21,22]. Within the next few days arterial switch procedure [23] may be performed.

Infants with mild cyanosis and increased pulmonary blood flow on chest X-ray are likely to have signs of congestive heart failure. The treatment of congestive heart failure, including administration of inotropic agents, diuretics and after-load reducing agents is similar to that of older children [24] and will not be discussed, except to state that the neonatal myocardial development is incomplete [25], and that the myocardial response to pre-load and after-load manipulations and inotropic agents is suboptimal. In conditions in which perfusion to the body (Table II-B) is ductal dependent, administration of PGE_1 is necessary. The dosage and administration of PGE_1 are the same as described above. Once the infant is stabilized, the lesions require surgical intervention.

Pulmonary Venous Congestion

Majority of patients with severe pulmonary venous congestion on chest X-ray are likely to have infra-diaphragmatic type total anomalous pulmonary venous connection and require emergent surgical correction to include anastomosis of the common pulmonary vein with the left atrium.

If the cause of cyanosis is persistent fetal circulation, it should be treated accordingly. Once the specific defect is diagnosed, the treatment is based on the identified defect and is discussed in detail elsewhere [26].

CONGESTIVE HEART FAILURE

Congestive heart failure in the neonate is usually associated with increased pulmonary blood flow and is more common with complex heart defects such as Swiss-cheese type of ventricular septal defect, double inlet left ventricle (single ventricle), double outlet right ventricle and tricuspid atresia with a large ventricular septal defect, all without associated pulmonary stenosis. Initially, aggressive anti-congestive measures should be instituted. If ductal dependent systemic circulation is present (Table II-B), PGE_1 infusion should be started as detailed in the preceding sections. Because most of these defects can't be corrected in the neonatal period despite recent advances in open heart surgery, surgical constriction or banding of the pulmonary artery [27] is useful in this subgroup of patients. Banding not only improves congestive heart failure, but also helps achieve normal pulmonary artery pressure so that bidirectional Glenn and Fontan procedures [28] can be safely performed later in the subgroup of patients who have single ventricle physiology. If associated aortic coarctation is present, the aortic obstruction must also be relieved.

LETHARGY AND LACK OF SPONTANEOUS MOVEMENT

Lethargy and lack of spontaneous movement are associated with sepsis in the newborn. It may also be seen in CHD babies who have severe hypoxemia associated with severe obstruction to pulmonary blood flow

(Table II-A), inadequate mixing in transposition of the great arteries with intact ventricular septum or poor systemic perfusion (Table II-B). Appropriate cultures and antibiotic treatment should be promptly instituted while investigating cardiac causes which may be addressed as detailed in the two preceding sections.

ARRHYTHMIA

A number of arrhythmias may occur in the neonate and the most common rhythm disturbance, supra-ventricular tachycardia (SVT) will be discussed.

SVT is one of the most frequent symptomatic arrhythmias in the neonate. It may also occur in fetal life, causing fetal hydrops. The majority of these episodes are in neonates without any other associated heart defects. The heart rate is very high in neonates (220 to 280 beats per minutes). The QRS complexes are narrow (Figure 1) although wider complexes may be seen when aberrant ventricular conduction is present. The presentation of the condition may simply be an increased heart rate observation by the caregiver or parents, or more serious symptoms and signs of heart failure may be observed by the patient's physician.

Management of Acute Episode

In neonates with moderate to severe heart failure, hypotension, shock, pallor, or decreased level of consciousness (neonates may have only irritability, tachypnea, and poor feeding), synchronized direct current (DC) cardioversion with 0.5 to 2 Watt-second/kg should be attempted [29]. The DC conversion should be synchronized to the peak of R wave, avoiding the vulnerable period of re-polarization. Adequate sedation should precede cardioversion. An alternative treatment is intravenous adenosine; this is not well studied for this purpose, however. Continuous ECG monitoring during the conversion is mandatory. Transvenous or esophageal overdrive pacing with a pacing rate at 10-15% shorter than SVT cycle length may be effective. The latter, however, requires pediatric cardiology or pediatric electrophysiology expertise and such pacing is rarely required in the neonate.

If the neonate is in mild or no heart failure, simulation of diving reflex by sudden or unexpected placement of ice bag (crushed ice and water in glove) or cold, wet cloth on face for 15 seconds may be effective. Rectal stimulation by using a rectal thermometer is another way of eliciting vagal stimulation (carotid massage or eye-ball massage is not recommended in the neonate). If these maneuvers are not successful in averting the SVT, adenosine 100 mcg/kg by rapid IV push may be used [30.31]. If not effective, increase doses by increments of 50 mcg/kg until conversion (maximum dose of 250 to 350 mcg/kg). Verapamil 0.1-0.2 mg/kg by very slow intravenous injection may be given in children and is not recommended in infants less than 1 year. If all the above fail, DC cardioversion or esophageal overdrive should be instituted. Digoxin was the most frequently used drug

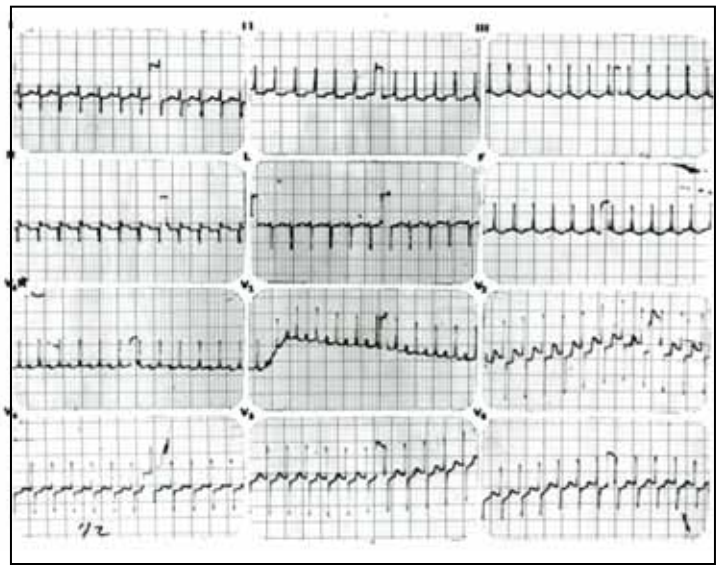

Figure 1. Electrocardiogram of an infant with supraventricular tachycardia. Note the heart rate is approximately 260 beats per minute and the QRS duration is very short and no definitive P waves were seen.

in the past, and is no longer the drug of choice because of delay in achieving conversion, narrow range of therapeutic to toxic effect and concern of producing more serious arrhythmia if Wolf-Parkinson-White (WPW) Syndrome is present.

Prevention of Recurrence

In neonates and infants, oral digoxin (10 mcg/Kg/day in two divided doses) for 6-12 months may be effective in preventing recurrence of SVT. In the presence of WPW syndrome, digoxin should not be used. Propranolol 1-4 mg/kg/day by mouth in 3 to 4 divided doses may be given in the presence of WPW Syndrome. Occasionally, both drugs may be required to prevent recurrence. Some authorities suggest that the effectiveness of these drugs in preventing recurrences is no better than no treatment.

Flecanide, sotalol and amiodarone either alone or in combination, have been used with varying degrees of efficacy and may be tried if recurrences are problematic despite treatment with digoxin and propranolol. Radiofrequency ablation is rarely, if ever, necessary in the neonate.

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Medical News, Products and Information

Mattel Children's Hospital UCLA Launches Program in Nanopediatrics

Newswise - Mattel Children's Hospital UCLA announced the launch of the Mattel UCLA NanoPediatrics Program, which will explore the future of personalized medicine for children, including the opportunities and risks involved. The program is one of the world's first dedicated solely to nanomedicine and pediatric patients.

"Why develop a nanopediatrics program? Because children are not small adults," said Dr. Edward McCabe, Physician-in-Chief of Mattel Children's Hospital and founding director of the new program. "We know that drugs affect children - they metabolize, excrete and may even utilize, developmentally, specific receptors - differently than adults.

"Unless children are included as a research priority for the application of nanotechnology, then we will simply be applying approaches developed for adults. This flawed strategy will place children at risk, as opposed to a program in which children will be the focus from the outset."

Nanotechnology involves manipulating atoms and molecules to create tiny devices, smaller than one-thousandth the diameter of a human hair (a nanometer is one-billionth of a meter). It is anticipated that nanomedicine, fueled by nanotechnology, will enable more personalized medical care that will be both predictive and preventive.

While considerable attention has been paid to nanomedicine, UCLA's nanopediatrics program, initially organized in May 2008, may be the first initiative to examine the promises and risks of nanodiagnostics and nanotherapeutics for children in a formal and organized manner.

Created thanks to a generous $1.8 million gift from the Mattel Children's Foundation, the program will support a nanopediatrics research core and pilot funding for projects that will potentially enable investigators to obtain grants from the National Institutes of Health.

"The Mattel Children's Foundation is excited to support this groundbreaking program in nanopediatrics, which can potentially revolutionize the research and treatment of illnesses that affect young patients," said Kevin Farr, Chairman of the foundation and Chief Financial Officer of Mattel Inc. "Our philanthropic vision is to make a meaningful difference, one child at a time, and we believe that the nanopediatrics program at Mattel Children's Hospital UCLA will bring new technologies and treatments to better the lives of children battling for their health."

Projects currently underway at UCLA include the development and application of nanodiagnostic tools such as DNA-based newborn screening tests for genetic abnormalities, the development of a new generation of nanodevices for the treatment of children with genetic diseases and cancer, and the investigation of the use of nanoparticles for diagnostic imaging both during pregnancy and after birth.

The Mattel UCLA NanoPediatrics Program will partner with the California NanoSystems Institute (CNSI) at UCLA, an integrated research center established in 2000, to encourage university collaboration with industry and enable the rapid commercialization of discoveries in nanosystems.

For additional information, visit: www.nanopediatrics.ucla.edu.

Increased Rate of Hemangiomas Linked to Rise in Number of Low Birth-Weight Infants in US

Newswise - Low birth weight is the most significant factor for the development of infantile hemangiomas, a common birthmark, according to a new study by researchers at The Medical College of Wisconsin and Children's Research Institute.

The study, led by Beth Drolet, MD, Professor of Dermatology and Pediatrics at the Medical College and medical director of pediatricdermatology and birthmarks and vascular anomalies clinic at Children's Hospital of Wisconsin, was published in the November 2008 issue of *The Journal of Pediatrics*.

"Hemangiomas are benign tumors composed of blood vessels. Our
institution has seen a dramatic increase in the number of infants presenting for care with hemangiomas. We believe the results of this study provide an explanation for this emerging pediatric health issue," says Dr. Drolet.

While factors such as being female, Caucasian and premature birth have been previously identified as risk factors for hemangiomas, Dr. Drolet's study found that low birth weight was the most statistically significant risk factor.

"For every 1.1 pound decrease in birth weight, the risk of hemangioma increased by nine-fold," says Dr. Drolet.

Recently, there has been an increase in the US of infants born under 5.5 pounds. In 2005, 8.2% of infants born in the US weighed less than 5.5 pounds. This is the highest percentage recorded since 1968 and is higher than the rate in most industrialized countries.

Additionally, a dramatic increase in low birth weight has been found in white, non-Hispanic infants. Low birth weight has increased 38% since 1990 in this group.

"This study reaffirms several known risk factors for infantile hemangiomas, specifically: female gender, white, non-Hispanic race/ethnicity, and prematurity," says Dr. Drolet. "But the link to low birth weight may explain why physicians believe more infants are developing hemangiomas. Based on low birth weight statistics, we estimate that the incidence of infantile hemangiomas has increased by 40% in the last 20 years."

The researchers compared 420 children who had been diagnosed with infantile hemangiomas at Children's Hospital of Wisconsin and the University of California - San Francisco Medical Center (UCSF), with 353 children less than two years old who had been diagnosed with skin anomalies other than infantile hemangioma.

Dr. Drolet and co-investigator, Dr. Ilona Frieden, Professor of Dermatology and Pediatrics at UCSF, formed a 10-member re-

search consortium to better study ways to prevent and treat infantile hemangiomas.

Earlier studies by the research consortium identified other risk factors for developing hemangiomas, including increased maternal age, maternal history of infertility, and assisted reproductive technologies. Children born to women who had experienced a miscarriage are also more likely to develop hemangiomas. Additionally, 33% of infants with hemangiomas had the disorder in their family histories.

While hemangiomas are amongst the most common birthmarks, their cause is not known. Infantile hemangiomas are not visible at birth, but become evident within the first few weeks of life. Because of this, they are less likely to be recorded in typical birth defect registries. Hemangiomas may result in permanent scarring or other medical issues that require treatment.

"The finding that a significantly higher percentage of children with infantile hemangiomas had a positive family history suggests at least some genetic predisposition," says Dr. Drolet.

There are currently no FDA-approved medical therapies for the treatment of infantile hemangiomas. Most treatments are limited, due to increasing the potential risk of scarring.

"We urgently need further research to evaluate existing medications so that more evidence-based approaches to management can be established," says Dr. Drolet.

"Our study also underscores the need for continuing education of providers caring for children in distinguishing benign hemangiomas from those with the greatest potential for complications and need for treatment."

The study was funded by the Dermatology Foundation, The American Skin Association, and Children's Research Institute.

Day One Medical Announces Launch of Advanced Brain Monitor for Critical Care

Day One Medical has announced the release of its first product offering, The Component Neuromonitoring System™ (CNS Monitor), an easy-to-use neurological monitoring system with advanced functionality. The CNS Monitor has received 510(k) clearance from the US Food and Drug Administration (FDA), and is available for purchase. Day One Medical will be featuring the CNS Monitor at the upcoming International Conference on Brain Monitoring & Neuroprotection in the Newborn in Orlando on February 20 – 22, 1009.

The CNS Monitor is a portable neurological data collection system. It can perform simplified EEG monitoring using just one or two channels, or can be used for full-array EEG monitoring with up to 16 electrodes. It can collect, store, and display vital signs and other measurements from a variety of patient monitors. An optional camera also allows the recording and display of patient video.

The CNS Monitor can compute and display amplitude-integrated EEG (aEEG), as well as other specialized EEG metrics including Spectral Edge Frequency, Inter-Burst Interval, Percent Suppression, Percent Asymmetry, and frequency band power percentages. Multiple display types and parameters can be combined onto one screen, enabling the comparison of EEG parameters with a patient's vital signs and other measurements. All collected data is time-synchronized, and can be archived to a CD, DVD, USB drive, or to a network location for later review.

The user interface and monitoring features are similar to a bedside patient monitor, making the CNS Monitor easy to use by clinical personnel. The use of monitoring "Protocols" within the system help to step the user through the monitoring process, and also enable the customization of data displays and recorded parameters. Context-sensitive reference information about device setup and operation may be accessed for assistance during the monitoring session.

By using the CNS Monitor, physicians and clinical staff will be able to simultaneously view, analyze, and record EEG (including video) along with vital signs measurements in order to assess the status of a patient's brain function.

The CNS Monitor was developed by Moberg Research, Inc. and will be sold for neonatal care applications through Day One Medical, LLC. Moberg Research performs research, product development, and services in the areas of neurological monitoring, informatics, and medical education. Day One Medical provides products for neonatal care and brain assessment and is an affiliate of Moberg Research, Inc.

For more information, contact: Damon Lees, Day One Medical, LLC, 224 S. Maple Way, Ambler, PA 19002 USA; Tel: (215) 283-0860. www.dayonemedical.com.

Perspectives on Safety: Identifying Adverse Events Not Present on Admission: Can We Do It?

By James M. Naessens, ScD

Interest is growing in the use of existing data sources to identify opportunities to improve the delivery and safety of medical care, to measure and compare quality and patient safety, and even to change provider incentives through pay for performance initiatives. The Agency for Healthcare Research and Quality's (AHRQ) Patient Safety Indicators (PSIs) (based on ICD-9-CM diagnosis codes from hospital billing data) were developed to screen for potential complications and medical mishaps [1,2]. Groups ranging from HealthGrades (www.healthgrades.com) to the University Healthsystem Consortium (UHC) use these PSIs to rate the quality of care at different institutions [3].

One problem with the use of PSIs and other algorithms [4] to identify potential problems with medical care is the difficulty in separating comorbidities (those conditions present at hospital admission) from complications or hospital-acquired conditions [5-8]. Beginning in October 2007, changes were made in hospital billing forms to meet the Center for Medicare and Medicaid Services (CMS) mandate to submit an additional field for each secondary diagnosis to indicate whether that condition was present at the time of hospital admission (POA) [9].

The POA designation will become increasingly important in the near future. CMS will soon implement a process that will not pay hospitals for an identified set of conditions that "could reasonably have been prevented through the application of evidence-based guidelines" [9]. The Leapfrog Group is collecting information by hospital, on the same conditions in its 2008 survey [10]. AHRQ now offers a version of PSIs that incorporates the new POA administrative codes to improve the utility of the indicators, by reducing the number of cases identified with conditions present before hospitalization (false positives).

Given the increasing focus on hospital quality measurement, accurately identifying adverse events and comorbidities present at the time of admission is critical. This article will explore how well our present instruments perform in this key area.

Will POA Coding Enable the Identification of Adverse Events Through Billing Data?

Even with the new POA codes, a number of issues must still be considered:

Variation in POA Coding

Several studies have shown that identifying whether a condition was present on admission is not an exact science. In our early work in assessing inter-rater reliability of determining the timing of an illness or complication based on blinded review of the medical record, we found that agreement differed across disease type. There was more agreement on the timing of myocardial infarct, stroke, and pulmonary embolism (kappa>0.8) than on the timing of renal failure, decubitus ulcer, and pneumonia (kappa from 0.58 to 0.73) [11]. A Canadian study found agreement between routinely abstracted data and chart review to be poor (kappa<0.5) for seven conditions, moderate (0.5<kappa<0.8) for four conditions, and high (kappa=0.87) only for cerebrovascular disease [12]. In recent assessments of interrater reliability among cases identified with selected PSIs, researchers at the University of Michigan found low agreement between nurse review and original coder review on cases present on admission, high agreement on conditions that developed in the hospital, and an overall kappa of 0.4 [7].

There also appears to be significant variation between institutions. A study of discharges in 2003 from hospitals in the states of New York and California, where POA coding has been in place for more than a decade, found that patterns in POA coding differed across institutions [13]. Although smaller hospitals had more discharges with all secondary diagnoses labeled as POA, the occurrence of acquired conditions at larger hospitals may be more related to higher intensity treatments and higher case mix than to quality of care issues. The study also found that the percentage of hospitals that coded all secondary diagnoses as POA on all records was higher in New York than in California. In an accompanying editorial, Iezzoni [14] suggests that the study raises serious questions about how consistently hospitals in experienced states perform POA coding. Clear coding guidelines and oversight will be necessary to ensure accuracy of POA indicators.

Variation in ICD-9-CM Coding and Limitations of Reporting

Variation is not only evident across institutions on POA coding; there are substantial differences in diagnosis coding practices. Romano and colleagues [15] found that half of the difference in

postoperative (after back surgery) complication rates observed across hospitals was attributed to variations in the collection, coding, and reporting of diagnosis codes. Furthermore, the study found that hospitals with higher-than-expected rates of complications reported twice as thoroughly as hospitals with fewer complications than expected, clear evidence of a reporting bias.

Other limitations in the use of administrative diagnostic data include the incomplete collection of conditions due to restrictions on the number of secondary diagnosis fields [1]. In our experience with Minnesota's mandatory reporting of the National Quality Forum list of serious adverse events, we reported "unstageable" pressure ulcers in addition to stage 3 or 4 ulcers acquired after admission. However, only 25% of the last 16 reported patients had an ICD-9-CM secondary diagnosis code of a pressure ulcer (codes 707.00–707.09). These patients typically have multiple morbidities and long hospitalizations. Our administrative system has a limitation of 15 diagnoses, and it is possible that the decubitus ulcer was identified by the coder, but was not placed high enough on the list of possible diagnoses to be captured in our repository.

Limitations in ICD-9-CM Coding System

There are issues about the granularity and coverage of our current coding system; hence the plans to eventually shift to ICD-10. In their study of PSIs in the Veterans Health Administration system, Rosen and colleagues [16] noted that adverse events from surgery are more amenable to ICD-9-CM coding than other types of events.

Differentiation of the Trivial from the Catastrophic

The presence of a hospital-acquired condition provides little information about the seriousness of an adverse event. Even after eliminating cases with POA conditions, review of cases coded with hemorrhage and/or hematoma or cases coded with accidental puncture and laceration identified a range of conditions from blood use within expected norms and incidental lysis of adhesions (both relatively trivial procedures) to life-threatening situations. Multiple studies [7,13], including our examination of hospitalizations in 2005 [6], have shown that the vast majority of patients with diagnoses coded as not present on admission appear to have relatively minor problems with no diagnosis-related group (DRG) or severity changes. While efforts should be made to reduce all adverse events, the severity of the problem should be considered for public reporting or pay for performance.

Interpretation: Adverse Event Versus Medical Error

How will the identification of adverse events be interpreted? Not all adverse events are preventable. In their assessment of the pediatric PSIs, Scanlon and colleagues [17] classified each event into three classes: preventable, nonpreventable, and uncertain. They found that the extent of cases that were clearly "nonpreventable" ranged from about 20%–80%, and clear preventability never exceeded 52%. Studies have also suggested that sicker patients are at higher risk of adverse events. We found higher rates of hospital-acquired conditions among hospital transfers and among physician-referred versus self-referred or primary care patients [6]. Current risk adjustment methods for PSIs may not be adequate for appropriate interpretation. Hughes [18] calls for efforts to separate "preventable" adverse events from events that result from underlying disease factors or are expected sequelae of treatment. It is unlikely that this can be done with only administrative data. In our own review of PSIs, we have seen substantial differences of opinions depending on the background and experience of the reviewer.

Incentives—DRG Creep in Reverse?

Based on the experience with the introduction of DRGs and the proliferation of software to help "optimize" the coding of hospital discharges, coding and reporting practices for conditions not present on admission can be expected to change. As Iezzoni [14] points out, an unintended consequence is that tying penalties in payment to the presence of a diagnosis code creates financial incentives to underreport those codes.

Summary

Echoing others, we must proceed with caution [6,7,14,17]. It is likely that POA coding will ultimately enhance the value of administrative data in identifying hospital adverse events, but not without further review and refinement. Today, however, the variability of thoroughness of reporting and accuracy of coding across institutions, combined with the low percentage of hospital-acquired conditions deemed "preventable," still limit the use of diagnoses from billing data as a source of quality measurement for public reporting and pay for performance.

"Interest is growing in the use of existing data sources to identify opportunities to improve the delivery and safety of medical care, to measure and compare quality and patient safety, and even to change provider incentives through pay for performance initiatives."

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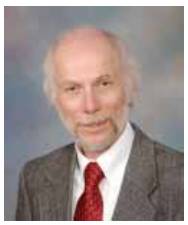

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