

the use of a computerized ADE monitor, a tool that explores the database and identifies signals that suggest an ADE may have occurred. Studies that use multiple approaches find more ADEs than does any individual approach, and this discrepancy suggests that the true underlying rate in the population is higher than would be identified by a single approach. About 6–10% of patients admitted to U.S. hospitals experience an ADE.

Injuries caused by drugs are also common in the outpatient setting. One study found a rate of 21 ADEs per every 100 patients per year when patients were called to assess whether they had had a problem with one of their medications. The severity level was lower than in the inpatient setting, but approximately one-third of these ADEs were preventable.

The period immediately after a patient is discharged from the hospital appears to be very risky. A recent study of patients hospitalized on a medical service found an adverse event rate of 19%; about one-third of those events were preventable, and another one-third were ameliorable (i.e., they could have been made less severe). ADEs were the single leading error category.

**Prevention Strategies** Most work on strategies to prevent adverse events has targeted specific types of events in the inpatient setting, with nosocomial infections and ADEs having received the most attention. Nosocomial infection rates have been reduced greatly in intensive care settings, especially through the use of checklists. For ADEs, several strategies have been found to reduce the medication error rate, although it has been harder to demonstrate that they reduce the ADE rate overall, and no studies with adequate power to show a clinically meaningful reduction have been published.

Implementation of checklists to ensure that specific actions are carried out has had a major impact on rates of catheter-associated bloodstream infection and ventilator-associated pneumonia, two of the most serious complications occurring in intensive care units. The checklist concept is based on the premise that several specific actions can reduce the frequency of these issues; when these actions are all taken for every patient, the result has been an extreme reduction in the frequency of the associated complication. These practices have been disseminated across wide areas, in particular in the state of Michigan.

Computerized physician order entry (CPOE) linked with clinical decision support reduces the rate of serious medication errors, defined as those that harm someone or have the potential to do so. In one study, CPOE, even with limited decision support, decreased the serious medication error rate by 55%. CPOE can prevent medication errors by suggesting a default dose, ensuring that all orders are complete (e.g., that they include dose, route, and frequency), and checking orders for allergies, drug–drug interactions, and drug–laboratory issues. In addition, clinical decision support can suggest the right dose for a patient, tailoring it to level of renal function and age. In one study, patients with renal insufficiency received the appropriate dose only one-third of the time without decision support, whereas that fraction increased to approximately two-thirds with decision support; moreover, with such support, patients with renal insufficiency were discharged from the hospital half a day earlier. As of 2009, only ~15% of U.S. hospitals had implemented CPOE, but many plan to do so and will receive major financial incentives for achieving this goal.

Another technology that can improve medication safety is bar coding linked with an electronic medication administration record. Bar coding can help ensure that the right patient gets the right medication at the right time. Electronic medication administration records can make it much easier to determine what medications a patient has received. Studies to assess the impact of bar coding on medication safety are under way, and the early results are promising. Another technology to improve medication safety is “smart pumps.” These pumps can be set according to which medication is being given and at what dose; the health care professional will receive a warning if too high a dose is about to be administered.

**The National Safety Picture** Several organizations, including the National Quality Forum and the Joint Commission, have made recommendations for improving safety. In particular, the National Quality

Forum has released recommendations to U.S. hospitals about what practices will most improve the safety of care, and all hospitals are expected to implement these recommendations. Many of these practices arise frequently in routine care. One example is “readback,” the practice of recording all verbal orders and immediately reading them back to the physician to verify the accuracy of what was heard. Another is the consistent use of standard abbreviations and dose designations; some abbreviations and dose designations are particularly prone to error (e.g., 7U may be read as 70).

**Measurement of Safety** Measuring the safety of care is difficult and expensive, since adverse events are, fortunately, rare. Most hospitals rely on spontaneous reporting to identify errors and adverse events, but the sensitivity of this approach is very low, with only ~1 in 20 ADEs reported. Promising research techniques involve searching the electronic record for signals suggesting that an adverse event has occurred. These methods are not yet in wide use but will probably be used routinely in the future. Claims data have been used to identify the frequency of adverse events; this approach works much better for surgical care than for medical care and requires additional validation. The net result is that, except for a few specific types of events (e.g., falls and nosocomial infections), hospitals have little idea about the true frequency of safety issues.

Nonetheless, all providers have the responsibility to report problems with safety as they are identified. All hospitals have spontaneous reporting systems, and, if providers report events as they occur, those events can serve as lessons for subsequent improvement.

**Conclusions about Safety** It is abundantly clear that the safety of health care can be improved substantially. As more areas are studied closely, more problems are identified. Much more is known about the epidemiology of safety in the inpatient setting than in outpatient settings. A number of effective strategies for improving inpatient safety have been identified and are increasingly being applied. Some effective strategies are also available for the outpatient setting. Transitions appear to be especially risky. The solutions to improving care often entails the consistent use of systematic techniques such as checklists and often involves leveraging of information technology. Nevertheless, solutions will also include many other domains, such as human factors techniques, team training, and a culture of safety.

## QUALITY IN HEALTH CARE

Assessment of quality of care has remained somewhat elusive, although the tools for this purpose have increasingly improved. Selection of health care and measurement of its quality are components of a complex process.

**Quality Theory** Donabedian has suggested that quality of care can be categorized by type of measurement into structure, process, and outcome. *Structure* refers to whether a particular characteristic is applicable in a particular setting—e.g., whether a hospital has a catheterization laboratory or whether a clinic uses an electronic health record. *Process* refers to the way care is delivered; examples of process measures are whether a Pap smear was performed at the recommended interval or whether an aspirin was given to a patient with a suspected myocardial infarction. *Outcome* refers to what actually happens—e.g., the mortality rate in myocardial infarction. It is important to note that good structure and process do not always result in a good outcome. For instance, a patient may present with a suspected myocardial infarction to an institution with a catheterization laboratory and receive recommended care, including aspirin, but still die because of the infarction.

Quality theory also suggests that overall quality will be improved more in the aggregate if the performance level of all providers is raised rather than if a few poor performers are identified and punished. This view suggests that systems changes are especially likely to be helpful in improving quality, since large numbers of providers may be affected simultaneously.

The theory of *continuous quality improvement* suggests that organizations should be evaluating the care they deliver on an ongoing basis and continually making small changes to improve their individual processes. This approach can be very powerful if embraced over time.