Letter to the Editor ■

Evaluating the Impact of Information Technology on Medication Errors: A Simulation

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Information technology has been shown to reduce medication errors and associated ADEs at every stage in medication administration.[1] Information systems include decision support at the prescription stage, computerized physician order entry, unit dosing systems, and bar-coding of individual medications among others. We developed a computer simulation model and used it to evaluate the effectiveness of a number of information technology applications, individually and collectively, to reduce medication errors and associated ADEs.[2] The model incorporated estimates from published studies of the potential reduction in medication errors that could result from implementation of various information technologies.

Shojania questions two of these estimates, specifically potential reductions in errors from implementing bar-coding and unit dosing. We assumed that bar-coding medications potentially could reduce drug administration errors by as much as 60%. This estimate is supported by other studies. Puckett[3] reports on the effect of the introduction of CliniCare, a point-of-care information system for medication management, in a primary and tertiary care center. All medications were bar-coded and scanned at or near the patient's bedside. He reports a medication error rate of 0.17% before implementation of the system. In the following year the medication error rate dropped by 59% to 0.07% and during the next year to 0.05%, a 70% decrease.

We estimated that the introduction of a unit dose system could reduce errors by as much as 80%. Unit dose systems dispense most medications from the pharmacy in a ready-to-administer form and are widely used in U.S. hospitals. Studies that have evaluated the impact of unit-dose dispensing on medication errors report reduction in medication error rates ranging from 53% to 85%.[4–7]

However, as Shojania points out, other studies have demonstrated mixed results from implementing some of these technologies. For example, an ethnographic study of the implementation of bar-code medication administration (BCMA) in several hospitals, while not reporting medication error rates before and after implementation, found several side effects that created the potential for new ADEs.[8]

Moreover, we do not know for certain how much of a reduction in error rates is associated with implementing unit dose and bar code systems in hospitals. This uncertainty is due to the limited number of studies, varied definitions and methodologies that have been used in the studies that have been performed, and the small number of institutions involved in these studies, making any one study subject to local and regional variations in providers, patient populations, etc. As a result we reran estimates of the cost savings that could be expected from an integrated medication system that included unit dosing and bar-coding of medications assuming that error reductions resulting from these two applications would only be in the order of 40% and 30%, respectively. We estimated potential savings of over $820,000 even with the lower rates, a significant impact of these interventions.

We used the model to estimate the effects of implementing information technology in reducing ADEs assuming two different rates at which medical errors translate into ADEs, namely 8% and 26%. These rates were arrived at from a study of medication errors on two medical/surgical units in the hospital we studied. Over a 12-week period a clinical pharmacist and a medical student examined every drug order that was entered into the hospital information system and compared it to the original written order. Errors were classified by type and severity.[9,10] The medication error rate was found to be 32 errors per 1,000 orders, a relatively high rate when compared to other published studies. Eight percent of the drug errors were classified as potentially serious or

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fatal and might have led to serious toxic reactions, inadequate treatment or death of the patient if not detected before administration of the medication. This rate was used as the lower estimate of ADEs resulting from medication errors in our study. The higher estimate assumed that an additional 18% of medication errors that involved omitted drugs, duplicate orders or incorrect information that would have resulted in inadequate treatment or toxic reactions if not detected also would have resulted in ADEs. The higher estimate was based on the assumption that 26% of medication errors could have resulted in ADEs.

While we do not know the real rate at which medication errors translate into ADEs, we feel that these estimates are justified on the basis of our own and other studies that have assessed the potential of medication errors to cause ADEs. The estimates range from 0% to 58%.[10–13] Bates and others[14] studied the relationship between medication errors and ADEs. They used self-report by pharmacists, nurse review of patient charts and review of medication sheets to detect medication errors. Incidents suspected of leading to ADEs were evaluated and classified as ADEs, potential ADEs, medication errors with no injury or other errors. The study found that 1% of the medication errors resulted in ADEs (2% if missed doses were excluded) and an additional 7% of the errors represented potential ADEs. Einbinder and Scully[15] found an even higher rate of ADEs using a clinical data repository at the University of Virginia hospital and the rules developed and used in a computer-based ADE monitor at Brigham and Women's Hospital.[16]

Finally, Shojania points out that $1.4 million, our estimate of the possible cost-savings that could be realized by introducing the information technology to reduce medication errors, does not provide an adequate return on investment to justify investing in CPOE systems. If only the direct cost saving from the implementation of information technology to reduce the additional days of hospitalization caused by ADEs is considered, this may be the case. However, as we discussed in the original article,[2] these information technology applications need to be combined with other prevention strategies to reduce ADEs even further. Other strategies include better reporting of medical errors[17] and the inclusion of a clinical pharmacist in the provision of patient care. One study found that involving a clinical pharmacist in rounds on ICU units resulted in a two-thirds reduction in medical errors.[8]

Moreover, our study does not consider additional costs resulting from ADEs such as costs of outpatient care for injured patients, disability, loss of life, and malpractice awards associated with ADEs. One study of medication related malpractice claims estimated that the average cost of defending malpractice claims due to preventable inpatient ADEs was $376,000.[19] Also, our model does not include the considerable administrative costs associated with processing ADEs. The time and expense for processing ADEs in hospitals—for administrators, pharmacists, nurses, risk managers—is considerable. If these additional costs are taken into account information systems that prevent ADEs, especially when coupled with other proven prevention strategies, are potentially cost-effective.

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