

ASHP national survey on informatics: Assessment of the adoption and use of pharmacy informatics in U.S. hospitals—2007

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The ASHP national survey on informatics focuses on the adoption and use of pharmacy informatics and technology within the medication-use process. Informatics and medication-use system technologies are present in all steps of the medication-use process: prescribing, transcribing, procurement, dispensing, administration, monitoring, and patient education. These technologies have been introduced to assist in reducing variation in health care delivery, streamline the use of human resources, and increase the safety of the medication-use process.

This national survey is the first to broadly assess the status of pharmacy informatics in all hospitals in the United States. As such, we focused on the presence or absence of technologies and how these technologies affect the operations of the pharmacy department. Because of the breadth

Purpose. Results of the 2007 ASHP national survey on informatics are presented.

Methods. All types and sizes of hospitals in the United States were included in the sample of 4112 pharmacy directors surveyed using an online data collection tool. The survey included over 300 data elements and was designed to assess the adoption and use of pharmacy informatics and technology within the medication-use process.

Results. In this national probability sample survey, the response rate was 25.9%. Hospitals appear to be moving toward an enterprise approach to information technology adoption and away from a best-of-breed approach. Although nearly half of hospitals have components of an electronic medical record (EMR), a complete digital hospital with a fully implemented EMR is far in the future, with only 5.9% of hospitals being fully digital (without paper records). An estimated 12.0% of hospitals use computerized prescriber-order-entry systems with decision support, 24.1% use bar-code medication administration, and 44.0% use

intelligent infusion devices (smart pumps). Many of these technologies were not optimally configured, and significant advances must be made for hospitals to fully realize the benefits of these technologies. Hospitals have implemented many technologies in drug distribution, with 82.8% of hospitals having automated dispensing cabinets, 10.1% having robots, and 12.7% having carousel systems to manage inventory. Finally, most hospitals reported plans to adopt most of these technologies.

Conclusion. This survey found that informatics and medication-use system technologies are widely present in all steps of the medication-use process. These technologies touch all health care professionals in the hospital and demonstrate the significant responsibility the pharmacy department holds for these technologies.

Index terms: American Society of Health-System Pharmacists; Computers; Data collection; Pharmacy, institutional, hospital; Technology; United States

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of the survey, the depth of information collected was limited. Future surveys will examine informatics issues in greater detail. Nevertheless,

this survey provides detailed information on the diffusion of informatics and technology in U.S. hospitals at the end of 2007.

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In assessing the adoption and use of pharmacy informatics and technology within the medication-use process, this study sought to describe the status and process of electronic medical records (EMRs), pharmacy information systems, electronic drug information, ordering, receiving, inventory control, unit-dose repackaging, computerized prescriber order entry (CPOE), electronic prescribing (ePrescribing), medication reconciliation, order delivery, order review, medication distribution preparation and technology, automated compounding devices, bar-code medication administration (BCMA), technology to track and assess trends in system processes and outcomes, and pharmacy information technology (IT) personnel and budget changes.

Methods

The diffusion, management, and use of pharmacy informatics and technology within the medication-use process were assessed using methods similar to those used in the ASHP national surveys of pharmacy practice in hospital settings.¹⁻³

Questionnaire development. The questionnaire was developed and pretested following procedures suggested by Dillman.⁴ Questions from previous ASHP national surveys of pharmacy practice in hospital settings that pertained to informatics and technology adoption were evaluated for clarity and distribution of response. The authors and leadership of the ASHP Section on Pharmacy Informatics and Technology added additional topics and questions. In excess of 300 data elements were included in this survey.

Survey sample. The population of hospitals was obtained from the SMG Marketing Group, Inc., 2007 hospital database,⁵ as were data on hospital characteristics (i.e., hospital type, ownership, and number of staffed beds). Therefore, we used the available data rather than gather these

data. Unlike ASHP national surveys of pharmacy practice in hospital settings that focused exclusively on general and children's medical-surgical hospitals in the United States, this study surveyed the entire population of hospitals, including specialty, federal, and Veterans Affairs hospitals. Pharmacy directors' names and e-mail addresses were compiled from internal ASHP databases.

Data collection. The questionnaire was delivered online by Qualtrics (Provo, UT), an online survey research technology provider. Pharmacy directors in the sample were contacted by e-mail up to four times during the survey period. The survey launched on November 5, 2007. A series of three reminder messages were sent by e-mail on November 13, November 27, and December 18 to those who did not respond to the initial request to complete the survey. The survey was closed on December 23, 2007. A final thank-you e-mail was sent to all respondents in January 2008.

Data analysis. Each member of the sample was assigned a unique identification number that allowed the survey response to be matched with hospital characteristics in the SMG database.

Data are presented by categories of staffed beds for general and children's medical-surgical hospitals. In addition, data are reported for Veterans Affairs hospitals and government and nongovernment specialty hospitals. Reporting data by number of staffed beds for general and children's medical-surgical hospitals aligns closely with data reporting methods used by the American Hospital Association.⁶

Because of the sampling procedure and variable response rates with each strata reported, it was necessary to use a design-based analysis.⁷ This technique produces population estimates that are much more accurate than not accounting for sampling design and response rates.

Data were provided from Qualtrics in an Excel spreadsheet (Microsoft Corp., Redmond, WA). Data were converted to SPSS version 15.0 (SPSS Inc., Chicago, IL) and Intercooled Stata version 7 readable format using DBMS Copy version 7 (Conceptual Software, Inc., Houston, TX). All nondesign-based analyses were conducted using SPSS 15.0. All design-based analyses were conducted using Stata 7 with the set of survey commands. To account for the sampling method and response rates, weights were assigned to respondents to adjust their contribution to the population estimate. For general and children's medical-surgical hospitals, the weights were 9.27 for hospitals with fewer than 50 staffed beds, 6.82 for hospitals with 50-99 beds, 5.56 for hospitals with 100-199 beds, 3.99 for hospitals with 200-299 beds, 4.42 for hospitals with 300-399 beds, 2.98 for hospitals with 400-799 beds, and 2.82 for hospitals with 800 or more staffed beds. The weights were 4.18 for Veterans Affairs hospitals, 12.37 for government specialty hospitals, and 14.59 for nongovernment specialty hospitals. The strata were the categories for types and sizes of hospitals, and the finite population correction was the total number of hospitals in the population (6944).

Descriptive statistics were used extensively. Chi-square analysis and analysis of variance or regression were used to examine how responses differed as a function of hospital characteristics. The a priori level of significance was set at 0.05.

Results and discussion

A total of 4112 pharmacy directors' names and e-mail addresses were identified and matched to a hospital in the SMG database. Overall, 1066 usable surveys were completed and returned, yielding a response rate of 25.9%. Little research has been published on response rates for online surveys of this length; however, our follow-up methods produced

responses from over 1000 hospitals that were well distributed by size and type of facility. This representativeness of the larger population of U.S. hospitals is very encouraging, given the length and complexity of the survey questions and lack of diffusion of many of these technologies in some segments of U.S. hospitals. Further, our approach of surveying as many pharmacy directors at U.S. hospitals as could be identified, as well as providing appropriate follow-up, led to the collection of data from over 15% of all U.S. hospitals. The response rate is similar to those of Internet-based surveys^{4,8} and mailed questionnaires.⁹

Table 1 shows the distribution by type of facility and number of staffed beds of the respondents' hospitals, the nonrespondents' hospitals, and the 4112 surveyed hospitals in the SMG hospital database. The type and size of facility differed significantly between respondents and nonrespondents ($p < 0.0001$). However, these differences are adjusted for in the design-based analysis.

Results are presented beginning with EMRs and the organizational philosophy of informatics and technology acquisition. As the EMR is the foundation upon which a completely integrated system of IT solutions is built, results related to the EMR are presented first and the rest are presented based on the steps in the medication-use process: prescribing, transcribing, procurement, dispensing, administration, monitoring, and patient education. Result for pharmacy IT personnel commitments are presented last.

IT Foundation. EMRs. Overall, 42.9% of hospitals had one or more components of the medical record (e.g., medication administration record, clinical documentation, recording of vital signs, CPOE, laboratory or radiology results, progress notes) in electronic form (Table 2). This varied by hospital type and size, with all Veterans Affairs hospitals having EMRs. Although nearly half of hospitals had components of an EMR, only 5.9% of all hospitals had a complete EMR system and did

not use paper-based patient charts (Table 2).

For hospitals with components of an EMR, only 53.2% of these hospitals allowed access to all health care providers in the hospital. Nurses (100%), pharmacists (98.7%), and physicians (95.8%) were routinely given access to the EMR. Other health professions given access included respiratory therapists (87.3%), midlevel practitioners (physician assistants and nurse practitioners) (86.4%), physical therapists and occupational therapists (80.0%), radiology technicians (65.4%), laboratory technicians (61.4%), unit clerks (49.4%), pharmacy technicians (49.3%), and nurse assistants (44.8%).

Furthermore, 40.2% of hospitals with components of an EMR captured all clinical documentation in the EMR. Not capturing clinical documentation erodes potential benefits of an EMR. For those hospitals that did not capture all clinical documentation in the EMR, the most common elements captured included allergies (96.3%), results (e.g., laboratory

Table 1.
Type and Size of Respondents' Hospitals^a

Characteristic	Respondents		Nonrespondents		Surveyed		Population	
	n	% ^b	n	% ^b	n	% ^c	n	% ^d
All U.S. hospitals	1066	25.9 ^e	3046	74.1	4112	100.0	6944	100.0
General and children's medical-surgical hospitals (by staffed beds)								
<50	182	25.7	526	74.3	708	17.2	1687	24.3
50-99	120	23.0	401	77.0	521	12.7	818	11.8
100-199	207	24.5	639	75.5	846	20.6	1150	16.6
200-299	164	30.8	369	69.2	533	13.0	654	9.4
300-399	94	27.2	252	72.8	346	8.4	397	5.7
400-799	126	36.8	216	63.2	342	8.3	376	5.4
≥800	17	37.0	29	63.0	46	1.1	48	0.7
Veterans Affairs hospitals	38	24.2	119	75.8	157	3.8	159	2.3
Specialty hospitals								
Government	30	24.2	94	75.8	124	3.0	371	5.3
Nongovernment	88	18.0	401	82.0	489	11.9	1284	18.5

^aFrom the SMG hospital database.

^bCalculated as a percentage of all hospitals surveyed in the category.

^cCalculated as a percentage of all hospitals surveyed.

^dCalculated as a percentage of all hospitals.

^e $\chi^2 = 50.6, df = 9, p < 0.0001$.

Table 2.
Use of Electronic Medical Records (EMRs)

Characteristic	Partial EMR		EMR Access for All Providers ^a		Complete EMR		All Clinical Documentation Captured ^a		Pharmacists View Complete EMR ^a		Pharmacists Document in EMR ^a	
	n	%	n	%	n	%	n	%	n	%	n	%
All U.S. hospitals (weighted estimate)	1066	42.9 ^b	514	53.2 ^c	1062	5.9 ^d	440	40.2	514	90.7	513	56.7 ^e
General and children's medical-surgical hospitals (by staffed beds)												
<50	182	30.8	56	46.4	182	3.3	50	44.0	56	87.5	56	66.1
50-99	120	45.8	55	49.1	119	2.5	52	50.0	55	90.9	55	50.9
100-199	207	50.2	104	45.2	207	4.8	94	38.3	104	93.3	104	50.0
200-299	164	53.7	88	53.4	163	3.7	82	31.7	88	90.9	87	60.9
300-399	94	58.5	55	50.9	93	4.3	51	35.3	55	92.7	55	58.2
400-799	126	57.9	73	49.3	125	4.8	67	34.3	73	93.2	73	50.7
≥800	17	47.1	8	62.5	17	0	8	12.5	8	100.0	8	37.5
Veterans Affairs hospitals	38	100.0	38	92.1	38	89.5	4	50.0	38	97.4	38	100.0
Specialty hospitals												
Government	30	26.7	8	75.0	30	0	8	62.5	8	87.5	8	50.0
Nongovernment	88	33.0	29	58.6	88	5.7	24	37.5	29	86.2	29	44.8

^aOf hospitals that have an EMR system.
^bUncorrected $\chi^2 = 82.7$, $df = 9$, design-based $F(5.74, 6058.49) = 11.2$, $p < 0.0001$.
^cUncorrected $\chi^2 = 25.9$, $df = 9$, design-based $F(6.33, 3188.95) = 2.6$, $p = 0.0145$.
^dUncorrected $\chi^2 = 320.4$, $df = 9$, design-based $F(5.66, 5949.27) = 50.7$, $p < 0.0001$.
^eUncorrected $\chi^2 = 33.0$, $df = 9$, design-based $F(5.95, 2994.79) = 3.4$, $p = 0.0023$.

tests, radiology) (92.4%), admission history (86.2%), vital signs (86.1%), medications (85.6%), social history (76.1%), orders (e.g., medications, laboratory tests, radiology, respiratory) (75.8%), discharge summary (74.1%), surgical history (71.2%), physical examination (66.1%), review of systems (63.6%), flow-sheet documentation (61.2%), consultations (59.7%), and progress notes (46.8%).

Most hospitals (90.7%) with an EMR provided pharmacists access to view available components of the EMR for the purpose of managing medication therapy. However, only 56.7% of hospitals with an EMR allowed pharmacists to document in the EMR. This feature allows for increased communication among all health care practitioners on medication-use issues.

IT acquisition. There are contrasting approaches to building an IT enterprise in hospitals. For many years, the “best-of-breed” approach was used, where the best product was selected for each application. This approach required building interfaces between applications that were to communicate with each other and share information.^{10,11} This process of building interfaces was often difficult at the hospital level. Vendors offer integrated or enterprise approaches that allow hospitals to contract with one vendor who has applications that are built to communicate and offer seamless technology integration. However, the enterprise approach often meant that some departments had to sacrifice desired features.¹²

Respondents were asked to categorize their hospital’s approach to IT acquisition as integrated or enterprise approach (i.e., select one vendor and use its suite of applications), best-of-breed approach (i.e., select the best product for each application and build interfaces between applications), equal mix of best-of-breed and enterprise approaches, or any approach between

integrated and equal mix or between best-of-breed and equal mix. Overall, 32.2% of hospitals used an enterprise approach, 22.9% leaned toward the use of an enterprise approach, 24.6% used an equal mix, 10.9% leaned toward the use of a best-of-breed approach, and 9.5% used a best-of-breed approach (Table 3). These results suggest that vendors offering enterprise solutions are better positioned in the marketplace.

Prescribing. CPOE. Overall, 17.8% of U.S. hospitals had a CPOE system (Table 4). The rate of adoption of CPOE differed significantly by type and size of facility ($p < 0.0001$). Clinical decision-support systems (CDSSs) are important components of CPOE, directing prescribers toward evidence-based drug therapy.¹³ Of those hospitals with CPOE, 67.2% had CDSSs in use to improve prescribing. Nearly one third of hospitals with CPOE systems did not have a CDSS. In these facilities, clinicians entered orders into electronic

systems that did not have rules that integrated order information, patient information, and clinical practice guidelines into computer system logic to provide feedback to prescribers. Therefore, we estimated that 12% of U.S. hospitals at the end of 2007 had CPOE with a CDSS (Table 4).

For hospitals without CDSSs, 21.2% planned to have live CDSSs within their CPOE system in the next 12 months, 36.9% in one to three years, 11.4% in more than three years, and 30.6% did not plan to have CDSSs in their CPOE system.

Overall, 51.4% of hospitals with CPOE and CDSSs used some out-of-the-box rules (i.e., rules available from the manufacturer and not modified by the hospital), and 86.6% developed custom rules. Further, 68.2% of hospitals with CDSSs had CDSS rules that required data (e.g., allergies, weight, renal function) from other electronic systems (e.g., EMRs, laboratory information systems), and 58.4% of hospi-

tals had weight-based dosing rules. Overall, 47.9% of hospitals with CPOE systems provided direct links to CDSS evidence from within the CPOE application.

In addition to not having a CDSS, other concerns about CPOE implementation include needing to manually reenter orders, using the CPOE system for all beds, and the percentage of orders prescribers enter directly into the CPOE system. Approximately one in seven hospitals with CPOE (16%) did not have its CPOE system integrated with its pharmacy information system (Table 4); these systems required manual reentry of orders into the pharmacy information system by pharmacy staff. It is likely that these hospitals have older CPOE systems. When hospitals replace their legacy systems with enterprise solutions that are naturally integrated, it is likely that the use of the potentially unsafe process of reentering orders will decline.

Table 3.
Approach to Information Technology Acquisition

Characteristic	n	% Respondents Using Approach				
		Integrated or Enterprise ^a	Between Integrated and Equal Mix	Equal Mix of Best of Breed and Enterprise	Between Equal Mix and Best of Breed	Best of Breed ^b
All U.S. hospitals (weighted estimate)	1006	32.2 ^c	22.9	24.6	10.9	9.5
General and children's medical-surgical hospitals (by staffed beds)						
<50	176	45.4	16.3	20.3	11.6	6.4
50-99	113	34.2	29.0	21.9	7.9	7.1
100-199	199	31.8	24.7	24.3	11.1	8.1
200-299	152	35.0	21.5	27.9	7.2	8.5
300-399	90	31.1	27.9	20.0	12.1	8.9
400-799	115	32.6	23.3	25.9	11.2	6.9
≥800	16	18.6	14.0	39.5	14.0	14.0
Veterans Affairs hospitals	32	37.6	21.8	15.8	18.8	6.0
Specialty hospitals						
Government	30	20.7	13.7	34.6	10.3	20.7
Nongovernment	83	15.9	28.1	29.2	12.2	14.6

^aSelect one vendor and use its suite of applications.

^bSelect the best product for each application and build interfaces between applications.

^cUncorrected $\chi^2 = 72.4$, $df = 36$, design-based $F(25.41, 25211.56) = 2.3$, $p = 0.0002$.

Table 4.
Use of Computerized Prescriber Order Entry (CPOE)

Characteristic	CPOE		CPOE with Clinical Decision-Support Systems		Must Manually Reenter Orders into Pharmacy Computer System ^a		CPOE Covers All Beds ^a		Orders Prescribers Enter into CPOE System ^a					
	n	%	n	%	n	%	n	%	n	%	1-25%	26-50%	51-75%	>75%
All U.S. hospitals (weighted estimate)	1038	17.8 ^b	1038	12.0 ^c	210	16.0	210	63.0 ^d	210	6.2 ^e	26.1	7.6	4.1	56.1
General and children's medical-surgical hospitals (by staffed beds)														
<50	179	8.9	179	6.2	16	25.0	16	37.5	16	31.3	50.0	6.3	0	12.5
50-99	119	11.8	119	6.7	12	8.3	12	25.0	12	25.0	33.3	8.3	8.3	25.0
100-199	203	12.8	203	8.9	26	15.4	26	61.5	26	0	42.3	7.7	3.8	46.2
200-299	157	15.3	157	11.5	24	12.5	24	58.3	24	0	33.3	12.5	12.5	41.7
300-399	93	30.1	93	18.3	28	14.3	28	53.6	28	3.6	35.7	7.1	14.3	39.3
400-799	118	33.9	118	22.0	40	12.5	40	72.5	40	2.5	17.5	10.0	5.0	65.0
≥800	17	41.2	17	29.4	7	14.3	7	57.1	7	0	28.6	14.3	0	57.1
Veterans Affairs hospitals	36	100.0	36	86.1	35	0	35	97.1	35	0	0	0	0	100.0
Specialty hospitals														
Government	30	26.7	30	20.0	8	12.5	8	87.5	8	0	0	12.5	0	87.5
Nongovernment	86	17.4	86	9.3	14	35.7	14	64.3	14	0	21.4	7.1	0	71.4

^aOf hospitals that have a CPOE system.

^bUncorrected $\chi^2 = 147.8$, $df = 9$, design-based $F(5.90, 6064.77) = 20.0$, $p < 0.0001$.

^cUncorrected $\chi^2 = 147.5$, $df = 9$, design-based $F(6.37, 6549.88) = 18.9$, $p < 0.0001$.

^dUncorrected $\chi^2 = 35.9$, $df = 9$, design-based $F(6.61, 1321.82) = 3.3$, $p = 0.0022$.

^eUncorrected $\chi^2 = 110.1$, $df = 36$, design-based $F(19.15, 3830.93) = 3.8$, $p < 0.0001$.

Furthermore, 63% of hospitals used their CPOE system to cover all their beds (Table 4). General and children's medical-surgical hospitals with fewer than 100 beds were least likely to use their CPOE for a majority of their hospital's beds. Finally, only 56.1% of hospitals had prescribers enter over 75% of orders into CPOE systems (Table 4). Prescribers could not enter all orders into the CPOE system due to clinical urgency and not being close to a CPOE terminal. However, having prescribers enter a majority of orders should be a goal of all health systems so that prescribers can have access to complete medication regimens and receive feedback from CDSSs designed to improve prescribing. That nearly 50% of systems had clinicians entering less than 75% of orders is problematic and suggests that their prescribing systems and processes could benefit from at least a review and possibly a failure mode and effects analysis to identify weakness in their prescribing system.¹⁴⁻¹⁶

Many hospitals struggle with entering all types of orders into the CPOE system. Overall, 30.9% of hospitals with CPOE have achieved getting all orders entered into CPOE. General and children's medical-surgical hospitals with fewer than 200 staffed beds were least likely to enter all orders into their CPOE system ($p = 0.0006$). The types of orders most likely to not be entered included operating room (72.7%), chemotherapy (70.3%), total parenteral nutrition (57.3%), radiology or contrast (47.1%), and continuous renal-replacement therapies (37.1%). For hospitals not yet entering all orders into CPOE, 21.9% planned to do this in the next 12 months, 50.9% in one to three years, 9.1% in more than three years, and 18.6% did not have plans to enter all orders into their CPOE system.

Some CPOE systems require certain information to be entered into the system before accepting

orders. Overall, 59.7% of hospitals had these hard stops active in their systems; 70.3% required allergy information, and 61.6% of hospitals with pediatric patients required patients' weight.

For hospitals without CPOE, 9.9% planned to have CPOE within one year, 44.2% in one to three years, 22.6% in more than three years, and only 23.3% did not plan to implement a CPOE system.

The adoption of CPOE appeared to be transitioning to the early-majority phase (i.e., innovation adopted by 16% or more of the population [up to 50%])¹⁷ and emerging from the early-adopter phase (i.e., innovation adopted by 2.5–16% of the population). Although the HIMSS Analytics model is very different from our data collection and format, our data and the HIMSS data revealed similarly slow rates of adoption of EMR and CPOE information technologies.¹⁸ As additional systems are implemented

and hospitals implement important safety components of these systems, prescribing and transcribing are likely to benefit.

ePrescribing. ePrescribing systems are used in the outpatient areas of health systems to improve prescribing, much like CPOE systems are used in inpatient environments. Overall, 20.7% of hospitals used ePrescribing (Table 5). The rate of adoption of ePrescribing in U.S. hospitals differed significantly by type and size of facility ($p < 0.0001$). Of those hospitals with ePrescribing, 44.0% had CDSSs in use to improve prescribing (Table 5). The rate of adoption of CDSSs within the ePrescribing system varied by type and size of facility ($p = 0.0173$). A majority of systems (73.2%) communicated prescription orders to outpatient pharmacies. Respondents estimated that an average of 34.1% of these prescriptions were electronically

transmitted to outpatient pharmacies. Further, 37.0% of hospitals made clinical patient information beyond the electronic prescription available to outpatient pharmacies. As electronic communication improves in the future, increasing direct transfer of prescription information to pharmacies should improve safety and efficiency, and allowing outpatient and ambulatory pharmacists access to detailed clinical information will enable improved drug therapy management.

Hospitals have treated ambulatory infusion orders differently. Some outpatient care areas are of sufficient size to merit preparation of infusions in an ambulatory care pharmacy. However, many rely on inpatient central pharmacy services for these compounded sterile preparations. Adding to the complexity of where these orders are prepared, the introduction of ePrescribing and CPOE systems provides different options for order

Table 5. Use of Electronic Prescribing (ePrescribing) in Outpatient Clinic Operations

Characteristic	ePrescribing System		Clinical Decision-Support Systems with ePrescribing System ^a		Communicates Orders to Outpatient Pharmacies ^a		Prescriptions Electronically Transmitted to Outpatient Pharmacy ^a	
	n	%	n	%	n	%	n	Mean ± S.E. %
All U.S. hospitals (weighted estimate)	1028	20.7 ^b	250	44.0 ^c	249	73.2	248	34.1 ^d ± 2.6
General and children's medical-surgical hospitals (by staffed beds)								
<50	179	16.8	30	30.0	30	73.3	30	37.0 ± 7.6
50–99	116	21.6	25	52.0	25	72.0	25	23.0 ± 7.1
100–199	202	19.8	40	40.0	40	65.0	39	25.1 ± 5.5
200–299	157	26.1	41	46.3	41	68.3	41	26.1 ± 5.3
300–399	93	30.1	27	66.7	27	74.1	27	29.1 ± 6.7
400–799	117	30.8	36	30.6	36	63.9	36	15.0 ± 4.1
≥800	17	35.3	6	0.0	6	66.7	6	7.8 ± 3.5
Veterans Affairs hospitals	33	97.0	32	81.3	31	96.8	31	93.8 ± 3.2
Specialty hospitals								
Government	30	13.3	4	25.0	4	75.0	4	56.3 ± 25.8
Nongovernment	84	10.7	9	33.3	9	77.8	9	23.3 ± 11.2

^aOf hospitals that have an ePrescribing system.

^bUncorrected $\chi^2 = 99.8$, $df = 9$, design-based $F(6.26, 6377.57) = 12.6$, $p < 0.0001$.

^cUncorrected $\chi^2 = 29.2$, $df = 9$, design-based $F(5.73, 1375.25) = 2.6$, $p = 0.0173$.

^dDesign-based $F(1, 238) = 3.92$, $p = 0.0489$.

entry. Hospitals with ePrescribing systems were split between entering orders into the outpatient ePrescribing system (16.2%) and using the inpatient CPOE system for entering orders (18.8%). The remaining hospitals did not enter outpatient orders into either system.

Overall, 58.9% of hospitals with ePrescribing and CDSSs used some out-of-the-box rules and 79.7% developed custom rules. For hospitals without CDSSs in their ePrescribing system, 9.9% planned to have a live CDSS in the next 12 months, 38.5% in one to three years, 11.7% in more than three years, and 39.9% had no plans to have a CDSS in their ePrescribing system.

For hospitals without ePrescribing, 7.1% planned to have ePrescribing within one year, 20.5% in one to three years, 8.0% in more than three years, and 64.4% did not have plans to implement an ePrescribing system.

Medication reconciliation. The Joint Commission identified prob-

lems with medication regimen continuity when patients were transferred between settings. In response to these concerns, the Joint Commission created the National Patient Safety Goal on Medication Reconciliation to stimulate complete and accurate reconciling of medications across the continuum of care.¹⁹ Hospitals were charged with developing a process for obtaining and documenting a complete list of patients' current medications at admission, upon transfer within the organization, and at discharge. This process bridges prescribing, transcribing, and monitoring components of the medication-use process.

The most common approach to medication reconciliation was a paper-based system (47.6%), followed by a combination of paper and electronic systems (42.0%) (Table 6). Only 10.4% of hospitals had an entirely electronic process for medication reconciliation. Overall, 54.5% of hospitals integrated their medica-

tion reconciliation process with their EMR or their outpatient ordering application or both.

Transcribing. *Imaging technology.* Imaging technology for medication orders was used by 33.3% of respondents (Table 7) but varied by type and size of facility ($p < 0.0001$), with Veterans Affairs, specialty, and general medical-surgical hospitals with fewer than 50 beds least likely to use imaging technology. The low rate of imaging technology use in Veterans Affairs hospitals is explained by the use of CPOE systems that electronically transmit orders. In 407 hospitals using imaging technology, 43.2% linked the medication order image to the patient record in the pharmacy information system.

Medication orders were delivered to pharmacy departments in many other ways, with 67.3% receiving orders by fax, 38.3% by manual delivery, 16.8% by CPOE, and 13.7% by pneumatic tube. Larger hospitals

Table 6.
Types of Medication Reconciliation Processes Used

Characteristic	Medication Reconciliation Process			Medication Reconciliation Integrated with Electronic Medical Record and/or Outpatient Ordering Application		
	n	Electronic	Paper Based	Combination	n	%
		%	%	%		
All U.S. hospitals (weighted estimate)	1026	10.4 ^a	47.6	42.0	598	54.5 ^b
General and children's medical-surgical hospitals (by staffed beds)						
<50	179	7.8	59.8	32.4	72	44.4
50-99	116	5.2	45.7	49.1	63	65.1
100-199	202	13.9	36.6	49.5	128	58.6
200-299	157	10.2	28.7	61.1	112	57.1
300-399	92	18.5	35.9	45.7	59	62.7
400-799	117	15.4	33.3	51.3	78	61.5
≥800	17	17.6	35.3	47.1	11	63.6
Veterans Affairs hospitals	32	56.3	3.1	40.6	31	87.1
Specialty hospitals						
Government	30	10.0	63.3	26.7	11	45.5
Nongovernment	84	4.8	60.7	34.5	33	36.4

^aUncorrected $\chi^2 = 126.1$, $df = 18$, design-based $F(12.57, 12774.49) = 8.0$, $p < 0.0001$.

^bUncorrected $\chi^2 = 32.2$, $df = 9$, design-based $F(6.33, 3723.80) = 3.4$, $p = 0.0022$.

Table 7.
Use of Imaging Technology for Medication Orders

Characteristic	Use Imaging Technology		Imaging Technology Linked to Patient Record in Pharmacy Information System ^a	
	n	%	n	%
All U.S. hospitals (weighted estimate)	1023	33.3 ^b	407	43.2
General and children's medical-surgical hospitals (by staffed beds)				
<50	178	16.9	30	33.3
50-99	116	35.3	41	46.3
100-199	202	41.1	83	44.6
200-299	156	58.3	91	49.5
300-399	92	60.9	56	51.8
400-799	117	56.4	66	43.9
≥800	16	68.8	11	36.4
Veterans Affairs hospitals	32	9.4	3	66.7
Specialty hospitals				
Government	30	16.7	5	40.0
Nongovernment	84	25.0	21	33.3

^aOf hospitals that have imaging technology.

^bUncorrected $\chi^2 = 117.7$, $df = 9$, design-based $F(6.34, 6419.77) = 15.0$, $p < 0.0001$.

tended to use technology more often to deliver medication orders to the pharmacy department.

Pharmacy computer system. Overall, 51.1% of hospitals had pharmacy computer systems integrated as part of a larger suite of products offered by a single manufacturer, 35.0% had pharmacy computer systems interfaced with other IT products but were not part of a suite of products from a single manufacturer, 11.2% had standalone pharmacy computer systems that did not support information transfer with other applications, and 2.7% of hospitals had no computerized pharmacy system (Table 8). Integration differed significantly by size and type of hospital ($p < 0.0001$).

Integrating information systems, including pharmacy, will be important as hospitals move toward increased use of EMRs. Each of these information systems may have the need for drug information and pharmacy-maintained information in different formats. Overall, 20.7%

of hospitals maintained from 0 to 1 database, 71.5% maintained from 2 to 5 databases, and 7.8% maintained 6 or more databases. Less than 1% of hospital pharmacy departments maintained over 15 separate drug databases.

Information system integration and database maintenance can be resource intensive for pharmacy departments. As pharmacy information systems age and other information systems are acquired by hospitals, enterprise systems are often considered. Other times, pharmacy departments change vendors to gain additional features. Overall, 23.2% of hospital pharmacy departments had a plan to change pharmacy information system vendors (Table 8). For hospitals planning to change vendors, 33.7% planned to complete this change within one year, 55.3% in one to three years, and 11.1% in more than three years.

Off-site medication order review. Off-site medication order review and entry technology has increased nurse

access to pharmacists when the pharmacy department is closed. Overall, 23.1% of hospitals used off-site medication order review and entry technology (Table 9). Most commonly, hospitals used an affiliated hospital having 24-hour pharmacy services (39.8%) followed by an on-call pharmacist (32.2%), a national or regional company (22.7%), and 5.2% had other arrangements. In over three fourths of the hospitals using an off-site pharmacist, linkages existed with automated dispensing cabinets (ADCs) so that medications were only released for administration to the patient after the off-site pharmacist had reviewed and approved the order (Table 9).

Procurement. For efficiency and safety reasons, some pharmacy departments have turned to the use of electronic order and receiving systems for supply-chain management. Overall, 95.6% of hospitals used online ordering from their primary wholesaler and 34.0% ordered schedule II controlled substances online (Table 10).

As concerns about the integrity of the drug supply have grown, the Food and Drug Administration encouraged the use of the drug pedigree to track and verify the handoffs of medications in the pharmaceutical supply chain.²⁰⁻²² This technology has not been widely adopted, with only 22.5% of hospitals verifying the pedigree of medications obtained from their primary wholesaler and 14.7% doing so from secondary wholesalers (Table 10). As concerns grow about the drug supply, pedigrees will be an important defense against counterfeit medications entering the supply chain.

Electronic inventory control using bar codes and radio frequency identification (RFID) can assist with product receiving and tracking assets in hospitals. Overall, bar codes were used for inventory control in 29.9% of hospitals and 2.0% used RFID. As technology continues to advance and

Table 8.
Pharmacy Computer Systems

Characteristic	Pharmacy Computer Integration						Plan To Change Vendor					
	n	%	Integrated as Part of a Larger Suite of Products Offered by a Single Manufacturer	%	Interfaced with Other Information Technology Products Part of a Suite of Products	%	A Standalone System that Does Not Support Information Transfer with Other Applications	%	No Computerized Pharmacy System	%	n	%
All U.S. hospitals (weighted estimate)	1065	51.1 ^a	35.0	11.2	2.7	1066	23.2 ^b					
General and children's medical-surgical hospitals (by staffed beds)												
<50	182	52.7	28.6	11.5	7.1	182	20.3					
50-99	120	60.0	34.2	4.2	1.7	120	20.8					
100-199	207	64.3	31.9	3.4	0.5	207	19.8					
200-299	163	57.1	39.3	3.7	0	164	27.4					
300-399	94	63.8	35.1	1.1	0	94	30.9					
400-799	126	57.1	36.5	5.6	0.8	126	35.7					
≥800	17	41.2	47.1	11.8	0	17	41.2					
Veterans Affairs hospitals	38	76.3	18.4	5.3	0	38	7.9					
Specialty hospitals												
Government	30	10.0	63.3	26.7	0	30	10.0					
Nongovernment	88	31.8	37.5	27.3	3.4	88	28.4					

^aUncorrected $\chi^2 = 183.4$, $df = 27$, design-based $F(16.35, 17252.82) = 9.0$, $p < 0.0001$.

^bUncorrected $\chi^2 = 23.9$, $df = 9$, design-based $F(6.31, 6662.78) = 3.1$, $p = 0.0043$.

costs of technology decline, the use of technology for inventory control will likely increase over time.

Dispensing. *First- and maintenance-dose delivery.* Centralized medication distribution systems include traditional manual unit dose as well as stationary robotic systems that automate the drug dispensing process using bar-code technology. Decentralized medication distribution systems include satellite pharmacies and ADCs. ADCs are interfaced with the pharmacy information system (e.g., profile system) or are independent (e.g., nonprofile-based system).

Overall, 52.7% hospitals used a decentralized automated profile-based system (e.g., ADCs for first-dose delivery), and 35.6% used a centralized manual system for first-dose delivery. Less-utilized systems as the primary method of first-dose delivery included robots (4.8%), nonprofile-based ADCs (4.3%), and satellite pharmacies (2.6%). For maintenance-dose delivery, nearly half of respondents used profile-based ADCs (46.3%), 42% used a centralized manual system, and 8.9% used a robot. Specialty, Veterans Affairs, and general and children's medical-surgical hospitals with fewer than 50 beds were more likely to use centralized manual systems for first- and maintenance-dose delivery than were larger general and children's medical-surgical hospitals. Conversely, larger general and children's medical-surgical hospitals were most likely to use profile-based ADCs and robots for first- and maintenance-dose delivery ($p < 0.0001$ for both).

Medication storage on nursing units. There are different models of medication storage on nursing units. The most common method included the use of patient-specific drawers in medication rooms as a secondary source for medications not available from an ADC (40.4%), followed by 25.3% using patient-specific drawers in a medication room as a primary source, 15.4%

Table 9.
Use of Off-Site Medication Order Review

Characteristic	Use Off-Site Order Review and Entry		Off-Site Review Linked to Automated Dispensing Cabinets ^a	
	n	%	n	%
All U.S. hospitals (weighted estimate)	1023	23.1 ^b	218	78.3
General and children's medical-surgical hospitals (by staffed beds)				
<50	178	24.2	42	73.8
50-99	116	33.6	38	92.1
100-199	202	20.3	41	82.9
200-299	156	16.7	24	75.0
300-399	92	14.1	13	84.6
400-799	117	13.7	14	78.6
≥800	16	25.0	4	75.0
Veterans Affairs hospitals	32	53.1	16	62.5
Specialty hospitals				
Government	30	23.3	7	71.4
Nongovernment	84	22.6	19	73.7

^aOf hospitals that use off-site order review and entry.

^bUncorrected $\chi^2 = 26.5$, $df = 9$, design-based $F(6.29, 6368.44) = 3.4$, $p = 0.0019$.

using a mobile medication cart with a computer, 14.1% using a nurse server outside the patient's room, and 4.8% using a nurse server in the patient's room.

Distribution and storage technology. Currently, 10.1% of hospitals used a robotic distribution system that automates the dispensing of unit dose inpatient medications in their centralized distribution system (Table 11). Use of a robot differed significantly by hospital type and size ($p < 0.0001$). Veterans Affairs and general and children's medical-surgical hospitals with 200 or more beds were most likely to have a robot, compared with specialty hospitals and hospitals with fewer than 200 staffed beds. For hospitals without a robot, 1.4% planned to have a robot within one year, 2.5% in one to three years, 1.8% in more than three years, and 94.2% did not have plans to implement a robot.

A majority of hospitals (82.8%) used ADCs in their medication distribution systems (Table 11). Use of ADCs differed significantly by

hospital type and size ($p < 0.0001$), with over 90% of Veterans Affairs and general and children's medical-surgical hospitals with 100 or more staffed beds using the devices. Government specialty hospitals were least likely to have ADCs. Of those hospitals with ADCs, 89.2% of hospitals had the ADC linked to their pharmacy computer system (e.g., a profile-based system). This system helps ensure that nurses have access to only the medication orders appropriate for a specified patient. For the small group of hospitals without ADCs, 13.2% planned to have ADCs within one year, 28.0% in one to three years, 11.1% in more than three years, and 47.8% did not have plans to implement ADCs for drug distribution on nursing units.

Overall, 12.7% of hospitals had carousel systems that automated drug storage in their inpatient pharmacy department (Table 11). Use of a carousel differed significantly by hospital type and size ($p < 0.0001$). Veterans Affairs and general and children's medical-surgical hospitals

with 400 or more beds were most likely to have a carousel system, compared with specialty hospitals and hospitals with fewer than 400 staffed beds. For hospitals without carousel systems, 5.2% planned to have a carousel within one year, 8.4% in one to three years, 4.1% in more than three years, and 82.3% did not have plans to implement a carousel.

Repackaging unit dose medications. Some systems in the pharmacy department (e.g., robots) and at the point of care (i.e., BCMA) require bar codes on all medication packages. In addition, some medications may not be available in unit dose packages (with or without bar codes), or the bar codes may not be readable by the scanning equipment used. Therefore, pharmacy departments must either repackaging medications into unit doses or outsource this activity.

Overall, 10.8% of hospitals outsourced unit dose repackaging (Table 12). The outsourcing of packaging differed significantly by hospital type and size ($p < 0.0001$). General and children's medical-surgical hospitals with 200 or more staffed beds were most likely to outsource unit dose packaging. Over 92% of hospitals used inhouse repackaging equipment for unit dose preparation. There is some overlap between outsourcing and inhouse repackaging since products may need to be packaged and bar coded emergently and more quickly than the outsource vendor can supply a repackaged product.

Overall, pharmacy directors estimated that 25.5% of doses required repackaging in their pharmacy department (Table 12). This varied by hospital type and size, with Veterans Affairs and large general and children's medical-surgical hospitals estimating higher percentages. For hospitals with BCMA systems or robots, pharmacy directors estimated that 39.1% of doses required repackaging (Table 12). Bar codes appear to create a greater need for repackaging.

Table 10.

Use of Information Technology in Pharmacy Ordering and Receiving

Characteristic	Online Ordering from Primary Wholesaler		Online Ordering of Schedule II Controlled Substances		Verify Drug Pedigree from Primary Wholesaler		Verify Drug Pedigree from Secondary Wholesaler		Use Bar Coding for Inventory Control		Use Radio Frequency Identification for Inventory Control	
	n	%	n	%	n	%	n	%	n	%	n	%
All U.S. hospitals (weighted estimate)	1057	95.6	1047	34.0 ^a	1053	22.5 ^b	1015	14.7	1057	29.9 ^c	971	2.0 ^d
General and children's medical-surgical hospitals (by staffed beds)												
<50	182	93.4	180	31.1	181	16.0	176	12.5	182	13.7	172	1.2
50-99	120	95.0	118	44.1	119	20.2	116	16.4	120	28.3	110	1.8
100-199	205	97.1	204	41.7	204	21.6	200	14.5	205	37.6	192	1.6
200-299	163	95.7	162	35.8	162	23.5	153	15.7	162	46.3	146	7.5
300-399	93	97.8	92	30.4	93	34.4	90	14.4	94	50.0	83	3.6
400-799	122	96.7	121	33.1	123	30.1	119	22.7	122	54.1	110	6.4
≥800	17	94.1	17	29.4	16	43.8	16	25.0	17	47.1	17	0
Veterans Affairs hospitals	38	100.0	36	50.0	38	47.4	31	29.0	38	76.3	28	3.6
Specialty hospitals												
Government	30	93.3	30	20.0	30	23.3	30	6.7	30	23.3	29	0
Nongovernment	87	96.6	87	27.6	87	23.0	84	14.3	87	19.5	84	0

^aUncorrected $\chi^2 = 22.8$, $df = 9$, design-based $F(6.27, 6498.23) = 2.9$, $p = 0.0066$.

^bUncorrected $\chi^2 = 23.9$, $df = 9$, design-based $F(6.33, 6598.43) = 3.1$, $p = 0.0044$.

^cUncorrected $\chi^2 = 114.4$, $df = 9$, design-based $F(6.29, 6585.36) = 14.6$, $p < 0.0001$.

^dUncorrected $\chi^2 = 25.2$, $df = 9$, design-based $F(5.87, 5636.39) = 5.4$, $p < 0.0001$.

Overall, pharmacy directors reported an average of 0.5 full-time-equivalent (FTE) staff committed specifically to repackaging operations in their pharmacy department (Table 12). This varied by type and size of hospital, with 1.0 or more FTEs committed to repackaging operations by Veterans Affairs and general and children's medical-surgical hospitals with 300 or more staffed beds. For hospitals with BCMA systems or robots, pharmacy directors estimated that an average of 0.8 FTE was committed to repackaging. This also differed by hospital type and size, with Veterans Affairs and general and children's medical-surgical hospitals with 300 or more staffed beds having the most FTEs for repackaging. These data suggest that hospitals with systems using bar codes require greater resource commitments than hospitals not using bar code systems.

Pharmacy directors were asked to rate their level of agreement (strongly disagree, disagree, neither disagree nor agree, agree, and strongly agree) with the following statements: The resources devoted to repackaging and relabeling of medications into unit dose packages with bar codes (1) are more costly than I anticipated, (2) require more time than I anticipated, or (3) are appropriate. Overall, 35.1% either agreed or strongly agreed that repackaging was more costly, 42.5% were neutral, and 22.4% either disagreed or strongly disagreed. Further, 39.6% either agreed or strongly agreed that repackaging required more time than anticipated, 36.4% were neutral, and 23.9% either disagreed or strongly disagreed. Finally, 41.6% either agreed or strongly agreed that repackaging was appropriate, 37.9% were neutral, and 20.6% either disagreed or strongly disagreed. These results suggest that cost and time may have been more than initially anticipated, but many directors felt that resource commitments were appropriate.

Table 11.
Use of Medication Distribution and Storage Technology

Characteristic	Robot		Carousel		Automated Dispensing Cabinets	
	n	%	n	%	n	%
All U.S. hospitals (weighted estimate)	1022	10.1 ^a	1022	12.7 ^b	1022	82.8 ^c
General and children's medical-surgical hospitals (by staffed beds)						
<50	178	3.4	178	10.1	178	70.2
50-99	115	3.5	115	6.1	115	83.5
100-199	202	5.4	202	8.9	202	93.1
200-299	156	20.5	156	13.5	156	95.5
300-399	92	28.3	92	15.2	92	98.9
400-799	117	35.0	117	30.8	117	97.4
≥800	16	43.8	16	43.8	16	100.0
Veterans Affairs hospitals	32	31.3	32	31.3	32	93.8
Specialty hospitals						
Government	30	10.0	30	20.0	30	53.3
Nongovernment	84	6.0	84	11.9	84	81.0

^aUncorrected $\chi^2 = 114.2$, $df = 9$, design-based $F(6.43, 6507.47) = 14.2$, $p < 0.0001$.

^bUncorrected $\chi^2 = 39.9$, $df = 9$, design-based $F(6.40, 6473.07) = 5.1$, $p < 0.0001$.

^cUncorrected $\chi^2 = 108.2$, $df = 9$, design-based $F(5.85, 5924.32) = 14.8$, $p < 0.0001$.

Automated compounding devices. Automated compounding devices were used by 29.9% of hospital pharmacy departments (Table 13). This varied by type and size of hospital, with general and children's medical-surgical hospitals with 200 or more beds most likely to use this technology. Most commonly, automated compounding devices were used for total parenteral nutrition (TPN) preparations (94.6%), followed by large-volume parenterals (16.9%), syringes (14.6%), small-volume parenterals (9.9%), flushes (4.7%), and chemotherapy (3.2%). Having automated compounding devices linked to the pharmacy information system streamlines preparation activities and potentially decreases transcription errors when programming the devices. Overall, 7.2% of hospitals with automated compounding devices had them interfaced with the pharmacy information system.

Finally, 13.4% of hospitals had plans to implement new automated compounding devices. For hospitals planning to implement new automated compounding devices,

TPN was most commonly indicated (59.9%), followed by syringes (36.4%), small-volume parenterals (28.4%), large-volume parenterals (19.8%), flushes (17.9%), and chemotherapy (16.0%).

Administration. *Technology used at the point of care.* Overall, 24.1% of hospitals use BCMA systems (Table 14). The use of BCMA varied by hospital type and size. All Veterans Affairs hospitals used BCMA, and general and children's medical-surgical hospitals with 100-399 beds were more likely to have BCMA to verify the accuracy of medication administration at the point of care.

For hospitals with BCMA, 85.8% allowed nurses to view medication administration information from within the BCMA application, 91.3% allowed for clinical documentation from within the BCMA system, 45.6% captured national drug code numbers from within BCMA, and 27.0% captured expiration dates and lot numbers for biological medications and immunizations. These features help clinicians provide for efficient patient care or assist with billing.

Traditionally, medication administration records (MARs) have been manual, paper-based systems. These manual systems also allow for nursing documentation of vital signs and patient information pertinent to medication administration. With the availability of electronic MARs (eMARs) and BCMA systems, various MAR formats and configurations now exist in hospitals. The most common system was still a manual paper-based system (53.8%), followed by the use of a BCMA system that included an eMAR and electronic nursing documentation (19.6%), an eMAR and electronic nursing documentation without BCMA (13.7%), an eMAR only without BCMA or the capability for nurses to electronically document (8.5%), and an eMAR with BCMA but no electronic documentation (4.5%) (Table 14). The safest system for medication administration and documentation is one that includes all three components (eMAR, BCMA, and electronic nurse documentation). As BCMA systems that have all these components are newly installed in hospitals,

Table 12.
Method Used for Repackaging Unit-Dose Medications

Characteristic	Outsource Unit-Dose Repackaging		Use Any Inhouse Repackaging Equipment		Medications Requiring Repackaging				Pharmacy Full-Time Equivalents Dedicated to Repackaging			
	n	%	n	%	All Respondents		Respondents with Robot or Bar-Code Medication Administration		All Respondents		Respondents with Robot or Bar-Code Medication Administration	
					Mean ± S.E.	n	Mean ± S.E.	n	Mean ± S.E.	n	Mean ± S.E.	n
All U.S. hospitals (weighted estimate)	1060	10.8 ^a	1018	92.2 ^b	955	25.5 ± 0.8	363	39.1 ^c ± 1.5	941	0.5 ^d ± 0.02	357	0.8 ^e ± 0.03
General and children's medical-surgical hospitals (by staffed beds)												
<50	182	5.5	175	85.7	160	19.8 ± 1.6	35	27.3 ± 3.3	155	0.3 ± 0.0	34	0.4 ± 0.1
50-99	120	9.2	118	93.2	112	22.1 ± 2.1	32	29.6 ± 3.8	111	0.3 ± 0.0	30	0.5 ± 0.1
100-199	206	10.2	200	94.0	191	24.9 ± 1.7	62	36.2 ± 3.4	187	0.5 ± 0.0	63	0.7 ± 0.1
200-299	163	19.0	153	94.8	146	34.9 ± 2.4	69	48.9 ± 3.5	147	0.7 ± 0.1	68	0.8 ± 0.1
300-399	94	20.2	92	100.0	87	35.6 ± 3.0	48	46.8 ± 4.4	88	1.0 ± 0.1	49	1.2 ± 0.1
400-799	123	26.0	113	97.3	106	35.8 ± 2.8	52	48.9 ± 4.2	105	1.2 ± 0.1	54	1.4 ± 0.1
≥800	17	35.3	15	86.7	10	41.8 ± 10.6	6	50.4 ± 16.3	9	2.1 ± 0.4	5	1.8 ± 0.4
Veterans Affairs hospitals	38	10.5	36	94.4	36	57.6 ± 5.7	36	57.6 ± 5.7	36	1.4 ± 0.1	32	1.4 ± 0.2
Specialty hospitals												
Government	30	6.7	30	93.3	26	28.5 ± 6.3	4	56.3 ± 24.2	26	0.5 ± 0.1	4	1.0 ± 0.7
Nongovernment	87	8.0	86	93.0	81	19.8 ± 2.3	19	29.7 ± 4.7	77	0.4 ± 0.1	18	0.5 ± 0.1

^aUncorrected $\chi^2 = 41.3$, $df = 9$, design-based $F(6.33, 6642.92) = 5.2$, $p < 0.0001$.

^bUncorrected $\chi^2 = 23.9$, $df = 9$, design-based $F(6.11, 6156.33) = 3.1$, $p = 0.0046$.

^cDesign-based $F(1, 353) = 4.62$, $p = 0.0323$.

^dDesign-based $F(1, 931) = 27.65$, $p < 0.0001$.

^eDesign-based $F(1, 347) = 16.87$, $p < 0.0001$.

less safe and less accurate systems will be replaced.

For hospitals without BCMA systems, 15.4% planned to have a system implemented within one year, 40.9% in one to three years, 12.9% in more than three years, and 30.8% did not have plans to implement BCMA.

Intelligent infusion devices (smart infusion pumps). A smart infusion pump is a point-of-care computer that integrates the infusion pump with clinical best practice guidelines. Smart infusion pumps have software that checks programmed doses against preset limits specific to a drug and clinical location. The clinician may either override an alert (soft limit) or not be allowed to continue at all (hard stop), depending on preset limits.

Overall, 44.0% of hospitals used smart infusion pumps (Table 15), and the use of smart infusion pumps varied by hospital type and size. Specialty hospitals and general and children's medical-surgical hospitals with fewer than 50 beds were least likely to have smart infusion pumps. In nearly 70% of hospitals with smart infusion pumps, pharmacy maintained the drug library. Some smart infusion pumps record events and allow for evaluation of these events for quality-improvement purposes. Overall, 46.9% of hospitals with smart infusion pumps used these logs for quality-improvement purposes. In addition, 29.9% of hospitals had smart infusion pumps with wireless capability, a feature that greatly eases updating the drug library, real-time monitoring of pump use, and tracking these assets. The next phase of smart-pump integration includes interfacing with the eMAR, CPOE system, and pharmacy systems. Overall, only 3% of hospitals with smart infusion pumps interfaced with the eMAR. The replacement of legacy pumps by smart infusion pumps should increase use of these advanced features and increase patient safety.²³

For hospitals without smart infusion pumps, 18.6% planned to have smart infusion pumps within one year, 28.7% in one to three years, 6.0% in more than three years, and 46.8% did not have plans to implement smart infusion pumps.

Monitoring and patient education. Using technology to track and predict trends regarding different aspects of the medication-use system can greatly improve efficiency and safety and free up resources, allowing additional patients to be monitored. Overall, 76.2% of hospitals were using technology to track and predict trends regarding areas of concern in the medication-use system. Diversion (76.3%) was most commonly monitored, followed by out-of-range laboratory test values (excluding anticoagulation and aminoglycoside values) (52.3%), late or missed doses (48.3%), out-of-range aminoglycoside values (45.3%), out-of-range anticoagulation values (45.1%), formulary adherence (31.7%), near misses with BCMA (24.6%), nonmatched drug and culture and sensitivity reports (21.0%), and smart-pump reports (19.5%) (Table 16).

Finally, pharmacist interventions were tracked and trended in 71.9% of hospitals. This varied by type and size of hospital, with general and children's medical-surgical hospitals with fewer than 50 staffed beds least likely (52.8%) to track pharmacist interventions. Knowing what interventions pharmacists perform on a daily basis enables pharmacy managers to justify the importance of clinical pharmacy services.

Pharmacy personnel. Overall, 35.8% of hospitals had pharmacy IT personnel (Table 17). This varied by type and size of hospital, with Veterans Affairs and general and children's medical-surgical hospitals with 200 or more staffed beds most likely to have pharmacy IT positions. The number of FTE pharmacy IT staff (i.e., 40 hours per week) averaged 1.9

Table 13. Use of Automated Compounding Devices in Sterile Product Preparation

Characteristic	Use Automated Compounding Device		Use of Device						
	n	%	Flushes	Syringes	Small-Volume Parenterals	Large-Volume Parenterals	Total Parenteral Nutrition	Chemotherapy	
			n	%	n	%	n	%	n
All U.S. hospitals (weighted estimate)	1021	29.9 ^a	404	4.7 ^b	14.6	9.9 ^c	16.9	94.6 ^d	3.2 ^e
General and children's medical-surgical hospitals (by staffed beds)									
<50	177	6.2	11	18.2	18.2	27.3	9.1	72.7	0
50-99	115	16.5	19	0	5.3	0	21.1	100.0	0
100-199	202	32.7	66	1.5	13.6	4.5	13.6	95.5	6.1
200-299	156	61.5	96	3.1	15.6	14.6	13.5	92.7	6.3
300-399	92	76.1	70	2.9	8.6	5.7	20.0	97.1	1.4
400-799	117	81.2	95	7.4	27.4	16.8	26.3	91.6	2.1
≥800	16	56.3	9	22.2	22.2	22.2	33.3	88.9	11.1
Veterans Affairs hospitals	32	40.6	13	15.4	7.7	23.1	23.1	100.0	7.7
Specialty hospitals									
Government	30	10.0	3	0	0	0	0	100.0	0
Nongovernment	84	26.2	22	4.5	13.6	4.5	13.6	100.0	0

^aUncorrected $\chi^2 = 266.1$, $df = 9$, design-based $F(6.42, 6492.22) = 33.9$, $p < 0.0001$.
^bUncorrected $\chi^2 = 19.8$, $df = 9$, design-based $F(5.27, 2074.72) = 2.2$, $p = 0.0472$.
^cUncorrected $\chi^2 = 24.3$, $df = 9$, design-based $F(5.12, 2017.60) = 2.7$, $p = 0.0168$.
^dUncorrected $\chi^2 = 28.4$, $df = 9$, design-based $F(4.46, 1756.10) = 5.3$, $p = 0.0002$.
^eUncorrected $\chi^2 = 10.9$, $df = 9$, design-based $F(5.56, 2192.42) = 2.6$, $p = 0.0201$.

Table 14.
Technology Used by Nurses When Administering Medications^a

Characteristic	BCMA		n	eMAR Only		eMAR with BCMA		eMAR, BCMA, and Electronic Nursing Documentation		eMAR and Electronic Nursing Documentation (without BCMA)		All Manual Paper-Based Systems	
	n	%		%	%	%	%	%	%	%	%	%	
All U.S. hospitals (weighted estimate)	1021	24.1 ^b	1020	8.5	4.5	19.6	13.7	53.8					
General and children's medical-surgical hospitals (by staffed beds)													
<50	177	14.7	177	8.5	2.3	12.4	9.0	67.8					
50-99	115	24.3	115	7.8	1.7	22.6	12.2	55.7					
100-199	202	30.2	202	8.4	5.0	25.2	14.9	46.5					
200-299	156	36.5	156	7.7	7.7	28.8	17.3	38.5					
300-399	92	40.2	92	8.7	7.6	32.6	23.9	27.2					
400-799	117	25.6	117	19.7	4.3	21.4	21.4	33.3					
≥800	16	6.3	15	26.7	0	6.7	26.7	40.0					
Veterans Affairs hospitals	32	100.0	32	0	18.8	81.3	0	0					
Specialty hospitals													
Government	30	10.0	30	10.0	0	10.0	6.7	73.3					
Nongovernment	84	15.5	84	6.0	6.0	9.5	15.5	63.1					

^aBCMA = bar-code medication administration, eMAR = electronic medication administration record.

^bUncorrected $\chi^2 = 111.7$, $df = 9$, design-based $F(5.77, 5837.85) = 14.9$, $p < 0.0001$.

and varied significantly by type and size of hospital ($p < 0.0001$). Larger general and children's medical-surgical hospitals had the most pharmacy IT personnel.

On average, hospitals had 0.35 FTE assigned to pharmacy IT managers, 0.65 FTE to pharmacists, 0.47 FTE to pharmacy technicians, and 0.44 FTE to pharmacy IT analysts or programmers (Table 17). These results provide additional information beyond the average of 25 FTEs per hospital reported in a survey of hospital chief information officers.²⁴ Substantial resources are being committed inside the pharmacy department in addition to the resources used to manage the IT infrastructure of the hospital.

Pharmacy directors were asked how they expected resources for IT to change in the next fiscal year. Overall, 30.0% of hospitals predicted an increase in pharmacy IT personnel, 68.3% indicated personnel would stay the same, and only 1.7% predicted a decrease. These data suggest that pharmacy resources will generally increase to manage medication-use system IT.

Finally, respondents indicated the focus of their pharmacy IT team. Overall, 12.6% of hospitals had their team primarily work within the confines of the pharmacy, providing maintenance of existing systems and user support along with some implementation activities, 30.4% had their pharmacy IT team work in the broader medication-use system within the organization and involved with hands-on implementation of new technologies for all steps in the medication-use process, 7.6% had the team serve in leadership roles within the organization in terms of setting strategy for technology adoption and use, 1.4% had their team serve in leadership roles both within the organization and outside the organization, and 48.0% did not have a pharmacy IT team.

Table 15.
Use of Intelligent Infusion Devices (Smart Pumps)

Characteristic	Smart Pumps		Pharmacy Maintains Smart Pump Library ^a		Quality-Improvement Logs Used From Smart Pumps ^a		Smart Pumps With Wireless Capabilities ^a	
	n	%	n	%	n	%	n	%
All U.S. hospitals (weighted estimate)	1020	44.0 ^b	498	69.6	492	46.9 ^c	492	29.9
General and children's medical-surgical hospitals (by staffed beds)								
<50	177	33.9	60	68.3	58	32.8	57	24.6
50-99	115	49.6	57	64.9	57	50.9	57	28.1
100-199	202	48.5	95	66.3	96	42.7	96	27.1
200-299	156	62.8	98	77.6	97	53.6	98	31.6
300-399	92	50.0	46	82.6	45	51.1	45	46.7
400-799	117	61.5	72	83.3	70	47.1	70	40.0
≥800	15	80.0	12	100.0	12	66.7	12	41.7
Veterans Affairs hospitals	32	71.9	23	65.2	22	31.8	22	22.7
Specialty hospitals								
Government	30	10.0	2	50.0	2	0	2	50.0
Nongovernment	84	39.3	33	60.6	33	60.6	33	27.3

^aOf hospitals that have smart pumps.

^bUncorrected $\chi^2 = 72.6$, $df = 9$, design-based $F(6.33, 6394.54) = 9.3$, $p < 0.0001$.

^cUncorrected $\chi^2 = 22.2$, $df = 9$, design-based $F(5.83, 2810.57) = 2.9$, $p = 0.0083$.

Summary

Results from this survey profile IT adoption across all hospitals in the United States. Hospitals appear to be moving toward an enterprise approach to IT adoption. Enterprise solutions are often used because developing interfaces for other systems and best-of-breed applications is too difficult and costly. This enterprise approach may explain the 23.2% of hospitals that reported that they will be changing pharmacy computer system vendors. This change may be welcome if additional integration and access to other systems are gained; however, loss of important features to pharmacy will be a concern.

An EMR is the fundamental infrastructure necessary for adoption of all resulting technologies and software. Although nearly half of the hospitals had some component of an EMR, only 5.9% were fully digital without paper records. Hospitals were challenged by providing access to all health care providers, capturing all clinical documentation, and

pharmacists' documenting of clinical interventions in the EMR. The development of standards that software vendors use in designing their systems will allow for a better connectivity between all hospital systems, and well-designed integration of all hospital information systems with an EMR will better suit practitioner and patient needs. Without these components, hospitals cannot achieve the envisioned digital hospital of the future.

Despite strong recommendations for adoption of CPOE by the Leapfrog Group, the Institute of Medicine, and the Certification Commission for Healthcare Information Technology,^{25,26} only 12% of hospitals had adopted CPOE with a CDSS. Decision support assists prescribers in making better medicine selections, provided they receive the decision-support alerts. Unfortunately, providers enter a majority of orders in only about half of hospitals. Additional challenges to CPOE implementation include interfaces

with the pharmacy computer system to avoid manually reentering orders and having the CPOE system cover all beds and all orders in the hospital. The use of a CDSS has been long established in pharmacy information systems, but it has not progressed to the extent that it is useful for all patient care providers. Pharmacists have suppressed the imperfect screening available for allergy and drug-drug interactions. Now, other providers are faced with the alerts and follow in the footsteps of pharmacists. The use of contextual CDSSs will be an asset for many care providers, providing an alert only when there is an actual problem. Using a CDSS is only as perfect as the alerts are meaningful and the provider takes the appropriate action. This survey found that significant advances must be made in these areas for hospitals to fully realize the benefits of CPOE.

Similar to previous ASHP national surveys of pharmacy practice in hospital settings, this survey found

Table 16.
Use of Technology To Track and Assess Trends in Areas of Concern in the Medication-Use System

Characteristic	n	% Respondents Tracking and Assessing Trends in Areas of Concern									
		Near Misses With Bar-Code Medication Administration	Late or Missed Doses	Formulary Adherence	Diversion	Anticoagulation Values Out of Range	Aminoglycoside Values Out of Range	Other Laboratory Values Out of Range	Nonmatched Drug and Culture and Sensitivity Reports	Smart-Pump Reports	No Reports Used
All U.S. hospitals (weighted estimate)	795	24.6 ^a	48.3 ^b	31.7 ^c	76.3 ^d	45.1 ^e	45.3 ^f	52.3	21.0	19.5 ^g	24.8 ^h
General and children's medical-surgical hospitals (by staffed beds)											
<50	114	22.8	51.8	24.6	68.4	40.4	47.4	57.0	18.4	10.5	34.1
50-99	85	28.2	49.4	20.0	72.9	52.9	55.3	57.6	25.9	29.4	26.1
100-199	166	24.7	45.2	22.3	81.9	48.2	51.2	50.0	22.3	18.7	15.7
200-299	131	30.5	48.1	37.4	84.0	50.4	46.6	53.4	22.9	25.2	13.4
300-399	84	36.9	57.1	44.0	86.9	52.4	41.7	50.0	19.0	23.8	7.7
400-799	98	24.5	41.8	43.9	86.7	53.1	44.9	56.1	19.4	32.7	14.8
≥800	13	0	15.4	61.5	69.2	23.1	38.5	30.8	15.4	38.5	13.3
Veterans Affairs hospitals	31	67.7	96.8	61.3	83.9	58.1	41.9	58.1	19.4	16.1	3.1
Specialty hospitals											
Government	18	11.1	50.0	66.7	66.7	27.8	16.7	33.3	22.2	0	37.9
Nongovernment	55	12.7	38.2	30.9	70.9	36.4	38.2	49.1	20.0	20.0	32.9

^aUncorrected $\chi^2 = 43.6$, *df* = 9, design-based $F(5.88, 4619.21) = 5.1$, *p* < 0.0001.
^bUncorrected $\chi^2 = 31.7$, *df* = 9, design-based $F(6.32, 4964.77) = 3.7$, *p* = 0.0010.
^cUncorrected $\chi^2 = 55.8$, *df* = 9, design-based $F(6.37, 5004.18) = 6.4$, *p* < 0.0001.
^dUncorrected $\chi^2 = 23.0$, *df* = 9, design-based $F(6.31, 4956.44) = 2.7$, *p* = 0.0118.
^eUncorrected $\chi^2 = 18.8$, *df* = 9, design-based $F(6.33, 4967.13) = 2.2$, *p* = 0.0406.
^fUncorrected $\chi^2 = 21.3$, *df* = 9, design-based $F(6.33, 4965.38) = 2.5$, *p* = 0.0207.
^gUncorrected $\chi^2 = 32.5$, *df* = 9, design-based $F(5.92, 4645.79) = 4.6$, *p* = 0.0001.
^hUncorrected $\chi^2 = 54.2$, *df* = 9, design-based $F(6.31, 6211.24) = 7.1$, *p* < 0.0001.

that hospitals are split between centralized and decentralized drug distribution systems.³ For maintenance doses, about half of hospitals used ADCs, about 40% of hospitals used a manual unit dose system, and about 10% of hospitals used a robot. Although over 80% of hospitals had ADCs, about half of hospitals used ADCs to provide maintenance doses on nursing units, and the remaining 30% of hospitals with ADCs used them to provide first doses, in procedure areas, to provide as-needed medicines, and for other uses. The use of automation in pharmacy practice will be a key to expanding the role of the pharmacist and pharmacy technician in the future.

The use of automation may allow pharmacists to entrust some of the traditional dispensing activities to pharmacy technicians and automated systems. This may allow the pharmacist to become more involved with patient care activities and allow the pharmacy technician to progress in that profession. A pharmacist will need to oversee the system and continuously review it for improvements and efficiency gains.

Overall, 44% of hospitals had smart infusion pumps, and nearly one quarter had BCMA. These technologies are designed to address the low rate of intercepting potential adverse drug events (medication administration errors) at the sharp end of medication use, the administration step.²⁷ However, hospital pharmacy departments have needed to commit substantial resources to repackaging medications into unit doses, and bar codes further increase resource commitments. There are multiple problems with bar coding medications. The use of bar codes to identify medications should start in the inventory and procurement stage. Hospitals that were using BCMA have a strong infrastructure developed for ensuring that the correct product has the correct bar code and has been appropriately identified in all systems

Table 17.
Pharmacy Information Technology (IT) Personnel^a

Characteristic	Have Pharmacy IT Positions		Total FTE(s) for IT ^b		Manager/ Director FTE(s)	Pharmacist FTE(s)	Technician FTE(s)	Analyst or Programmer FTE(s)
	n	%	n	Mean ± S.E.				
All U.S. hospitals (weighted estimate)	1015	35.8 ^c	476	1.9 ± 0.1 ^d	0.35 ± 0.03 ^e	0.65 ± 0.05 ^f	0.47 ± 0.03	0.44 ± 0.09 ^g
General and children's medical-surgical hospitals (by staffed beds)								
<50	176	9.7	16	0.9 ± 0.4	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.1 ± 0.1
50-99	115	32.2	37	1.0 ± 0.2	0.1 ± 0.1	0.4 ± 0.1	0.3 ± 0.1	0.2 ± 0.1
100-199	200	44.5	86	1.4 ± 0.1	0.2 ± 0.0	0.6 ± 0.1	0.4 ± 0.1	0.2 ± 0.0
200-299	155	70.3	106	1.5 ± 0.1	0.3 ± 0.0	0.5 ± 0.1	0.4 ± 0.1	0.2 ± 0.0
300-399	91	75.8	69	2.2 ± 0.2	0.4 ± 0.1	0.8 ± 0.1	0.6 ± 0.1	0.4 ± 0.1
400-799	117	87.2	101	3.0 ± 0.2	0.6 ± 0.1	0.9 ± 0.1	0.7 ± 0.1	0.8 ± 0.1
≥800	15	93.3	14	4.9 ± 1.0	0.9 ± 0.2	1.6 ± 0.3	1.1 ± 0.3	1.3 ± 0.6
Veterans Affairs hospitals	32	96.9	30	1.4 ± 0.1	0.3 ± 0.1	0.5 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
Specialty hospitals								
Government	30	20.0	5	7.0 ± 4.6	1.2 ± 0.7	0.8 ± 0.4	1.1 ± 0.7	3.8 ± 3.1
Nongovernment	84	16.7	12	2.1 ± 0.7	0.4 ± 0.1	1.0 ± 0.5	0.3 ± 0.2	0.4 ± 0.2

^aFTE = full-time equivalent.

^bOf hospitals that have pharmacy IT positions.

^cUncorrected $\chi^2 = 309.6$, $df = 9$, design-based $F(6.33, 6360.71) = 39.3$, $p < 0.0001$.

^dDesign-based $F(1, 466) = 18.01$, $p < 0.0001$.

^eDesign-based $F(1, 466) = 24.81$, $p < 0.0001$.

^fDesign-based $F(1, 466) = 10.0$, $p = 0.0017$.

^gDesign-based $F(1, 466) = 16.50$, $p = 0.0001$.

(e.g., pharmacy information system, CPOE, robotics, BCMA). The use of bar coding for dispensing and administration has its possibilities to ensure patient safety, but they must be developed to optimize workflow.²⁸ Hospital directors should be aware of these issues when implementing technologies that rely on bar codes (e.g., BCMA, robots).

This survey further confirms that larger hospitals (400 or more staffed beds) have adopted CPOE before starting to adopt BCMA.^{1,3} Nevertheless, all technologies are important to improve the safety of the medication-use system, and most hospitals had plans to adopt most of these technologies (Table 18).

Pharmacy departments had many dedicated IT personnel, averaging 1.9 FTEs per hospital. This level of support for IT within the pharmacy department is significant, and hospital pharmacy directors predict that this role will expand. The use of pharmacists and other qualified health care personnel in building these complicated systems is essential. Pharmacists can leverage their many years of experience taking care of patients' medication needs to design optimal systems. Pharmacy technicians rely on their experience and expertise in the drug distribution system to build data dictionaries and formularies and improve workflow. Using clinical pharmacists to test and develop CDSSs is essential, as they are working with providers who trust their knowledge and skills. Moving forward requires pharmacists to receive additional training in pharmacy informatics.^{29,30}

When reviewing the expansion of IT in this survey, many institutions were planning to add more software and automation to their enterprise, but few of them expected any more personnel dedicated to this expansion. It is important to remember that all of these systems take time to build, time to implement, and much time for maintenance once the sys-

Table 18.

Status of and Plans for Information Technology (IT) Adoption^a

Characteristic	Weighted %					
	Previous ASHP National Hospital Pharmacy Survey (Year)	2007 ASHP IT Survey				
		Have Technology	Plan To Acquire Within Next 12 Months	Plan To Acquire Within 1–3 Years	Plan To Acquire in More Than 3 Years	No Current Plans To Acquire Technology
CPOE (n = 1037)	NS	17.8	8.2	36.3	18.6	19.1
CPOE with CDSS (n = 1038)	10.4 (2007)	12.0	NS	NS	NS	NS
BCMA (n = 1012)	19.6 (2007)	24.1	11.7	31.0	9.8	23.3
Robot (n = 1022)	15.0 (2005)	10.1	1.3	2.3	1.6	84.7
Carousel (n = 1012)	NS	12.7	4.6	7.3	3.6	71.8
ADC (n = 1022)	71.8 (2005)	82.8	2.3	4.8	1.9	8.2
Smart pumps (n = 1018)	41.1 (2007)	44.0	10.4	16.0	3.4	26.1
EMR (n = 1066)	41.0 (2007)	42.9	NS	NS	NS	NS
Complete EMR (n = 1062)	3.6 (2007)	5.9	NS	NS	NS	NS

^aCPOE = computerized prescriber order entry, CDSS = clinical decision-support system, NS = not surveyed, BCMA = bar-code medication administration, ADC = automated dispensing cabinet, EMR = electronic medical record.

tem has gone into production. FTE reductions may not be realized with technology expansion as new needs and responsibilities for these technologies are developed.

When designing a complete EMR infrastructure, it is important that those involved focus on their metrics and benchmarking to assess the success of the system. Each stakeholder will have desired outcomes from the software or automation that has been implemented. It is important to design reports and structure the data so they can be easily interpreted. Furthermore, the success of current and future projects depends on working with vendors to supply reports that are relevant and provide measurable data. Our survey did not focus on this aspect of measurement, and this could be a possible area for future surveys. The use of EMRs for research and pharmacovigilance is an important aspect that can only be a reality if standard data structure codes and terminology are used.

Finally, this survey sample comprised responses from pharmacy directors from all U.S. hospitals, and responses were obtained from all types and sizes of hospitals. This is in

contrast to the ASHP national surveys of pharmacy practice in hospital settings that only include general and children's medical-surgical hospitals. The differences in samples should be considered when comparing results from these surveys. Nevertheless, results from this survey are similar to results found in previous ASHP national surveys of pharmacy practice in hospital settings (Table 18). Differences are often explained by the inclusion of Veterans Affairs hospitals and specialty hospitals in the IT survey sample and additional adoption of technologies from 2005 to 2007.

Conclusion

This survey found that informatics and medication-use system technologies are widely present in all steps of the medication-use process. These technologies touch all health care professionals in the hospital and demonstrate the significant responsibility the pharmacy department holds for these technologies.

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