

ASHP national survey of pharmacy practice in hospital settings: Dispensing and administration—2002

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The ASHP national survey of pharmacy practice in hospital settings focuses on the role pharmacists play in managing and improving the medication-use process. The national surveys are organized according to six steps in the medication-use process: prescribing, transcribing, dispensing, administration, monitoring, and patient education and wellness. ASHP's hospital survey was redesigned on the basis of this construct into a three-part series beginning in 1998 and concluding in 2000. Therefore, the cycle repeats every three years. The 2002 survey represents the second part in this cycle and is concerned with dispensing and administration. When combined, the 2001–2003 surveys will represent a composite picture of the current role of pharmacists in managing and improving the process of medication use.

In assessing the role of pharmacists in dispensing and administration, the present study sought to describe the inpatient drug distribution system, the use of technology in drug

Abstract: Results of the 2002 ASHP national survey of pharmacy practice in hospital settings that pertain to dispensing and administration are presented.

A stratified random sample of pharmacy directors at 1101 general and children's medical–surgical hospitals in the United States were surveyed by mail. SMG Marketing Group, Inc., supplied data on hospital characteristics; the survey sample was drawn from SMG's hospital database.

The response rate was 46.7%. During 2002, both inpatient and outpatient hours of service increased compared with 2001. Paradoxically, there was an 8.5% decrease in pharmacy staffing and a 7% vacancy rate, suggesting that pharmacists are busier. Most hospitals (80%) had a centralized inpatient dispensing system, but 44% were planning to become more decentralized. Automated dispensing cabinets were used by 58% of hospitals with decentralized drug distribution systems. Most hospitals (81.4%) dispensed more than three quarters of oral doses as unit doses and 63.3% of injectable doses to non-critical care patients, increases from 1999. A large percentage of hospitals (89%) repackaged both oral and injectable medications. More hospitals were repackaging medications

than three years ago, primarily because of lack of commercial availability. Approximately 20% of pharmacies either partially or completely outsourced drug preparation activities. Nurses administered medications in virtually all hospitals (99.7%). Despite widespread recommendations to use bar-code technology to check and document doses administered, only 1.5% of hospitals used this technology, an increase from 1.1% in 1999. Nearly two thirds of hospitals used computer-generated medication administration records.

While pharmaceutical services are expanding, workforce issues continue to challenge pharmacists trying to maintain and enhance safe medication systems. Safe systems continue to be in place in most hospitals, but the adoption of new technology to improve safety is slow.

Index terms: Automation; Codes; Computers; Contract services; Data collection; Dispensing; Documentation; Drug administration; Manpower; Packaging; Pediatrics; Personnel, pharmacy; Pharmaceutical services; Pharmacy, institutional, hospital; Safety; Technology

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distribution, medication preparation and dispensing, drug administration, the use of bar-code technology, the use of medication administration records, repackaging operations, outsourcing of pharmacy operations and preparation activities, and quality improvement activities.

Methods

The extent to which pharmacists are involved in the dispensing and administration aspects of the medication-use process was assessed by using methods similar to those of the 2001 ASHP survey.¹

Questionnaire development. The 2002 questionnaire was developed and pretested by using procedures suggested by Dillman.² Each question from the 1999 questionnaire was evaluated for clarity, response, and nonduplication in the three parts of the survey. A few question domains were added or expanded where appropriate, such as the questions about repackaging operations. As with past surveys, data on hospital characteristics (i.e., number of licensed beds, number of occupied beds, U.S. Bureau of the Census region, ownership, U.S. Bureau of the Census metropolitan statistical area [MSA] status,³ and medical school affiliation status) were available in the SMG Marketing Group, Inc., 2002 hospital database.⁴ Therefore, we used the available data rather than gathering these data.

Survey sample. From the SMG database of 6812 hospitals, a sampling frame of 4966 general and children's medical-surgical hospitals in the United States was constructed. Specialty, federal, and Veterans Affairs hospitals were excluded from the sampling frame. Hospitals were stratified by size before sampling, and random samples of 200 hospitals within these strata were taken to construct the sample of 1200 hospitals, as was done in the 2001 ASHP survey.

In April 2002, each of the 1200 hospitals was telephoned (Reliance

Teleservice, Arnold, MD) to verify the name of the pharmacy director. After eliminating closed hospitals, hospitals that no longer had pharmacies, hospitals without a permanent director of pharmacy, and pharmacies unwilling to provide the director of pharmacy's name, the adjusted sample comprised 1101 hospitals.

Data collection. Pharmacy directors in the sample were contacted up to six times during the survey period. An announcement letter was sent to the entire sample on May 8, 2002; this was followed two days later by the first survey mailing. To maximize the response rate, all members of the sample were sent a \$25 ASHP certificate for membership services or publications as an incentive with the first survey packet. Two weeks after the initial survey mailing, reminder post cards were mailed to the entire sample (on May 27, 2002). The surveys were mailed a second time to nonrespondents on June 3, 2002. The survey was sent a third time by overnight mail to remaining nonrespondents from June 12 to June 17, 2002. A return envelope was not included in this mailing. Reliance Teleservice attempted a final telephone contact with nonrespondents during the last week of June 2002.

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.

As in the 2001 survey, data in this report are presented by categories of staffed beds to allow closer alignment with data presented by the American Hospital Association.⁵ This terminology matches that of licensed beds used in previous surveys.

Because of the stratified random sampling procedure, it was necessary to employ a design-based analysis. This technique produces population estimates that are much more accurate than a method that does not account for the complex sampling

design. In addition, this technique improves the reliability of the population estimates and the estimates for each subdomain (e.g., hospital size). Stratified random sampling also ensured that the sample was representative of the population. An excellent review of this sampling methodology and analysis has been provided by Levy and Lemeshow.⁶

Data were entered by using SPSS version 10.0.7 (SPSS Inc., Chicago, IL). Data were converted to a Stata version 6 readable format (Stata Corp., College Station, TX) by using DBMS Copy version 7 (Conceptual Software, Inc., Houston, TX). All non-design-based analyses were conducted by using SPSS version 10. All design-based analyses were conducted with Stata 6 using the set of survey commands. To account for oversampling the largest hospitals, weights were assigned to respondents to adjust their contribution to the population estimate. The weight was 18.02 for hospitals with fewer than 50 staffed beds, 15.01 for hospitals with 50–99 beds, 14.70 for hospitals with 100–199 beds, 7.29 for hospitals with 200–299 beds, 3.78 for hospitals with 300–399 beds, and 4.41 for hospitals with 400 or more beds. The strata were the categories for number of staffed beds, and the finite population correction was the total number of hospitals in the population (4966). This means that smaller hospitals count more in the overall calculations than larger hospitals (because of the large number of small hospitals and the small number of large hospitals in the United States.) For example, if only 5% of small hospitals offer a service, but 60% of larger hospitals offer that service, the overall proportion of hospitals offering the service may be only 15%, because the smaller hospitals are weighted in the analysis to account their undersampling. This approach is advantageous because the proportion of hospitals offering a service in each hospital size category is more accu-

rate and the overall proportion of hospitals is more accurate.

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 0.05.

Results and discussion

During the response period, which lasted 11 weeks (from May 10, 2002, through July 26, 2002), 514 surveys were returned, for a response rate of 46.7%. This response rate is substantially higher than for most mail questionnaires.⁷

The response rates for the 1998 ASHP survey (51.8%),⁸ the 1999 survey (51.3%),⁹ the 2000 survey (50.2%),¹⁰ the 2001 survey (49.0%),¹ and now the 2002 survey (46.7%) were all higher than the response rates for the 1996 and 1994 surveys (37.1% and 43.9%, respectively).^{11,12} The most likely explanation for the higher response rates is the reduced number of questions on each of the past four surveys. Each of the 1998, 1999, 2000, 2001, and 2002 surveys focused only on two of the six steps in the medication-use process. Possible explanations for the slight decrease in the response rate this year include the absence of a return envelope in the third survey mailing and the inclusion in the current survey sample of hospitals contacted during the previous cycle. Nevertheless, the response rates for these extensive surveys are near 50%, which is laudable given the time demands on pharmacy directors.

Hospital and pharmacy characteristics. Table 1 shows the size, location, ownership, and affiliation status of the respondents' hospitals, the nonrespondents' hospitals, the surveyed hospitals, and the 4966 general and children's medical-surgical hospitals with pharmacies in the SMG hospital database. The characteristics of the surveyed hospitals are present-

ed to highlight the complex sampling design used in this survey. The regional distribution of hospitals was not significantly different from that of nonrespondents and was quite similar to that of hospitals sampled. Relative to nonrespondents and the surveyed hospitals, smaller hospitals with fewer than 100 staffed and occupied beds were somewhat underrepresented, as were hospitals outside an MSA, for-profit institutions, and hospitals not affiliated with a medical school. Because a design-based analysis was used, these slight differences were adjusted for in the population estimates.

The sampling design ensured approximately equal distribution of hospitals by number of staffed beds. Nearly two thirds of the respondents' hospitals and health systems were in the South and the Midwest. Most were nonprofit organizations (90%), most were not affiliated with a medical school (60%), and most were located within an MSA (69%).

Several indicators of annual health-system and pharmacy activity are presented in Table 2. On average, the hospitals and health systems described in this article projected an occupancy rate of approximately 51% nationally. Occupancy rates differed significantly as a function of hospital size, with smaller institutions reporting lower occupancy rates than larger ones. The average length of stay was about seven days and varied significantly with hospital size. Hospitals with 50-99 staffed beds had greater lengths of stay than other hospitals.

Inpatient pharmaceutical services were provided approximately 101 hours per week (Monday through Sunday), with smaller hospitals and health systems providing services significantly fewer hours a week than larger ones. Ambulatory care pharmaceutical services were provided an average of about 78 hours per week by 43% of the respondents, with significant differences by hospital size.

Overall, 29.2% of hospitals were

estimated to provide 24-hour inpatient pharmaceutical services. This varied significantly with staffed-bed size; the larger the hospital, the larger the percentage providing 24-hour inpatient pharmaceutical services (uncorrected $\chi^2 = 256.61$, design-based $F(3.83, 1918.35) = 51.19$, $p < 0.0001$). For example, 6.7% of hospitals with fewer than 50 staffed beds provided 24-hour inpatient pharmaceutical services, compared with 2.9% of hospitals with 50-99 beds, 13.8% of hospitals with 100-199 beds, 64.8% of hospitals with 200-299 beds, 83.2% of hospitals with 300-399 beds, and 89.0% of hospitals with 400 or more beds.

Drug distribution system. Over 80% of hospitals had a centralized inpatient drug distribution system, and nearly 20% had decentralized systems (Table 3). The use of a centralized or decentralized system was a function of hospital size. For example, 41% of hospitals with 400 or more beds had decentralized systems, whereas less than 11% with fewer than 100 beds had such systems. In 1999, an estimated 75% of hospitals had centralized distribution systems.⁹ Therefore, it appears that pharmacy operations continue to be centralized.

Hospital pharmacy directors were asked what direction they would like their inpatient drug distribution system to go in the future. A majority of hospital pharmacy directors (56%) responded that they would like a centralized system in the future; 44%, a decentralized system (Table 3). The preference for moving to a decentralized system was a function of hospital size. For example, more than 54% of directors in hospitals with 100 or more beds said they would like to move to a decentralized system, versus 31% of directors in hospitals with fewer than 100 beds. Overall, these data suggest that the frequency of decentralized systems could more than double in the future. However, the contraction of decentralized delivery over the past three years, coupled

Table 1.
Size, Location, Ownership, and Affiliation of Respondents' Hospitals^a

Characteristic	Respondents		Nonrespondents		Surveyed		Population	
	n	%	n	%	n	%	n	%
All hospitals	514	46.7	587	53.3	1101	...	4966	100.0
Staffed beds ^b								
<50	64	12.5	105	17.9	169	15.3	1153	23.2
50-99	69	13.4	117	19.9	186	16.9	1036	20.9
100-199	87	16.9	99	16.9	186	16.9	1279	25.8
200-299	92	17.9	95	16.2	187	17.0	671	13.5
300-399	101	19.6	88	15.0	189	17.2	382	7.7
≥400	101	19.6	83	14.1	184	16.7	445	9.0
Occupied beds ^c								
<50	134	26.1	230	39.2	364	33.1	2257	45.6
50-99	78	15.2	86	14.7	164	14.9	1006	20.3
100-199	144	28.1	143	24.4	287	26.1	993	20.1
200-299	86	16.8	68	11.6	154	14.0	393	7.9
300-399	42	8.2	28	4.8	70	6.4	153	3.1
≥400	29	5.7	31	5.3	60	5.5	148	3.0
Region								
West	92	18.1	116	19.9	208	19.0	913	18.6
Midwest	144	28.3	156	26.8	300	27.5	1428	29.1
South	181	35.6	214	36.7	395	36.2	1847	37.6
Northeast	92	18.1	97	16.6	189	17.3	725	14.8
MSA status ^d								
Within an MSA	356	69.3	368	62.7	724	65.8	2740	55.2
Outside an MSA	158	30.7	219	37.3	377	34.2	2226	44.8
Ownership ^e								
For-profit	53	10.3	87	14.8	140	12.7	642	12.9
Nonprofit	461	89.7	500	85.2	961	87.3	4324	87.1
Medical school affiliation ^f								
Yes	203	40.0	173	30.0	376	34.7	1188	24.3
No	304	60.0	403	70.0	707	65.3	3698	75.7

^aFrom the SMG hospital database. MSA = metropolitan statistical area.

^b $\chi^2 = 21.064$, d.f. = 5, $p < 0.001$.

^c $\chi^2 = 25.949$, d.f. = 5, $p < 0.001$.

^d $\chi^2 = 5.252$, d.f. = 1, $p < 0.022$.

^e $\chi^2 = 5.022$, d.f. = 1, $p < 0.025$.

^f $\chi^2 = 11.909$, d.f. = 1, $p < 0.001$.

with tight budgets, may limit the ability of pharmacy directors to further decentralize the drug distribution system.

Technology used in distribution.

An estimated 8% of hospitals used a robotic distribution system that automates the dispensing of inpatient unit doses within the centralized distribution system (Table 4). Use of a robot differed significantly with hospital size, with over 24% of the largest hospitals (300 or more staffed beds) having robots, compared with none of the smallest hospitals (fewer than 100 beds). In 1999, only 4.5% of hospitals used robots for automating the unit dose system.⁹ Despite the relatively high cost of robots, the benefits of this technology appear to be influencing the rate of adoption.

A majority of hospitals (58%) employed point-of-use dispensing devices (automated storage and distribution devices) in their decentralized distribution systems (Table 4). Utilization of point-of-use dispensing devices differed significantly with hospital size, with over 68% of hospitals with 100 or more staffed beds using the devices, versus less than 42% of hospitals with fewer than 100 beds. The prevalence of point-of-use dispensing devices in 1999 was 55%.⁹

Of hospitals with point-of-use dispensing devices, 82.2% had pharmacists check the accuracy and integrity of medications contained in the devices either before or after replenishment of medications. Some 72.4% of hospitals had the point-of-use dispensing device linked to their

pharmacy computer system. This system helps ensure that nurses have access only to the medication orders appropriate for a specified patient. Linkage of the point-of-use dispensing device to the pharmacy computer system differed with hospital size (uncorrected $\chi^2 = 20.28$, d.f. = 5, design-based $F(3.80, 1286.70) = 3.27$, $p < 0.0126$). Hospitals with fewer than 50 staffed beds had linkages 66.7% of the time, compared with 53.6% of hospitals with 50-99 beds, 82.5% of hospitals with 100-199 beds, 66.2% of hospitals with 200-299 beds, 86.8% of hospitals with 300-399 beds, and 72.7% of hospitals with 400 or more beds. The percentage of hospitals having the point-of-use dispensing device linked to the pharmacy computer system has increased dramatically

Table 2.
Hospital and Pharmacy Activity Levels by Number of Staffed Beds

Activity Measure	n	Mean ± S.D.
% beds occupied ^a		
All hospitals	507	50.9 ± 19.8
<50	60	35.1 ± 18.6
50–99	67	47.2 ± 19.1
100–199	87	54.3 ± 15.8
200–299	91	59.3 ± 15.0
300–399	101	61.1 ± 13.6
≥400	101	66.4 ± 17.3
Average length of stay (days) ^b		
All hospitals	507	7.2 ± 9.1
<50	60	6.6 ± 8.5
50–99	67	10.5 ± 14.7
100–199	87	6.6 ± 8.0
200–299	91	5.4 ± 2.0
300–399	101	5.6 ± 2.1
≥400	101	6.3 ± 4.1
Hours of inpatient pharmacy operation per week ^c		
All hospitals	507	101.0 ± 49.0
<50	60	57.3 ± 34.2
50–99	68	69.9 ± 26.9
100–199	87	101.5 ± 32.9
200–299	91	145.8 ± 32.1
300–399	101	158.2 ± 23.7
≥400	100	161.9 ± 19.0
Hours of ambulatory care pharmacy operation per week ^d		
All hospitals	217	78.0 ± 44.1
<50	16	65.0 ± 31.9
50–99	22	64.9 ± 31.2
100–199	28	77.4 ± 39.8
200–299	46	95.4 ± 52.9
300–399	51	93.7 ± 51.9
≥400	54	75.4 ± 46.5

^aDesign-based $F(1, 501) = 150.22, p < 0.0001$.

^bDesign-based $F(1, 501) = 4.03, p < 0.0451$.

^cDesign-based $F(1, 501) = 768.63, p < 0.0001$.

^dDesign-based $F(1, 211) = 7.86, p < 0.0055$.

from only 32.4% in 1999.⁹ The increase is probably due to rapid adoption of this improved technology.

For hospitals with the point-of-use dispensing device linked to the pharmacy computer system, an estimated 22.8% ± 2.4% (mean ± S.E.) of medications were dispensed as “overrides.” This fundamentally unsafe practice overrides the intent of the linkage. Efforts to decrease the percentage of overrides can increase the safety of medication use.

Bar codes were used in nearly 10% of hospitals to verify doses before dispensing (Table 4). Larger hospitals were much more likely to use bar-code technology to verify doses before dispensing than smaller hospitals. The increase from 4.6% of hospitals using

this technology in 1999⁹ to 9.5% of hospitals in 2002 may be a result of greater adoption of robots.

Delivery of first and maintenance doses. A majority of hospitals (65%) used a centralized manual system for delivering first doses (Table 5). About one fourth used a decentralized automated system (e.g., point-of-use dispensing devices) for first-dose delivery. For maintenance-dose delivery, nearly 70% of hospitals used a centralized manual system and 22% a decentralized automated system. Smaller hospitals were more likely to use centralized manual systems for first- and maintenance-dose delivery than larger hospitals. Conversely, large hospitals were more likely to use decentralized manual

systems (e.g., satellite pharmacies), centralized automated systems (e.g., robots), and decentralized automated systems (e.g., point-of-use dispensing systems) for first-dose delivery than smaller hospitals. Larger hospitals also moved more from maintenance-dose delivery to robots, and smaller hospitals moved more from point-of-use dispensing systems to centralized manual systems. Hospitals relied primarily on centralized manual drug delivery systems for first- and maintenance-dose delivery. For maintenance-dose delivery, hospitals relied more on centralized manual systems and robots and less on satellite pharmacies and point-of-use dispensing systems.

Checking unit doses dispensed by pharmacy. Hospital pharmacy directors were asked the primary method used to check unit doses dispensed by the pharmacy. An estimated 76% of hospitals had technicians prepare and pharmacists check unit doses (Table 6). The next most frequent methods were having pharmacists prepare doses with no check (11%) and using robots with no check (5%). The method used differed with the number of staffed beds. Smaller hospitals were much more likely to have pharmacists prepare unit doses with no check, and larger hospitals were much more likely to have robotic filling with no check. A total of nearly 12% of hospitals with fewer than 50 staffed beds reported some other method of checking unit doses. Over half of these reported integrating nurses into the process.

When examining manual systems, the importance of having a system of checking unit doses dispensed by pharmacy cannot be overstated. Not checking unit doses is a fundamentally unsafe practice that should be minimized. Although they are not utilized extensively, systems in which technicians prepare and other technicians check unit doses have been shown to be as accurate as systems in

Table 3.
Current Structure and Future Direction of Drug Distribution System

Characteristic	n	%			
		Current Structure		Future Direction	
		Centralized	Decentralized	Centralized	Decentralized
All hospitals	503	80.5	19.5	55.9	44.1
Staffed beds					
<50	62	88.7 ^a	11.3	69.8 ^b	30.2
50–99	68	89.7	10.3	75.0	25.0
100–199	85	80.0	20.0	45.8	54.2
200–299	91	74.7	25.3	38.9	61.1
300–399	99	67.7	32.3	39.8	60.2
≥400	98	59.2	40.8	44.2	55.8

^aUncorrected $\chi^2 = 29.18$, d.f. = 5, design-based $F(3.86, 1919.06) = 5.90$, $p < 0.0001$.

^bUncorrected $\chi^2 = 43.64$, d.f. = 5, design-based $F(3.81, 1856.05) = 9.06$, $p < 0.0001$.

Table 4.
Technology Used in Drug Distribution System

Characteristic	n	%		
		Robot	Point-of-Use Dispensing Device	Bar Codes Used To Verify Doses before Dispensing
All hospitals	511	7.8	58.2	9.5
Staffed beds				
<50	63	0 ^a	29.0 ^b	1.6 ^c
50–99	69	0	42.0	0
100–199	86	5.8	68.6	7.0
200–299	92	10.9	78.3	14.1
300–399	100	24.0	83.0	25.5
≥400	101	32.7	88.9	38.6

^aUncorrected $\chi^2 = 75.00$, d.f. = 5, design-based $F(2.77, 1398.08) = 28.12$, $p < 0.0001$.

^bUncorrected $\chi^2 = 96.76$, d.f. = 5, design-based $F(3.72, 1865.34) = 20.64$, $p < 0.0001$.

^cUncorrected $\chi^2 = 79.32$, d.f. = 5, design-based $F(3.41, 1713.67) = 18.26$, $p < 0.0001$.

which pharmacists check technicians' work.^{13,14} In 1999 it was reported that 12.3% of hospitals used the "tech-check-tech" method.⁹ However, respondents could identify more than one method of checking dispensed medications. Therefore, it appears that the data from 1999 and 2002 are not comparable and that the 2002 figure of 2.4% of hospitals using the tech-check-tech method is a more accurate estimate of the adoption of this method.

Proportion of doses dispensed in unit dose form. For this survey, a unit dose was defined as a dose dispensed by the pharmacy that is ready to administer to a patient (i.e., no further dosage calculation or manip-

ulation is required). For example, warfarin sodium 2.5 mg is ordered and a package containing warfarin sodium 2.5 mg is dispensed. A unit dose package that contains warfarin sodium 5 mg with a "note strength" label for the same patient is not considered to be in unit dose form. Similarly, if gentamicin 55 mg is ordered, a syringe containing gentamicin 55 mg is prepared and dispensed, not a syringe containing gentamicin 60 mg with a note strength label.

For non-critical care beds, 81.4% of hospitals dispensed 75% or more of oral unit doses in unit dose form. Larger hospitals were more likely to have implemented this safe system than smaller hospitals (uncorrected

$\chi^2 = 20.81$, d.f. = 5, design-based $F(3.73, 1893.57) = 4.49$, $p < 0.0017$). Also for non-critical care beds, 63.3% of hospitals dispensed 75% or more of injectable medications in unit dose form. For critical care beds, 59.8% of hospitals dispensed 75% or more of injectable medications in unit dose form. Results for injectable medications did not differ with the number of staffed beds. The percentage of hospitals dispensing unit doses in unit dose form increased from 79.9% for non-critical care oral medications in 1999 to 81.4% in 2002, from 52.2% for non-critical care injectable medications in 1999 to 63.3% in 2002, and from 52.4% for critical care injectable medications in 1999 to 59.8% in 2002.⁹ These increases may be attributable to increased awareness of the need to provide the fewest opportunities for error in the drug distribution and administration system.

Point-of-care-activated devices. An estimated 82.0% of hospitals used point-of-care-activated devices for small-volume injectable products. Almost all (97.0%) of these hospitals required nurses to activate the devices. While the potential waste for returned small-volume injections can be decreased with these systems, they may be less safe because of the additional steps required for proper use compared with pharmacy-prepared, ready-to-use i.v. admixtures. Greater attention should be given to mini-

mizing the opportunities for error in this area of medication administration; however, such efforts may decrease the intended advantages of this delivery system.

Preparation of i.v. doses by nurses. Nurses were required to prepare approximately 19% of i.v. admixture and solution doses from vials or ampuls (Table 7). The percentage of i.v. doses requiring preparation by nurses differed with the number of staffed beds. For example, only 13% of i.v. doses were prepared by nurses in hospitals with 400 or more beds, whereas 35% of i.v. doses were prepared by nurses from vials or ampuls in hospitals with less than 50 beds. While lower pharmacy staffing levels and less frequent medication use in small hospitals appear to influence the need to have nurses prepare i.v. doses, pharmacy directors should be mindful of the need to reduce opportunities for error. Nurse preparation of i.v. doses without pharmacist involvement increases the opportunity for medication errors.

Use of commercially available products. A total of 87.1% of hospitals purchased one or more commercially available small-volume injectable products whenever possible. Commercially available small-volume injectable products include frozen and premixed products and point-of-care-activated devices. Additionally, 87.6% of hospitals purchased commercially available premixed large-volume injections whenever possible. Only 71.4% of hospitals with less than 50 staffed beds purchased commercially available premixed large-volume injections, whereas over 89% of hospitals with 50 or more beds purchased premixed large-volume injections (uncorrected $\chi^2 = 41.09$, d.f. = 5, design-based $F(3.66, 1847.78) = 9.15$, $p < 0.0001$). The estimate for commercially available small-volume injections appears high; however, the data describe the purchase of just one or more of the available products and

not all products that are commercially available. Nevertheless, these data appear to accurately reflect the high level of adoption of these products in the marketplace.

I.V. admixture recycling program. Overall, 85.6% of hospitals were estimated to recycle unused i.v. admixtures (Table 8). The rest did not recycle i.v. admixtures, a fundamentally safer practice. The practice of recycling i.v. admixtures differed with the number of staffed beds, with hospitals in the smallest two categories being much more likely to not recycle i.v. admixtures. Although it is safer not to recycle i.v. admixtures, policies and procedures can be adopted that reduce the chance for errors when relabeling and dispensing recycled i.v. admixtures. For example, 68% of hospitals checked the recycled i.v. admixtures for expiration dates and visually examined integrity before reuse. Larger hospitals were more likely to follow this practice. An estimated 50% of hospitals had policies on relabeling (e.g., removing the original label immediately before applying the new label). Larger hospitals had this policy in place more frequently than smaller hospitals. In addition, 12.7% of hospitals conducted monthly quality assurance and 22.2% documented and identified trends in waste rates in their i.v. admixture recycling. Larger hospitals were much more likely to document and determine trends in waste rates. In 1999, 83% of respondents recycled i.v. admixtures, while 71% had a policy requiring recycled i.v. admixtures to be checked for expiration dates and visually examined them for integrity before reuse, 54% had a policy on relabeling, 28% documented waste rates, and 16% conducted quality assurance checks each month to ensure that relabeling policies were followed.⁹

There appears to have been a slight increase in the percentage of hospitals that recycle i.v. admixtures and an associated increase in the per-

Table 5. Primary Method of First-Dose and Maintenance-Dose Delivery

Characteristic	n	First-Dose Delivery				Maintenance-Dose Delivery			
		Centralized Manual	Decentralized Manual	Centralized Automated	Decentralized Automated	Centralized Manual	Decentralized Manual	Centralized Automated	Decentralized Automated
All hospitals	504	64.5	4.3	4.6	26.7	69.7	1.6	7.1	22.3
Staffed beds									
<50	62	77.4 ^a	1.6	1.6	19.4	83.9 ^b	0	1.6	14.5
50-99	69	76.8	2.9	2.9	17.4	82.6	0	1.5	15.9
100-199	86	62.8	4.7	4.7	27.9	70.9	3.5	4.7	20.9
200-299	90	62.2	1.1	3.3	33.3	63.3	1.1	10.0	25.6
300-399	98	41.8	5.1	11.2	41.8	36.6	3.0	17.8	42.6
≥400	99	29.3	17.2	12.1	41.4	31.0	3.0	28.0	38.0

^aUncorrected $\chi^2 = 65.34$, d.f. = 15, design-based $F(11.64, 5797.80) = 4.39$, $p < 0.0001$.

^bUncorrected $\chi^2 = 94.36$, d.f. = 15, design-based $F(10.42, 5229.26) = 7.34$, $p < 0.0001$.

Table 6.

Primary Method Used To Check Unit Doses Dispensed by Pharmacy

Characteristic	n	%					Other
		Technician Prepares, Pharmacist Checks	Pharmacist Prepares, No Check	Robot Prepares, No Check	Technician Prepares, Technician Checks	Technician Prepares, No Check	
All hospitals Staffed beds	505	76.3	11.3	4.7	2.4	1.5	3.4
<50	61	54.1	27.9 ^a	0	3.3	3.3	11.5
50-99	69	81.2	14.5	0	0	1.5	2.9
100-199	86	87.2	5.8	3.5	2.3	1.2	0
200-299	91	87.9	1.1	5.5	3.3	1.1	1.1
300-399	98	77.6	2.0	13.3	5.1	0	2.0
≥400	100	70.0	1.0	23.0	2.0	0	4.0

^aUncorrected $\chi^2 = 138.31$, d.f. = 25, design-based $F(16.93, 8449.87) = 6.48$, $p < 0.0001$.

Table 7.

Percentage of I.V. Admixtures or Solutions That Require Nurses To Prepare Dose from Vials or Ampuls

Characteristic	n	Mean ± S.E. % I.V.s Requiring Nurse Preparation
All hospitals Staffed beds ^a	506	19.4 ± 1.3
<50	63	34.5 ± 4.2
50-99	68	21.7 ± 3.5
100-199	86	12.9 ± 1.7
200-299	92	12.3 ± 1.6
300-399	97	9.2 ± 1.2
≥400	100	13.1 ± 1.7

^aDesign-based $F(1, 500) = 32.77$, $p < 0.0001$.

centage with policies on examining expiration dates and product integrity. However, there also appears to have been a decline in the percentage of hospitals that have policies on re-labeling, that document waste rates, and that conduct monthly quality assurance. These variables should continue to be monitored.

Two-pharmacist check before dispensing. Some drug therapies and patient groups have higher risks, and pharmacists must be especially vigilant when dispensing medications in these categories or to these patients. Over half (52.8%) of hospitals required a two-pharmacist check before dispensing high-risk medications (e.g., antineoplastic agents) (Table 9). Almost a third (29.9%) required a two-pharmacist check before dispensing medication to high-risk groups (e.g., pediatric patients).

For both high-risk situations, larger hospitals were more likely than smaller ones to require a two-pharmacist check before dispensing. Smaller hospitals may be limited in their ability to implement such a policy because of pharmacist staffing levels. Furthermore, some hospitals may not dispense antineoplastic agents or serve pediatric patients. In 1999, 38% of respondents reported having a two-pharmacist check for high-risk patient groups or high-risk medications.⁹ When the two questions from the 2002 survey are combined, 54.6% of hospitals required two-pharmacist checks in these situations. Therefore, the vigilance of pharmacists appears to have increased.

Automation used in total parenteral nutrition (TPN) preparation. Large-volume base compounding devices were used in an

estimated 32.1% of hospitals to support inpatient TPN preparation, with larger hospitals having implemented this technology more frequently than smaller hospitals (Table 10). However, only 12.1% of hospitals used additive compounding devices; again, larger hospitals were more likely to use this technology. In 1999, 28% of respondents reported using automation in i.v. production.⁹ When the two questions from the 2002 survey are combined, an estimated 33.0% of hospitals used automation in i.v. production.

Quality assurance in TPN preparation. Pharmacy directors were asked about quality assurance methods used for inpatient TPN preparation in their pharmacies. Types of quality assurance methods included gravimetric analysis (indirect assessment of individual additives by weight), chemical analysis (direct measurement of the final content of an individual additive), refractometric analysis (indirect measurement of the final content of an individual additive), and sterility testing (in-process or end-process testing). The most frequently used quality assurance method in TPN preparation was gravimetric analysis (26.6%), followed by sterility testing (23.0%), chemical analysis (8.4%), and refractometric analysis (6.1%). Larger hospitals were more likely to use all of these quality assurance methods than

Table 8. Policies for I.V. Admixture Recycling

Characteristic	n	%				
		Check Recycled Admixtures for Expiration and Visual Integrity	Policy Addresses Relabeling	Document Waste Rates	Conduct Quality Assurance Monthly	Do Not Recycle Admixtures
All hospitals Staffed beds	510	67.9	50.0	22.2	12.7	14.4
<50	62	53.2 ^a	21.0 ^b	9.7 ^c	11.3	38.7 ^d
50–99	69	55.1	52.2	15.9	7.3	17.4
100–199	86	75.6	58.1	26.7	16.3	3.5
200–299	92	83.7	64.1	29.4	20.7	2.2
300–399	100	81.0	64.0	34.0	6.0	3.0
≥400	101	77.2	61.4	34.7	11.9	5.9

^aUncorrected $\chi^2 = 36.01$, d.f. = 5, design-based $F(3.75, 1891.85) = 7.66$, $p < 0.0001$.
^bUncorrected $\chi^2 = 53.83$, d.f. = 5, design-based $F(3.78, 1904.88) = 11.16$, $p < 0.0001$.
^cUncorrected $\chi^2 = 23.90$, d.f. = 5, design-based $F(3.82, 1925.47) = 4.85$, $p < 0.0008$.
^dUncorrected $\chi^2 = 84.16$, d.f. = 5, design-based $F(3.69, 1862.28) = 18.75$, $p < 0.0001$.

Table 9. Use of Two-Pharmacist Check before Dispensing

Characteristic	n	%	
		High-Risk Patient Groups	High-Risk Drugs
All hospitals Staffed beds	508	29.9	52.8
<50	60	21.7 ^a	25.0 ^b
50–99	69	20.3	37.7
100–199	86	25.6	51.2
200–299	92	44.6	83.7
300–399	100	49.0	86.0
≥400	101	46.5	85.2

^aUncorrected $\chi^2 = 29.71$, d.f. = 5, design-based $F(3.83, 1922.87) = 6.06$, $p < 0.0001$.
^bUncorrected $\chi^2 = 108.64$, d.f. = 5, design-based $F(3.70, 1857.16) = 23.05$, $p < 0.0001$.

Table 10. Automation Used To Support Total Parenteral Nutrition Preparation

Characteristic	n	%	
		Large-Volume Base Compounder	Additive Compounder
All hospitals Staffed beds	496	32.1	12.1
<50	55	3.6 ^a	0 ^b
50–99	68	11.8	4.4
100–199	85	29.4	4.7
200–299	91	55.0	19.8
300–399	99	74.8	30.3
≥400	98	80.6	52.0

^aUncorrected $\chi^2 = 157.78$, d.f. = 5, design-based $F(3.78, 1853.06) = 31.34$, $p < 0.0001$.
^bUncorrected $\chi^2 = 110.83$, d.f. = 5, design-based $F(3.58, 1751.91) = 27.19$, $p < 0.0001$.

smaller hospitals, with the exception of chemical analysis. In 1999, 27% of respondents reported using end-product testing on TPN preparations.⁹ A previous survey of hospital, home care, and long-term-care phar-

macists by O’Neal et al.¹⁵ found that 43.2% of respondents complied with established guidelines by using gravimetric analysis daily to address quality assurance in TPN preparations, 7.4% used sterility testing daily, 3.5%

used chemical analysis daily, and 10.0% used refractometric analysis daily. The differences in these data can be explained by differences in samples and definitions. In the present survey, the data describe the quality assurance methods used in the hospital pharmacy, while the O’Neal et al.¹⁵ data describe the proportion of respondents who comply with guidelines published by the American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) to assess quality on a daily basis.¹⁶ Nevertheless, these data provide additional information on quality assurance activities used to assess TPN preparations. Preparing items for nutrition support is a problem-prone and high-risk activity, and good quality assurance programs, such as those noted by A.S.P.E.N., are needed to ensure patient safety, regardless of the size of the hospital.

Quality improvement for drug preparation and dispensing. Formal quality-improvement strategies are important tenets of a hospital pharmacy’s proactive work to guard against errors in drug preparation and dispensing. These strategies range from simple and seemingly obvious to very time-consuming and complex. A total of 86.1% of hospitals had a formal quality-improvement process for evaluating pharmacy dispensing errors discovered by nurses; 58.4%, for evaluating the accuracy of the phar-

macy patient medication record; 52.7%, for evaluating the accuracy of cart filling by technicians; 48.1%, for evaluating the accuracy of i.v. admixtures; 41.7%, for accounting for missing doses; 37.5%, for evaluating the sterility of i.v. admixtures; 36.1%, for measuring dispensing turnaround time; and 27.1%, for auditing doses returned in patient medication drawers (Table 11). In 1999, two thirds of respondents reported having a formal quality-improvement process for evaluating the accuracy of technician cart filling and the accuracy and sterility of i.v. admixtures, while over half of respondents reported evaluating the accuracy of the pharmacy patient medication record, accounting for missing doses, and assessing dispensing turnaround time, and nearly one third reported auditing doses returned in patient medication drawers.⁹

It appears that the proportion of hospitals initiating these quality-improvement activities has declined for all strategies. A recent report from the American Hospital Association calls attention to a “growing workforce crisis” in health care that “threatens the ability to meet community needs.”¹⁷ Perhaps the work-force shortage is affecting the ability of pharmacists to carry out these important activities. Alternatively, pharmacy directors may not see the benefit of continuing these often time-intensive activities. Whatever the explanation, it is clear that quality-improvement activities improve pharmaceutical services, patient care, and patient safety. Therefore, pharmacy departments must continue to look for opportunities to improve drug preparation and dispensing operations.

Medication delivery. Automation can be used to support inpatient drug distribution. An estimated 30.4% of hospitals used pneumatic tubes to support medication delivery. Only 2.1% of hospitals used a trackless robot. Larger hospitals used both pneumatic tubes and trackless

robots more frequently than smaller hospitals (uncorrected $\chi^2 = 157.78$, d.f. = 5, design-based $F(3.78, 1853.06) = 31.34$, $p < 0.0001$, and uncorrected $\chi^2 = 110.83$, d.f. = 5, design-based $F(3.58, 1751.91) = 27.19$, $p < 0.0001$, respectively). In 1999, 29% of respondents reported using automated transportation systems.⁹ When the two questions from the 2002 survey are combined, 31.7% of hospitals used automation to support inpatient medication delivery.

Medication cart exchanges. The mean \pm S.E. time between patient medication drawer exchanges was 28.4 ± 0.65 hours. An estimated 82.2% of hospitals exchanged carts every 24 hours, and 14.5% did so every 48 hours. The ASHP Statement on Unit Dose Drug Distribution recommends that, for most medications, not more than a 24-hour supply of doses be available in the patient care area at any time.¹⁸ Special circumstances may necessitate that cart exchanges occur less frequently than daily; however, every effort should be made to minimize the availability of a more than 24-hour supply in patient care areas.

Drug administration. Nearly all hospitals (99.7%) gave primary responsibility for drug administration to nurses. In only one hospital did primary responsibility not rest with nursing; this hospital reported joint responsibility between nursing and pharmacy. Despite the chronic and severe nursing shortage¹⁷ and evidence that supports a 10-fold decrease in medication errors with pharmacy-based drug administration programs,¹⁹ few hospitals rely on professionals other than nurses to administer medications. One strategy for increasing the value of pharmacy in an organization may be to implement a pharmacy-based drug administration program. This would relieve the pressure on nurses to conduct medication administration and focus nurses’ activities on more appropriate use of their skills and time.

Table 11. Formal Quality Improvement Process for Drug Preparation and Dispensing

Characteristic	n	%							
		Dispensing Errors Found by Nurses	Accuracy of Pt. Medication Record	Accuracy of Tech. Cart Filling	Accuracy of I.V. Admixtures	Missing-Dose Accounting	Sterility of I.V. Admixtures	Dispensing Turnaround Time	Audit of Doses Returned in Pt. Drawers
All hospitals	508	86.1	58.4	52.7	48.1	41.7	37.5	36.1	27.1
Staffed beds									
<50	63	82.5 ^a	63.5	41.3 ^b	39.7	54.0 ^c	31.8	31.8 ^d	47.6 ^e
50-99	68	76.5	64.7	50.0	48.5	39.7	33.8	30.9	29.4
100-199	86	90.7	48.8	55.8	57.1	33.7	36.1	26.7	19.8
200-299	91	94.5	57.1	64.8	57.1	45.1	49.5	47.3	22.0
300-399	99	90.9	60.6	56.6	44.4	34.3	38.4	52.5	10.1
≥400	101	87.1	58.4	57.4	52.5	38.6	46.5	55.5	11.9

^aUncorrected $\chi^2 = 16.56$, d.f. = 5, design-based $F(3.75, 1882.01) = 3.55$, $p < 0.0082$.
^bUncorrected $\chi^2 = 11.69$, d.f. = 5, design-based $F(3.79, 1902.33) = 2.45$, $p < 0.0476$.
^cUncorrected $\chi^2 = 12.25$, d.f. = 5, design-based $F(3.79, 1904.48) = 2.57$, $p < 0.0395$.
^dUncorrected $\chi^2 = 22.91$, d.f. = 5, design-based $F(3.82, 1916.82) = 4.75$, $p < 0.0010$.
^eUncorrected $\chi^2 = 40.93$, d.f. = 5, design-based $F(3.73, 1872.52) = 8.79$, $p < 0.0001$.

Pharmacist approval of medication orders. Over three fourths (79.4%) of hospitals formally required pharmacists to review and approve all medication orders before administration of the drug (Table 12). This requirement varied significantly with staffed-bed size; the larger the hospital, the larger the percentage requiring pharmacist approval. For example, only 55.9% of hospitals with fewer than 50 staffed beds required pharmacist approval of medication orders, while 92.0% of hospitals with 400 or more beds required pharmacist approval. Pharmacist review of all medication orders before administration is an important part of the checks and balances of the medication-use process.

Pharmacist review of medication orders in areas where medical procedures are performed can add value to the organization. Lesar et al.²⁰ reported 3.13 errors for each 1000 drug orders written, including 1.81 significant errors, at a university teaching hospital. Having a pharmacist routinely review drug orders has been recommended as a safe medication practice.²¹ An estimated 17.1% of hospitals had a formal policy requiring a pharmacist to review and approve medication orders before administration to a patient undergoing labor and delivery; 8.8%, to a patient in surgery; 5.6%, to a patient in the radiology department; 5.1%, to a patient in the endoscopy or catheterization laboratory; and 4.0%, to a pa-

tient in the emergency department. In 1999, 16% of respondents reported that pharmacists review medication orders in surgical and procedure areas.⁹ When the six questions from the 2002 survey are combined, 25.2% of hospitals had pharmacists review medication orders in areas where medical procedures are performed.

Safe systems for drug administration at the bedside. Bar-code technology has been recommended as a safe medication practice and can be used to improve the safety of drug administration at the bedside.^{21,22} An estimated 1.5% of hospitals used bar-code technology in the administration process to scan and verify the correct patient and the correct drug (Table 13).

Given that bar-code technology has achieved only limited penetration of hospitals, other methods can be used to improve safety in administration. Over 89% of hospitals regularly verified the patient's name by oral questioning or checking the patient's wristband before administration, as well as by regularly conducting preadministration checks of the medication order and the drug item. Over 80% required nurses to remove unit-dose packaged medication from the package immediately before administration (Table 13). These routine processes make medication administration safer in hospitals. In 1999, 77% of respondents reported that medications were removed from packages immediately before administration; 75%, that the patient's name was verified; and 47%, that preadmin-

istration order checks were made.⁹ These data suggest that the standard of practice has improved over the past three years.

Medication administration records (MARs). Nearly two thirds of hospitals used computer-generated MARs, while one third used handwritten ones (Table 14). Smaller hospitals were more likely to use handwritten MARs than larger hospitals. The estimates for handwritten MARs are similar to the findings of the 1999 survey.⁹ Handwritten MARs are unsafe because they require transcription and can be difficult to read. It is likely that the use of safer, computer-generated MARs will increase in the future as hospital information systems improve and as electronic charting of medication doses grows.

Most (over 90%) of hospitals noted the patient's allergy history on the MAR and checked the MAR against the original order (Table 15). Two thirds of hospitals noted why a dose was not given on the MAR, and more than half entered monitoring variables on the MAR and verified that doses were administered and charted on the MAR. Approximately 40% had new medication orders reviewed by pharmacy before transcription onto the MAR. Only 13% of hospitals required that the computer-generated MAR be updated only with a printed label from pharmacy, and less than 4% provided the patient with a copy of the MAR or a similar ongoing medication record. In 1999, 73% of hospitals checked the MAR against the original order.⁹

Safety of injectable medication delivery. Pharmacy directors were asked about activities that regularly occur in their hospital to increase the safety of injectable medication delivery. Overall, 82% of hospitals had educational programs on i.v. administration equipment, 71% offered educational programs on administration of and precautions for high-risk drug therapies, and 62% had educational programs on administration

Table 12.
Policy That Pharmacists Approve All Medication Orders before Drug Administration

Characteristic	n	%
All hospitals	506	79.4
Staffed beds		
<50	59	55.9 ^a
50-99	68	79.4
100-199	87	85.1
200-299	91	92.3
300-399	101	89.1
≥400	100	92.0

^aUncorrected $\chi^2 = 53.82$, d.f. = 5, design-based $F(3.72, 1859.72) = 11.61$, $p < 0.0001$.

Table 13.
Safe Systems for Drug Administration at Bedside

Characteristic	Weighted %
Bar-code technology used at bedside to verify pt. identity and correct drug (n = 505) ^a	1.5
Other methods regularly used before drug administration (n = 511)	
Pt. name verified by oral questioning or wristband	89.3
Preadministration checks of order and drug	89.2
Removal by nurse of medications from unit dose packaging immediately before administration	80.2

^aEstimates exclude federal facilities, Veterans Affairs hospitals, and specialty hospitals.

Table 14.
Types of Medication Administration Records

Characteristic	n	%	
		Computer Generated	Handwritten
All hospitals	505	64.4	35.6
Staffed beds			
<50	63	46.0 ^a	54.0
50–99	67	59.7	40.3
100–199	86	72.1	27.9
200–299	92	69.6	30.4
300–399	100	85.0	15.0
≥400	97	75.3	24.7

^aUncorrected $\chi^2 = 31.98$, d.f. = 5, design-based $F(3.76, 1874.53) = 6.79$, $p < 0.0001$.

Table 15.
Routine Tasks Associated with Medication Administration Records (MARs) (n = 509)

Task	Weighted %
Allergy history noted on MAR	96.3
MAR checked against original order	92.7
Reason for dose not given recorded on MAR	66.3
Monitoring variables entered on MAR	60.0
Verification that doses were administered and charted on MAR	56.1
New medication order reviewed by pharmacy before transcription onto MAR	43.3
MAR updated with label from pharmacy (i.e., not handwritten)	13.0
Patient provided copy of MAR or similar ongoing medication record	3.9

of i.v. push medications (Table 16). Hospitals with 400 or more staffed beds were most likely to have approved lists of i.v. push medications and educational programs on administration of and precautions for high-risk medication therapies.

Medication repackaging. An estimated 89% of hospitals repackaged oral medications (Table 17). Repackaging of oral medications varied significantly with staffed bed size; the larger the hospital, the larger the percentage repackaging oral medica-

tions. For example, only 79.4% of hospitals with fewer than 50 staffed beds repackaged oral medications, while 99.0% of hospitals with 400 or more staffed beds repackaged them. In 1999, 86% of respondents said they repackaged oral medications.⁹ Not only are more hospitals repackaging oral medications, the proportion of pharmacy-repackaged oral medications has increased in nearly 70% of hospitals over the past three years. In only 20% of hospitals did the proportion of pharmacy-repackaged oral medications remain the same, and only 10% had a decrease. The reasons given for repackaging of oral medications included less availability of products from manufacturers in unit dose form (90.1%), minimization of dose manipulation at the bedside (50.3%), the cost advantage of buying in bulk and repackaging (25.0%), utilization of automated cart-fill or dispensing technologies (23.7%), and utilization of bar-code technology at the point of drug administration (4.5%).

A total of 29% of hospitals repackaged injectable medications (Table 17). As with oral medications, repackaging of injectable medications varied significantly with staffed bed size; larger hospitals were more likely to repackaging injectable medications. In 1999, 40% of respondents reported repackaging injectable medications.⁹ Thus, fewer hospitals are repackaging injectable medications than three years ago; furthermore, the proportion of pharmacy-repackaged injectable medications has remained the same in 64% of hospitals over the past three years. In only 28% of hospitals did the proportion of pharmacy-repackaged injectable medications increase, and only 8% had a decrease. The reasons given for repackaging of injectable medications included minimization of dose manipulation at the bedside (75.4%), less availability of products from manufacturers in unit dose form (58.8%), the cost advantage of

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buying in bulk and repackaging (29.3%), utilization of automated cart-fill or dispensing technologies (16.0%), and utilization of bar-code technology at the point of drug administration (4.8%).

Hospital directors reported what was most likely to happen when medications became unavailable from manufacturers in unit dose packaging. Over three fourths (78.5%) of hospitals repackaged bulk items in unit dose packaging. Conversely, 21.5% of hospitals used “note strength” labels and required nurses to manipulate the dose before administration. The use of note strength labels varied significantly with hospital bed size, with smaller

hospitals using them more frequently. Whenever nurses must manipulate a dose, an additional opportunity for error arises. Smaller hospitals must work to keep the use of note strength labels to a minimum.

ASHP has published recommended standards for repackaging operations.²³ Eighty-two percent of hospitals repackaged only one drug product at a time in the work area, 90.1% performed a double-check to verify that the packaging system was set up correctly and procedures were performed properly, and 95.0% kept control records for all packaging runs. Keeping control records for all repackaging runs varied significantly with staffed bed size; the larger the

hospital, the larger the percentage maintaining control records. For example, 87.8% of hospitals with fewer than 50 staffed beds kept records for all runs, while 99.0% of hospitals with 300 or more staffed beds kept records. ASHP lists 11 types of information that should be kept in control records.²³ Nearly all hospitals kept the product manufacturer’s or supplier’s control or lot number (98.0%), the date units were packaged (96.0%), the initials of the operator and the checker (if any) (96.0%), a complete product description (name, strength, dosage form, route, etc.) (95.6%), the product’s manufacturer or supplier (92.0%), the number of units packaged (91.6%), and the expiration date of the original container (90.5%). Less frequent types of information kept in the control records included the beyond-use dates of repackaged products (78%), the pharmacy’s control number (if different from the manufacturer’s) (71%), a sample of the label and a sample of the finished package (where feasible) (39%), and descriptions and lot numbers of packaging materials used (27%). Only 12.5% of hospitals kept all 11 types of information recommended by ASHP.

Outsourcing. An estimated 10.2% of hospitals outsourced all pharmacy operations to a contract pharmacy services provider (Table 18). The smaller

Table 16.
Activities Regularly Used To Increase Safety of Injectable Medication Delivery (n = 504)

Task	Weighted %
Educational programs on i.v. administration equipment	81.9
Educational programs on administration of and precautions for high-risk drug therapies	70.7
Educational programs on administration of i.v. push medications	61.6
Approved list of i.v. push medications	56.6
Supplemental labels for i.v. push medications	53.3

Table 17.
Repackaging of Oral and Injectable Medications

Characteristic	n	%			
		Hospitals That Repackage Oral Medications	Hospitals That Repackage Injectable Medications	Repackage Bulk Items in Unit Dose Packaging	Use “Note Strength” Labels and Require Nurses To Manipulate Dose
All hospitals	510	89.0	29.2	78.5	21.5
Staffed beds					
<50	63	79.4 ^a	14.3 ^b	63.9 ^c	36.1
50–99	69	88.4	15.9	82.4	17.6
100–199	85	89.4	29.1	73.3	26.7
200–299	92	95.7	48.9	89.9	10.1
300–399	100	95.0	49.0	91.7	8.3
≥400	101	99.0	51.5	93.9	6.1

^aUncorrected $\chi^2 = 20.60$, d.f. = 5, design-based $F(3.66, 1844.96) = 4.54$, $p < 0.0017$.

^bUncorrected $\chi^2 = 53.42$, d.f. = 5, design-based $F(3.83, 1935.39) = 10.88$, $p < 0.0001$.

^cUncorrected $\chi^2 = 32.73$, d.f. = 5, design-based $F(3.69, 1817.60) = 7.14$, $p < 0.0001$.

Table 18.

Outsourcing of All Pharmacy Operations

Characteristic	n	%
All hospitals	513	10.2
Staffed beds		
<50	63	19.1 ^a
50–99	69	17.4
100–199	87	4.6
200–299	92	2.2
300–399	101	6.9
≥400	101	2.0

^aUncorrected $\chi^2 = 29.41$, d.f. = 5, design-based $F(3.69, 1869.40) = 6.49$, $p < 0.0001$.

Table 19.

Outsourcing of Drug Preparation and Returns (n = 513)

Activity Outsourced	n	Weighted %
Any preparation activity	137	21.0
Specific preparation activities ^a		
Total parenteral nutrient solutions	62	52.4
Patient-controlled analgesia and epidural analgesia preparations	24	16.7
I.V. admixtures and small-volume i.v. solutions	23	15.7
Unit dose repackaging (drug only)	21	12.1
Flushes	17	9.1
Unit dose repackaging (bar coding)	22	8.9
Returns and credit activities	469	92.2

^aBase: hospital pharmacies that outsource any preparation activity.

the hospital, the larger the percentage that outsourced all pharmacy operations. Only 2.0% of hospitals with 400 or more staffed beds outsourced all pharmacy operations, versus 19.1% of hospitals with fewer than 50 staffed beds. This survey is the first to estimate the extent of outsourcing of all pharmacy operations to a contract pharmacy services provider.

Approximately 21% of hospitals partially or completely outsourced preparation activities (Table 19). Larger hospitals were more likely than smaller ones to outsource some part of preparation activities (uncorrected $\chi^2 = 33.64$, d.f. = 5, design-based $F(3.86, 1959.35) = 6.85$, $p < 0.0001$). For example, 46.5% of hospitals with 400 or more staffed beds outsourced some part of preparation activities, while 15.9% of hospitals with fewer than 50 staffed beds did so. Of hospitals that outsourced some part of preparation activities, slightly more than half outsourced

TPN preparation. Only hospitals with 300 or more beds outsourced unit dose repackaging for bar coding. More than 92% of hospitals outsourced return and credit activities.

Pharmacy operations. Tables 20 and 21 show results for several measures of annual pharmacy activity levels.

Operating expenses. Prior-year inpatient pharmacy acquisition costs of pharmaceuticals, including drug products derived from blood and diagnostic agents but excluding i.v. fluids and sets, varied significantly with hospital size (Table 20). The larger the hospital, the higher the expenditure. However, the cost of inpatient pharmaceuticals per patient-day did not vary with hospital size, and the average cost was \$102.

Staffing. The number of full-time-equivalent (FTE) pharmacists (i.e., pharmacists working 40 hours per week) averaged about 9 and varied significantly with hospital size (Table

21). The larger the hospital, the greater the number of FTE pharmacists. The number of FTE technicians averaged about 8 and also varied significantly with hospital size. In 2001, the number of FTE pharmacists and the number of FTE technicians for all hospitals averaged 9.4 and 8.3, respectively.¹ These data suggest a decline of 8.5% in pharmacist staffing and stable technician staffing.

There were 10.4 and 10.0 FTE pharmacists and FTE technicians, respectively, per 100 occupied beds (average daily census) across all hospitals (Table 21). Larger hospitals had fewer FTE pharmacists and technicians per 100 occupied beds than smaller hospitals.

Overall, 10.2% of hospitals had some portion of an FTE pharmacist's time devoted to medication safety officer or coordinator responsibilities. A medication safety officer was defined as "an individual whose job it is to ensure that the medication-use system is designed to prevent accidental harm to patients. The individual seeks to implement best practices related to measuring, monitoring, and continually improving the performance of the medication-use system." When hospitals with 400 or more staffed beds were compared against those with fewer than 400 beds, there was a significant difference in the percentage having some portion of an FTE pharmacist's time devoted to a medication safety office position (uncorrected $\chi^2 = 14.00$, d.f. = 1, design-based $F(1, 497) = 25.52$, $p < 0.0001$). For example, 8.6% of hospitals with fewer than 400 staffed beds had some portion of an FTE pharmacist's time devoted to a medication safety officer position, versus 26.3% of hospitals with 400 beds or more.

An estimated 7.3% of FTE pharmacist positions were vacant nationally (Table 21). In a 2000 survey of hospital pharmacy directors and managers, ASHP found a national vacancy rate of 8.9% for FTE pharmacist positions.²⁴ In 2002, ASHP

Table 20.
Inpatient Pharmacy Total Acquisition Cost of Pharmaceuticals in Prior Fiscal Year^a

Characteristic	Total Inpatient Pharmacy Acquisition Cost of Pharmaceuticals		Cost of Inpatient Pharmaceuticals per Patient-Day	
	<i>n</i>	Mean ± S.E. Cost (\$)	<i>n</i>	Mean ± S.E. Cost (\$)
All hospitals	446	3,848,311 ± 140,959	441	102.49 ± 1.65
Staffed beds				
<50	43	534,481 ± 86,884 ^b	40	110.23 ± 3.48
50–99	57	1,097,284 ± 132,286	56	101.13 ± 3.43
100–199	73	2,609,098 ± 227,646	73	103.14 ± 4.34
200–299	87	4,838,707 ± 327,464	86	96.50 ± 3.42
300–399	91	7,343,394 ± 341,096	91	96.08 ± 2.36
≥400	95	14,408,372 ± 1,068,900	95	104.43 ± 3.65

^aDefined as total acquisition cost (i.e., total purchases) for all pharmaceuticals, including drug products derived from blood and diagnostic agents but excluding i.v. fluids and i.v. sets.

^bDesign-based $F(1, 440) = 301.44, p < 0.0001$.

found a national vacancy rate of 6.9%.²⁵ The consistent estimates suggest that approximately 7% of pharmacist positions were unfilled nationally in 2002.

The number of vacant FTE hospital pharmacist positions can be calculated from these data. Given the number of FTE pharmacist positions reported, the data project a mean ± S.E. of 41,058 ± 1,279 FTE hospital pharmacist positions nationally in 2002 (95% confidence interval, 38,546–43,571). Therefore, we estimate 3,000 vacancies for FTE pharmacist positions in hospitals in 2002.

The ratio of pharmacists to technicians was similar across hospital sizes (range, 0.88–1.08). In 1999, this ratio ranged from 1.02 to 1.19.⁹ The decline in the pharmacist-to-technician ratio, coupled with the decline in pharmacist staffing, suggests that the pharmacist shortage may be leading to better use of technicians. While technology (such as robotic distribution, computerized prescriber order entry, medication distribution cabinets, and automated compounding devices) can replace personnel, the consistency of the pharmacist-to-technician ratio across hospital size categories suggests that technology adoption may not be a good predictor of the ratio. Furthermore, given the current shortage of pharmacists and the difficulty many

pharmacy directors face in filling pharmacist positions, it seems prudent to further consider increasing the hiring of qualified pharmacy technicians.

These figures may provide some information for pharmacy managers on key benchmarks. However, caution should be exercised in interpreting the figures. Not all hospitals and health systems are the same. While these figures provide averages, each hospital and health system offers unique products and services that are likely to present key challenges to these benchmarks.

Ambulatory care patient groups served by inpatient pharmacy. Table 22 reports the types of services provided to ambulatory care patients under the direction and management of the inpatient pharmacy department. The table also reports the percentage of hospitals offering dispensing services only, clinical services only, or a combination of dispensing and clinical services. A majority of hospitals provided services to emergency-room patients. Less than half of hospitals provided services to clinic patients, patients being discharged, and hospital employees. About a third of respondents reported that nursing-home or long-term-care patients were served by the inpatient pharmacy, and home care or home infusion patients and adult daycare patients were served by less

than one sixth of inpatient pharmacy departments. Both dispensing and clinical services were most typically provided to all patient groups, with the exception of emergency-room patients, who most frequently received only dispensing services.

Summary and conclusion

The purpose of these ASHP surveys is to determine the extent to which safe medication practices are in place in hospitals and how pharmacists are contributing to medication-use safety. When possible, this is assessed by asking survey participants if they follow evidence-based best practices or published professional standards of practice. It is important to audit these practices periodically because of changes in health care, including increases in workload and acuity, rising pressure to reduce health care costs, work force shortages in nursing and pharmacy, and growing demands to improve quality and safety. The increase in hours of service found in 2002 compared with 2001 suggests that pharmacists are responding to increases in acuity and concerns about quality and safety. But the vacancy rate for pharmacist positions found in this survey suggests that pharmacists are busier and may paradoxically be less able to ensure the very safety that they are trying to provide.

Table 21. Pharmacy Staffing in Prior Fiscal Year

Characteristic	n	FTE ^a Pharmacists		FTE Pharmacists per 100 Occupied Beds		% Vacant FTE Pharmacist Positions		FTE Pharmacy Technicians		FTE Technicians per 100 Occupied Beds	
		Mean ± S.E.	95% CI ^b	Mean ± S.E.	95% CI	Mean ± S.E.	95% CI	Mean ± S.E.	95% CI	Mean ± S.E.	95% CI
All hospitals	503	8.6 ± 0.26	8.0–9.1	10.40 ± 0.54	7.3 ± 0.7	8.4 ± 0.28	7.9–9.0	10.00 ± 0.61			
Staffed beds											
<50	62	1.6 ± 0.21 ^c	1.2–2.0	13.42 ± 1.76 ^d	3.1 ± 1.2	1.6 ± 0.29 ^e	1.0–2.2	11.66 ± 1.80 ^f			
50–99	67	3.0 ± 0.23	2.6–3.5	12.03 ± 1.62	10.0 ± 2.5	2.8 ± 0.22	2.3–3.2	10.55 ± 1.31			
100–199	85	6.0 ± 0.35	5.3–6.7	8.30 ± 0.51	8.2 ± 1.5	6.8 ± 0.58	5.7–8.0	10.19 ± 1.47			
200–299	91	12.7 ± 0.76	11.2–14.2	9.53 ± 0.87	9.2 ± 1.1	11.8 ± 0.68	10.5–13.2	8.68 ± 0.68			
300–399	99	17.1 ± 0.76	15.6–18.6	8.27 ± 0.34	8.0 ± 0.7	17.4 ± 0.84	15.7–19.0	8.36 ± 0.36			
≥400	99	32.8 ± 2.25	28.4–37.2	8.73 ± 0.40	6.0 ± 0.5	30.9 ± 2.18	26.7–35.2	8.33 ± 0.43			

^aFTE = full-time-equivalent.

^bCI = confidence interval.

^cDesign-based F(1, 497) = 377.68, p < 0.0001.

^dDesign-based F(1, 490) = 9.76, p < 0.0019.

^eDesign-based F(1, 497) = 358.65, p < 0.0001.

^fDesign-based F(1, 480) = 5.68, p < 0.0176.

It might be expected, therefore, that pharmacists would take shortcuts through some of the labor-intensive systems that have been shown to improve patient safety. These evidence-based best practices include unit dose drug distribution systems and i.v. admixture systems. However, most hospitals reported having these safety systems in place. But change is in the wind. That more than 40% of respondents reported an intent to create a more decentralized drug distribution system suggests that the centralized unit dose and distribution systems that are the standard for patient safety may no longer be responsive to the needs of acutely ill patients with a shorter length of stay and drug therapy that changes too often for a 24-hour cycle. Pharmacists have improved the linking of point-of-care dispensing systems to the pharmacy system and are purchasing more ready-to-use products, but vigilance will be needed to avoid returning to the floor-stock systems that were shown to be unsafe 40 years ago.

Areas for improvement suggested by this survey include increased reliance on technicians and technology to optimize the use of scarce and expensive pharmacist time. Specific technologies that are underutilized include pharmacy-linked point-of-care dispensing cabinets, computer-generated MARs, and bar-code-based bedside drug administration documentation systems. Pharmacists may need to spend more time ensuring the availability of ready-to-administer medications for nurses and maintaining quality assurance programs when they do extemporaneously prepare these doses.

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■ **REPORTS** **Dispensing and administration**

Table 22.
Ambulatory Care Patient Groups Served by Inpatient Pharmacy

Ambulatory Care Patient Group	n	Provide Service to Patient Group	%		
			Dispensing	Clinical	Both
Home care patients	502	17.3	20.6	22.8	56.5
Emergency-room patients	505	81.6	47.9	7.0	45.2
Patients being discharged	508	41.9	22.9	37.0	40.1
Hospital or health-system employees	509	40.9	34.4	7.3	58.3
Clinic patients	504	47.5	27.8	16.4	55.8
Adult daycare patients	502	9.4	29.7	15.1	55.2
Nursing-home or long-term-care patients	503	32.3	15.8	11.0	73.2

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