

Evaluation of the automated dispensing cabinets users' level of satisfaction and the influencing factors in Al-Ahsa hospitals

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Abstract

Automated dispensing cabinets (ADCs) are decentralized, computer-controlled systems used to store, distribute, and track medications at the point of care in the wards.

Objective: The objective of the current study is to evaluate how healthcare practitioners are satisfied with ADCs and scrutinize some influencing factors that could affect this satisfaction.

Material: A cross-sectional survey study was designed and distributed online to healthcare providers in Al-hasa hospitals.

Results: A total of 166 participants. Regarding the frequency and pattern of ADC use, around 79.5% used ADC and 85.4% were informed about using ADC on a daily basis. As for the level of satisfaction with ADC, an exact 81.9% gave a high rate for overall satisfaction, 81.3% were highly satisfied with the system's accuracy, and 74.7% were highly satisfied with the time it takes to complete the task. Regarding usability of the system, 69.8% thought it was easy whereas 36.8% agreed that the time required for reloading medication is longer than before ADC. Furthermore, 79.5% agreed that ADC allowed them to accomplish their job safely, and 67.4% agreed that it improved their productivity. Regarding challenges, 74.7% agreed that all drawer types assure safe access and removal of medications, and 18.7% agreed that there is a significant potential for loss of data.

Conclusion: This study investigated healthcare staff's perceptions and satisfaction with ADCs in Al-hasa hospitals. The healthcare participants were mostly highly satisfied with the use of the ADCs which translated into better patient care and improved patient safety as well as higher productivity.

Keywords

Automated dispensing cabinets, patient safety, healthcare practitioners, satisfaction

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Introduction

Using medication in a hospital requires a multistep procedure that includes prescription, transcription and documentation, dispensing, administering, and monitoring. Through these steps, the medication gets from the pharmacy to the patient during which medication must be carefully managed at all stages.¹ As per the American Pharmacists Association, Medication Therapy Management refers to a

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particular service or cluster of services that optimize therapeutic outcomes for individual patients. Achieving specific therapeutic outcomes that enhance a patient's quality of life while lowering risk is the aim of medication therapy.² In recent years, healthcare organizations have had to take the possibility that patients may suffer harm as a result of medical treatment. Medication-related adverse events appear to be one of the primary causes of this harm.³ An adverse drug event (ADE) is any harm subsequent to a medical intervention involving a drug.⁴ ADEs can be further classified as nonpreventable (npADEs) and preventable (pADEs). Nonpreventable ADEs (npADEs) are stated as unintentional and harmful reactions to a drug following appropriate use whereas preventable (pADEs), are defined as harm to the patient resulting from mistakes or errors made during the drug treatment process.⁵ Medication errors are the third biggest cause of death in the United States.⁶ Medication errors can have a significant financial impact on the healthcare industry in addition to eroding people's confidence in doctors and the healthcare system.⁷ Therefore, focus on scrutinizing the root causes of ADEs at the prescribing phase, and the development and testing of interventions is imperative to minimize harm from medications. Medication errors can have many different causes, but the most common one is human error.^{8,9} The Institute of Medicine's report "To Err Is Human" highlighted the problem of medical errors and sparked a debate about how best to reduce them.¹⁰

In KSA, a prospective cohort study was performed to define the incidence of ADEs and evaluate their severity and preventability in four Saudi hospitals. The study concluded that ADEs were most common in ICUs (60.8%) followed by medical (27.3%) and surgical (11.8%) units causing significant morbidity and mortality.¹¹ Another study executed in Saudi Arabia revealed that the primary causes of medication errors were lack of policies (14.3%), inexperienced workers (22.7%), workload (31.6%), and illegible prescriptions (12.7%). Additionally, the study indicated that miscommunication (19.04%) and a lack of education (67.47%) were the leading causes of drug errors, with miscommunication overlook and sound alike coming in second (7.54%).¹² Moreover, the hospital pharmacy's dispensing process is a potential source of preventable human error.¹³ The total incidence of MEs in Saudi Arabia hospitals was estimated at 44.4%. Prescribing errors, dispensing errors, and administration error incidents represent 40.2%, 28.2%, and 34.5% out of the total number of reported MEs, respectively as a metaanalysis revealed.¹⁴ It is unrealistic to expect humans to perform flawlessly every time.¹⁴ A system that is dependent on human performance is more prone to errors than one that is built with a stronger emphasis on carefully thought-out procedures and regulations.¹⁵ As a critical component of patient safety in healthcare delivery, various pharmaceutical safety techniques have been developed to solve this issue. The strategies function by providing ways

that minimize prescription errors and negative side effects.¹⁶ Pharmacy automation refers to the computerized process of distributing, classifying, packing, and counting prescription medications.¹⁷ There are a lot more easily accessible automation systems nowadays, and one of them is the automated dispensing system (ADS).¹⁸ ADS will enable hospitals to store and dispense drugs close to the point of use with a computer-controlled and monitored system.¹⁹ ADS is applied for sustaining medication safety, enhancing drug distribution, decreasing medication error risk, providing 24-h exchange service, refining control over narcotics and other medications and tracking and proactively monitoring the drug use process.^{19,20} Automated dispensing cabinets (ADCs) are an example of ADS.²¹ ADCs are defined as decentralized, computer-controlled systems used to stock, allocate, and track medications at the point of care in the wards. ADCs provide a way to control the inventory.¹

The motivation behind this research originates from the increasing adoption of ADCs in healthcare settings, including Al-Ahsa hospitals. While ADCs offer potential benefits such as improved medication distribution and inventory management, their successful implementation relies heavily on user satisfaction. By evaluating users' levels of satisfaction with ADCs and identifying the influencing factors, this study aims to contribute valuable insights into enhancing the usability and effectiveness of ADCs in Al-Ahsa hospitals. Eventually, the findings of this research have the potential to inform decision-making processes and improve medication management practices, ultimately leading to better patient care outcomes.

Materials and methods

Ethical considerations

This study was approved by IRB in Almosa Specialist Hospitals (ARC-23.02.03). All healthcare providers read the aim of the study before participating, and that they were not obliged to contribute. No formal consent form was used, but a returned questionnaire was considered to be implied consent to participate.

Study design and area

A cross-sectional study was designed and distributed online to healthcare providers who use ADC including pharmacists, pharmacy technicians, nurses, and others in Al-hasa hospitals especially from Almosa Specialist Hospitals and National Guard Hospital.

Study subjects

All pharmacists, pharmacy technicians, nurses, and healthcare providers who use ADC in Al-hasa hospitals were included. No exclusion criteria.

Study tool

A previously validated and published questionnaire was utilized with minor modifications.²² The questionnaire consisted of four major sections. The first section included questions about the participants' demographic and professional characteristics including age, gender, title, qualification, years of work, the rate of their computer skills. The second part was about the frequency and pattern of ADC use among study participants. The third section included questions about the level of satisfaction using ADC. The last section of the questionnaire was about the factors that influence the level of satisfaction with ADC including usability of the system, perceived benefits, challenges, and training quality, and finally how ADC affected their occupation.

Data analysis

The data were collected, reviewed and then fed to Statistical Package for Social Sciences Version 21 (SPSS: An IBM Company). All statistical methods used were two-tailed with an alpha level of 0.05 considering significance if the *p*-value was less than or equal to .05. The overall satisfaction level regarding ADC was assessed by summing up discrete scores for different satisfaction items. Healthcare workers with an average satisfaction score of less than 4 were considered to have poor satisfaction levels but others with an average score of 4–5 were considered with high satisfaction. Descriptive analysis was done by prescribing frequency distribution and percentage for study variables including participants' personal data, experience years, and titles. Also, the frequency and pattern of ADC use were tabulated. Participants' satisfaction and factors affecting satisfaction were tabulated and the overall satisfaction level was graphed. Cross tabulation for showing the distribution of participants' satisfaction levels by their associated factors was carried out with Pearson chi-square test for significance and exact probability test if there were small frequency distributions.

Results

Demographic characteristics of healthcare participants

A total of 166 participants completed the study questionnaire. Participants' ages ranged from 20 to 48 years with a mean age of 31.8 ± 5.4 years. Exact of 119 participants were females, 130 (78.3%) were non-Saudi. As for the title, the vast majority (80.1%; 133) were nurses and 21 (12.7%) were pharmacists. Considering qualification, 145 (87.3%) had bachelor of science degree and 12 (7.2%) had diploma. A total of 91 (54.8%) worked in their current hospital for 1–5 years, 34 (20.5%) worked for 5–10 years and 16 (9.6%) for more than 10 years but 25 (15.1%) worked for less than 1 year. Of 105 (63.3%) rated their computer skills as good and 36 (21.7%) as excellent but only two had poor skills (Table 1).

Table 1. Personal characteristics of healthcare participants, Saudi Arabia (*n* = 166).

Demographic data	No	%
Age in years		
<30	67	40.4
30–39	78	47.0
40+	21	12.7
Gender		
Male	47	28.3
Female	119	71.7
Nationality		
Saudi	36	21.7
Non-Saudi	130	78.3
Title		
Nurse	133	80.1
Pharmacists	21	12.7
Pharmacy technician	4	2.4
Anesthesia technician	3	1.8
Physician	2	1.2
Midwife	1	0.6
Respiratory therapist	1	0.6
Anesthesia consultant	1	0.6
Qualification		
Bachelor of science degree	145	87.3
Diploma	12	7.2
Master of science degree	9	5.4
Years of work in your current hospital		
<1 year	25	15.1
1–5 years	91	54.8
5–10 years	34	20.5

(continued)

Table 1. Continued.

Demographic data	No	%
>10 years	16	9.6
How would you rate your computer skills?		
Poor	2	1.2
Moderate	23	13.9
Good	105	63.3
Excellent	36	21.7

Frequency and pattern of ADC use among healthcare participants

Table 2 illustrates the frequency and pattern of ADC use among the study participants. A total of 132 (79.5%) of the study participants used an ADC, and 112 (84.8%) of them used in Al-hasa hospitals only. Among users, 130 (98.5%) use the ADC in their current hospital which was for 1–12 months among 66 (50.8%), for one to five years among 50 (38.5%), and for more than five years among 14 (10.8%). Around 111 (85.4%) reported using ADC on a daily basis. The ADC was not installed in the ward where I work and the use of the ADC is restricted to a few employees were the two causes among nonusers.

Level of satisfaction about ADC among the healthcare participants

Table 3 elucidates the level of satisfaction about ADC among the study healthcare providers. Exact 75.3% gave a high rate for overall satisfaction with the ADC, 81.3% were highly satisfied with the system's accuracy, and 74.7% were highly satisfied with the time it takes to complete the task with such an ADS.

Factors influence level of satisfaction about ADC among the healthcare participants

Factors that influence the level of satisfaction about ADC among study healthcare providers were summarized in Table 4. Regarding usability of the system, 69.8% thought it was easy from logging in to actually using the system in ADC, 36.8% agreed that the time required for reloading or dispensing medication is longer than it was prior to the installation of an ADC, and only 17.5% became confused when they use the ADC. With regard to perceived benefits, 79.5% agreed that ADC allowed them to accomplish their job safely, and 67.4% agreed

Table 2. Frequency and pattern of automated dispensing cabinet used among the healthcare participants.

ADC use	No	%
Have you ever used an automated dispensing cabinet?		
Yes	132	79.5
No	34	20.5
If yes, where did you use the automated dispensing cabinet? (n = 132)		
Al-hasa hospitals and other hospitals	7	5.3
Al-hasa hospitals only	112	84.8
Other hospitals but not Al-hasa hospitals	13	9.8
Do you use the automated dispensing cabinet in your current hospital? (n = 132)		
Yes	130	98.5
No	2	1.5
If yes, for how long have you been using the automated dispensing cabinet in your current hospital? (n = 130)		
1–12 months	66	50.8
1–5 years	50	38.5
>5 years	14	10.8
If no, reasons for not using the automated dispensing cabinet (n = 2)		
The automated dispensing cabinet was not installed in the ward where I work.	1	50.0
Use of the automated dispensing cabinet is restricted to a few employees.	1	50.0
Frequency of using an automated dispensing cabinet (n = 130)		
Daily	111	85.4
Weekly	8	6.2
Less than weekly	11	8.5

that using ADC improved their productivity. About challenges, 74.7% established that all drawer types assure safe access and elimination of medications, and 57.8% reported that amount of time between when a written

Table 3. Level of satisfaction about automated dispensing cabinet among healthcare participants.

Satisfaction	Very dissatisfied		Dissatisfied		Neutral		Satisfied		Very satisfied	
	No	%	No	%	No	%	No	%	No	%
How would you rate your overall satisfaction with the automated dispensing system?	4	2.4	1	.6	36	21.6	72	43.37	53	31.9
How satisfied are you with the automated dispensing system's accuracy?	5	3.0	4	2.4	22	13.3	67	40.4	68	41.0
How satisfied are you with the time it takes to complete the task with an automated dispensing system?	6	3.6	4	2.4	32	19.3	68	41.0	56	33.7

order is sent to the pharmacy and when it is available from the ADC is adequate. Additionally, only 18.7% of the participants agreed that there is a substantial prospective for loss of data with ADC, and 18.7% there is a noteworthy potential failure to use ADC. Considering training quality, 77% agreed that the training provided about ADC use (entering the system, reloading, etc.) was complete and adequate, and 80.7% can use it confidently after training.

Overall satisfaction level about ADC among the healthcare participants

A total of 125 (75.3%) were highly satisfied with ADC and only 41 (24.7%) showed low satisfaction levels as illustrated in Figure 1. Regarding the effect of ADC on work among healthcare providers, around 83.1% of ADC users stated that it made their work easier, 8.4% told it time-consuming and more difficult but 6.9% had a neutral opinion (Figure 2).

Distribution of healthcare participants' satisfaction level by their associated factors

Table 5 shows the distribution of participants' satisfaction levels by their associated factors. A total of 79.5% of those who ever used an ADC were highly satisfied with it versus 58.8% of others who did not use it with verified statistical significance ($p = .012$). Similarly, 82.9% of daily users were satisfied with the method compared to 54.5% of others with less use rate ($p = .047$). Other factors showed insignificant association with healthcare providers' satisfaction level.

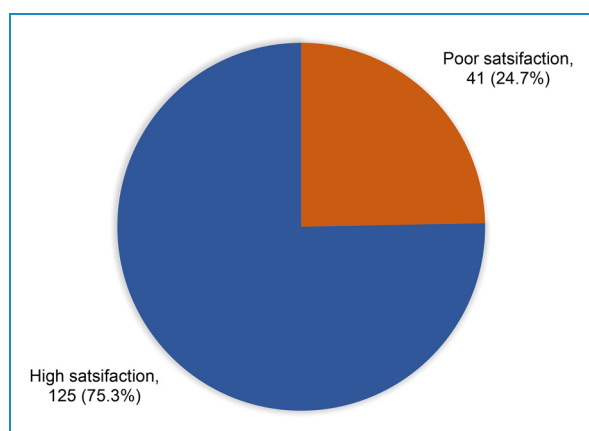
Discussion

The Ministry of Health in KSA is executing an effective transformation in the healthcare system to advance a superior health system which allies with the Saudi Vision of 2030.²³ One of the healthcare objectives is to expand the excellence and consistency of services and the performance and accountability of healthcare organizations and staff to deliver care that is safe, effective, patient-centered, timely and equitable. One of the tools to address such a goal is the use of an Automated drug dispensing system as an example of pharmacy automation, which is a technology that positively impacts drug dispensing efficiency and deterring medication errors.²⁴ Pharmacists' responsibilities to expand the dissemination scheme and expand the competence have been helped by technology. For example, ADCs and other similar devices are utilized progressively more in healthcare organizations. In a study performed in Jeddah in 2019 revealed that only 28.6% of all Jeddah hospitals and 20.7% Riyadh hospitals in 2012²⁵ used ADCs which is

Table 4. Factors influencing the level of satisfaction about automated dispensing cabinet among the healthcare participants.

Satisfaction	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	No	%	No	%	No	%	No	%	No	%
Usability of the system										
From logging in to actually using the system in ADC, I thought it was easy.	13	7.8	7	4.2	30	18.1	54	32.5	62	37.3
I do become confused when I use the ADC.	76	45.8	33	19.9	28	16.9	21	12.7	8	4.8
The time required for reloading or dispensing medication is longer than it was prior to the installation of an ADC.	40	24.1	24	14.5	41	24.7	37	22.3	24	14.5
Perceived benefits										
Using an ADC improves my productivity.	13	7.8	2	1.2	39	23.5	56	33.7	56	33.7
The ADC allows me to do my job safely.	13	7.8	1	0.6	20	12.0	48	28.9	84	50.6
Challenges										
There is a significant potential for loss of data with ADC.	50	30.1	25	15.1	60	36.1	23	13.9	8	4.8
There is a significant risk of potential failure to use ADC.	44	26.5	20	12.0	71	42.8	25	15.1	6	3.6
The amount of time between when a written order is sent to the pharmacy and when it is available from the ADC is acceptable.	15	9.0	11	6.6	44	26.5	47	28.3	49	29.5
All drawers' types assure safe access and removal of medications.	11	6.6	5	3.0	26	15.7	49	29.5	75	45.2
Training quality										
The kind of training provided to me about ADC use (entering the system, reloading, etc.) was complete and adequate	12	7.3	4	2.4	22	13.3	47	28.5	80	48.5
I can use the ADC confidently after training.	13	7.8	2	1.2	17	10.2	39	23.5	95	57.2

ADC: automated dispensing cabinet.

**Figure 1.** Overall satisfaction level about automated dispensing cabinet among the healthcare participants.

inferior to the rate in the United States (70.2%).²⁶ In another study conducted across the Gulf Cooperation Councils (GCC) countries' hospitals, about 37.5% of hospitals only used ADCs in their patient care areas²⁷ specifying that the use of technological solutions for distributing medication in GCC countries' hospitals as a whole and in KSA specifically is still in its initial phases. Furthermore, during COVID-19 pandemic, the Department of Pharmaceutical Care initiated a departmental crisis preparedness plan, as a part of the general hospital preparedness plan which included expanding the use of automation in handling inpatient pharmacy services at King Abdulaziz Medical City in Jeddah.²⁸

This study was conducted in hospitals that use ADCs to explore the healthcare professionals' perceptions and satisfaction with the use of the ADC system in Al-Hasa

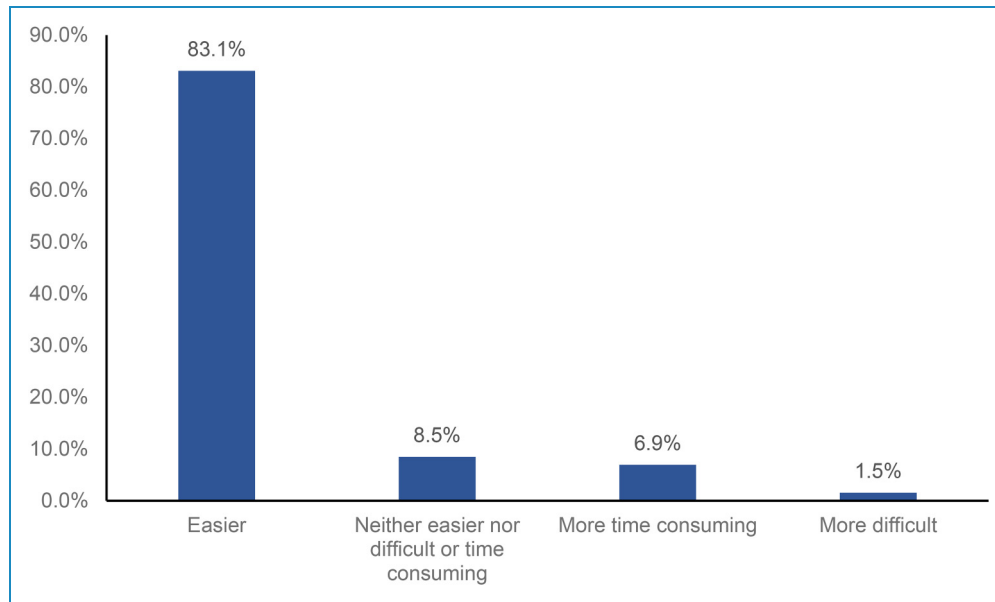


Figure 2. Effect of automated dispensing cabinet on work among the healthcare participants.

hospitals. It is imperative to enhance working situations for healthcare professional, as this will improve their satisfaction with their work. The results disclosed that almost all of the participant used or are using ADC in their current hospital daily. The majority of the participants expressed a high rate of overall satisfaction with the ADC specifically the accuracy, and the time it takes to complete the task. Another factor influencing the level of satisfaction with ADC was the usability of the system as most of the participants thought it was easy to use the system. Similarly, an earlier study undertaken at King Faisal Specialist Hospital emphasized the usefulness, ease of usage, and apparent efficacy of expanding the control system, and training of the new technology staff had shown positive effects on augmenting nursing staff's attitudes toward using these newly installed automated machines.²⁹

The outcomes of the study exposed that healthcare professionals were satisfied with the technology use and understood that it simplifies their work, adds to safer healthcare and reduces medication errors and "near misses." In accordance with a study performed in Saudi Aramco Medical Services Organization, one of the Middle East's first institutions to start the automated drug dispensing systems (ADDSS). They reported amplified medication allocating efficiency, supported cost control, lessened the frequency of adverse events related to medications, and improved throughput of the health workforce as a result of ADDSS.³⁰ Likewise, another study found that the frequency of controlled and uncontrolled medications has declined substantially.³¹ With regard to perceived benefits, most participants agreed

that ADC permitted them to accomplish their jobs safely, thus improving productivity.

About challenges the participants face while using the ADC, three-fourth of them established that all drawers' types assure safe access and deletion of medications, and almost half reported the amount of time between when a written order is sent to the pharmacy and when it is available from the ADC is acceptable. Few participants, less than 20%, expressed a challenge which is the significant potential for loss of data, and the failure to use ADC. Considering training quality, two-third of the participants agreed that the training provided about ADC use was adequate, and currently can use the ADC confidently after training. In harmony with our results, an earlier study was executed to recognize the disputes related to maintaining the ADCs in National Guard Health Affairs hospitals in Riyadh from the pharmacy technicians' perspective and to propose some solutions to overcome these problems that complicate the usability of the ADCs.³²

In the existing study, the overall satisfaction level with ADC among the majority of the participants was highly satisfied and stated that it made their work easier.

In the current age of technological advances, automated dispensing machines have certainly met the requirements for an efficient medication distribution system.³³ The implementation of ADC is a step toward greater patient safety and improved healthcare environment.

Limitations

This investigation has several limitations. It was accompanied in only Al-Hasa hospitals. The sample size was not

Table 5. Distribution of healthcare participants' satisfaction level by their associated factors.

Factors	Overall satisfaction level				p-value
	Poor satisfaction		High satisfaction		
	No	%	No	%	
Age in years					.304
<30	20	29.9	47	70.1	
30-39	15	19.2	63	80.8	
40+	6	28.6	15	71.4	
Gender					.876
Male	12	25.5	35	74.5	
Female	29	24.4	90	75.6	
Nationality					.357
Saudi	11	30.6	25	69.4	
Non-Saudi	30	23.1	100	76.9	
Qualification					.511 ^S
Bachelor of science degree	38	26.2	107	73.8	
Diploma	1	8.3	11	91.7	
Master of science degree	2	22.2	7	77.8	
Years of work in your current hospital					.629
<1 year	7	28.0	18	72.0	
1-5 years	25	27.5	66	72.5	
5-10 years	6	17.6	28	82.4	
>10 years	3	18.8	13	81.3	
How would you rate your computer skills?					.471 ^S
Poor	1	50.0	1	50.0	
Moderate	8	34.8	15	65.2	
Good	25	23.8	80	76.2	
Excellent	7	19.4	29	80.6	
Have you ever used an automated dispensing cabinet?					.012*
Yes	27	20.5	105	79.5	

(continued)

Table 5. Continued.

Factors	Overall satisfaction level				p-value
	Poor satisfaction		High satisfaction		
	No	%	No	%	
No	14	41.2	20	58.8	
Do you use the automated dispensing cabinet in your current hospital?					.297 [§]
Yes	26	20.0	104	80.0	
No	1	50.0	1	50.0	
If yes, For how long have you been using the automated dispensing cabinet in your current hospital?					.442
1-12 months	14	21.2	52	78.8	
1-5 years	11	22.0	39	78.0	
>5 years	1	7.1	13	92.9	
Frequency of using an automated dispensing cabinet					.076
Daily	19	17.1	92	82.9	
Weekly	2	25.0	6	75.0	
Less than weekly	5	45.5	6	54.5	

P: Pearson X2 test; §: exact probability test; * $p < .05$ (significant).

calculated. The findings can therefore not be generalized to other populations or settings in KSA.

Implications

The findings from this research have several critical implications for healthcare management, technology implementation, and policy formulation. By understanding the specific factors that influence user satisfaction, hospital administrators can make informed decisions about how to configure and implement ADCs more effectively. This might involve adjustments in training programs, user interface design, system functionality, or support structures. The results can inform policymakers at the local and national levels, contributing to the development of standards and guidelines that optimize the use of technology in medication management. These policies could ensure that ADCs are utilized in ways that maximally benefit patient safety and healthcare efficiency. The study could highlight areas where ADC users require additional support or training. Hospitals might use this information to develop targeted training programs that address specific user needs, thereby

enhancing the overall user experience and effectiveness of ADC operations. Insights from the study may drive technological improvements in ADC systems. Manufacturers could utilize findings related to user experience to enhance the design and functionality of ADCs, leading to more user-friendly systems that are better adapted to the needs of healthcare professionals. Improving the satisfaction of ADC users has the potential to enhance the quality of care provided to patients by reducing medication errors, speeding up service delivery, and ensuring that healthcare professionals are supported in their roles.

Policy recommendations

Based on the findings from this evaluation of user satisfaction with ADCs and the factors influencing this satisfaction in Al-Ahsa hospitals, many policy recommendations could be proposed. Regulatory bodies should develop and enforce standards for the key features and functionalities of ADCs to ensure consistency and reliability across different healthcare settings. These standards should consider the factors that significantly influence user satisfaction, such as ease

of use, security features, and system reliability. Furthermore, health departments should mandate comprehensive training programs for all ADC users to ensure they are proficient in using these systems. Training should be ongoing and adapt to new updates or features of the ADCs to help mitigate resistance to technology and enhance user satisfaction. And finally, this research's results could help to implement a policy requiring hospitals to conduct regular audits and gather user feedback specifically on ADC usage. This feedback should be systematically analyzed and used to inform continuous improvements in ADC deployment and functionality.

Conclusions

This study explored healthcare staff's perceptions and satisfaction with ADCs in Al-hasa hospitals. The healthcare participants were generally satisfied with the use of the ADCs which was translated into better patient care and improved patient safety as well as higher productivity. These findings strongly support the government's efforts to improve patient care by using ADC and enhance automation. The survey result exposed a chance to augment the medication use management process of dispensing and administration practices in hospitals in KSA. The adoption of change associated with implementing and using these new technologies in KSA hospitals is gradual.

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