

Clinical, Operational, and Economic Impacts of Automated Medication Dispensing Cabinets in Perioperative and Ambulatory Surgical Center Settings: A Systematic Literature Review

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BACKGROUND

- Automated dispensing cabinets (ADCs) are computerized medication dispensing cabinets frequently utilized in various healthcare settings for storing and dispensing medications. 1 They are designed to enhance medication management and patient safety by providing secure storage and controlled access to medications for healthcare professionals.
- Utilization of ADCs in hospital settings has become standard practice across the U.S.,² with greater than 93% of hospitals using ADCs as part of their medication dispensing process.³
- Implementation of ADC technology in hospitals has shown to reduce medication errors, 4-7 improve operational efficiency, ^{5, 8-9} and reduce costs. ^{6-8, 10-11}
- Safety and professional organizations including the Institute for Safe Medication Practices (ISMP), American Society of Health-System Pharmacists (ASHP), and The Joint Commission have recommended the adoption of ADCs in outpatient care areas, such as Ambulatory Surgical Centers (ASCs) and perioperative settings outside of the hospital. 1, 12-14
- Utilization of ASCs have been increasing significantly each year over the past few decades, 15-¹⁷ with Medicare payments to ASCs exceeding \$5 billion in 2019. ¹⁸
- Nevertheless, there has been a substantial delay in implementing technology in these settings. 12-

I OBJECTIVE

To assess the documented impact of ADCs in ASCs and perioperative care areas.

METHODS

Search Strategy

- A systematic literature review (SLR) was conducted in PubMed and Google Scholar in November 2022 to assess the documented impact of ADCs in ASCs and perioperative care areas.
- The SLR was performed according to the Preferred Reporting Items for Systematic Reviews and Meta- Analyses (PRISMA) guidelines and best practices. 19
- A review of citations was conducted for all full text reviews in order to identify studies that met our inclusion criteria but were not identified in our original search.

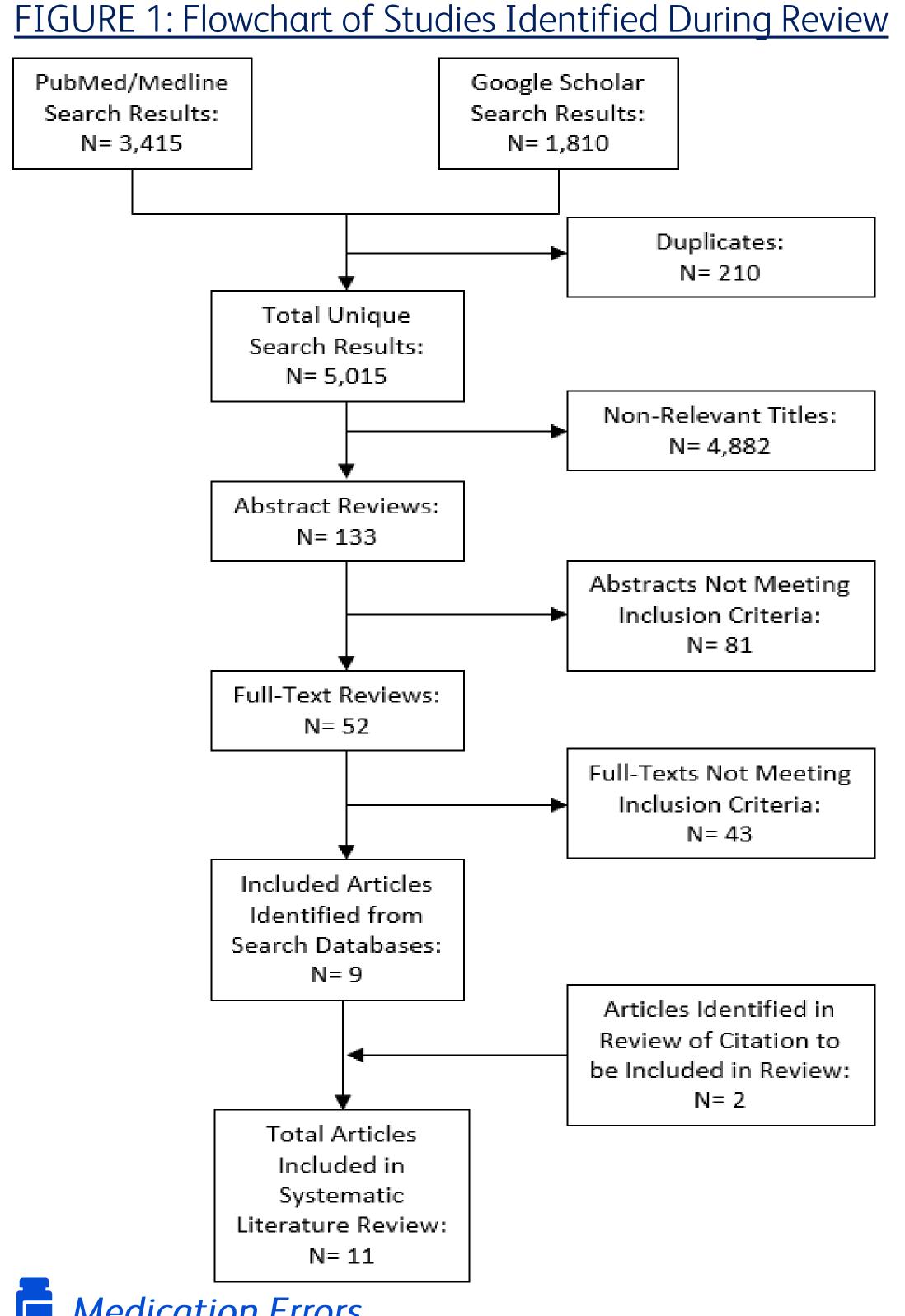
Study Selection

- Original research studies were included if they reported empirical data on ADCs in ASCs, perioperative areas, and operating rooms.
- The search criteria consisted of site locations in North America or Europe, with articles written in English and published in the last thirty years.
- Outcomes of the studies were categorized as medication errors, drug diversion, inventory management, workforce satisfaction, economic impact, and operational efficiency.
- Once the duplicates were removed, all titles were assessed to identify potentially relevant ones. The identified articles then underwent abstract screening and were reviewed by two reviewers.
- Full-text reviews were then conducted by two reviewers for titles and abstracts that appeared to potentially meet the review's inclusion criteria. Conflicting decisions of inclusion/exclusion by the reviewers would be solved by a third reviewer.

Data Extraction

- Data abstraction was conducted by one reviewer with verification of abstracted data conducted by a separate reviewer.
- Elements of the abstracted data included title, study objective, setting, data timeframe, main outcomes assessed, and results.

RESULTS



Medication Errors

- Three studies assessed medication errors, and all found reductions post implementation of ADCs.
- A study conducted in a cancer surgical unit in Italy by Portelli et al. found that the implementation of an ADC decreased medication errors from 2.7% to 0%.²⁵
- Schwarz et al. conducted a medication safety study in a hospital in California which included a cardiovascular (CV) surgery unit. The study revealed a reduction in the rate of medication errors per patient after implementation (0.0058 vs 0.0075), although statistical significance was not tested due to the small sample
- A study in Texas assessing a 600-bed hospital which included 2 medical-surgical units showed that the medication error rate decreased significantly after ADC implementation from 16.9% to 10.4%.²⁰

Drug-Diversion/Controlled-Substance Inventory-- Management

- Six studies evaluated drug-diversion or controlled substances (CS) inventory. ^{27, 29-31, 33, 35}
- The Portelli et al. study found a reduction in wastage of the 4 narcotics assessed in the study along with the reduction of inventory needed on-hand.³³
- A study assessing 6 geographically distinct facilities and more than 100 anesthetizing centers identified significantly lower rates (per 1,000 cases) of missing CS in the post period compared to the pre period (0.42 vs 1.12, difference: 0.7, 95% CI: 0.38-1.02, p<0.0001).³⁵
- A hospital in Pennsylvania found that post implementation of ADC activity in real time had a significantly improved reconciliation accuracy of CS. The Discrepancy rate was 5.2%post-implementation compared to 8.8% preimplementation indicating a difference of -3.6% (95% CI: -4.3% to -2.8%).³⁰

Workforce Satisfaction

- Three studies assessed workforce satisfaction. ^{24, 26, 29}
- One study found 77% of anesthesia providers stating the system was easy to use and 84% of providers said it met their needs, ²⁹ while another study found 81% of nurses working in surgical and/or anesthesia units saying they were satisfied with ADC usage. 24
- In the study by Schwarz et al., all of the nurses who responded to the survey expressed their liking for the ADC system for CS, while 65% liked the system for all medications. 26 Additionally, 70% of the nurses stated they would recommend the system to other nursing units, and all of them would recommend the system for CS. ²⁶

Economic Impact

- Only one study assessed the potential economic impact of ADCs in ASCs and perioperative areas. 26
- o This study found that the addition of 23 ADCs and 23 auxiliary units for their 10 acute care units (comprised of 330 beds) and 4 critical care units (comprising of 48 beds) could result in labor savings with reductions of 0.8 full-time equivalents (FTE) for pharmacists, 2.6 FTEs for pharmacy technicians, 1.2 FTEs for pharmacy billers, and 3.0 FTEs for nurses. ²⁶
- o A net savings of \$908,000 was calculated over the first 5 years, which accounts for \$2.08 million in labor savings (based on 1994 U.S. average salary and benefits) along with \$108,000 in decreased narcotic use and pilferage while considering the cost of adding the ADCs. ²⁶

TABLE 1: Systematic Literature Review Included Study Information

1st Author	Setting	Location	Main Outcome(s) Assessed
	1 institution implementing ADCs in		
Berge ¹⁹	operating rooms.	MN, US	-Drug diversion
	3 units at a 600-bed hospital including 2		
Borel ²⁰	medical-surgical units	TX, US	-Medication errors
	Operating rooms and procedural rooms		-Inventory management/drug
Epstein 2011 ²¹	where anesthesia care in provided	PA, US	diversion
Epstein 2016 ²²	Operating rooms	PA, US	-Drug diversion
			-Inventory management/drug
			diversion
Horvath ²³	GI endoscopy unit	US	-Billing
Metsämuuronen ²⁴	Anesthesia and surgical units	Finland	-Workforce satisfaction
			-Medication errors
		Milan,	-Medication wastage
Portelli ²⁵	Cancer surgical unit, OR specifically	Italy	-Workforce efficiency
			-Missed doses
			-Medication errors
			-Workload/ operational efficiency
	36 bed cardiovascular (CV) surgery unit &		-Workforce satisfaction
Schwarz ²⁶	8 bed CV ICU	CA, US	-Economic impact
	6 geographically distinct facilities & more		-Drug diversion/missing controlled
Shah ²⁷	than 100 anesthetizing locations	US	substances
	270 bed tertiary care facility w/ 11		-Timely administration of
Shirley ²⁸	nursing units	PA, US	medications
	Children's hospital, specifically in 14		
	sterile operating rooms, 2 CV ORs, & 9		-Medication discrepancies
Thomas ²⁹	non-sterile procedural rooms	CO, US	-Workforce satisfaction
	NIC	23, 33	TOTAL SACISTACTION

LIMITATIONS

- Our search was limited to articles published in English and may have excluded relevant articles on the topic published in other languages.
- Publication bias may exist if studies were conducted that showed negative results and the researchers opted not the publish said study due to its findings.
- While eleven studies were identified in the review and provided evidence for the different outcomes we were assessing, these studies were relatively small in scale, and their results may not be generalizable to all institutions and/or geographic regions.

CONCLUSION

- ADC implementation in ASCs and perioperative care was found to decrease medication errors, reduce drug diversion/missing controlled substances, improve inventory management, increase workforce satisfaction, and reduce labor hours.
- Despite the current evidence, the literature assessed did not indicate the cause for the delay in adoption.
- Larger-scale studies are needed to support these findings, which would allow a more robust understanding of the multifactorial impact of ADCs in these settings.

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