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Title: Automation of in-hospital pharmacy dispensing: a systematic review

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SUPPLEMENTARY MATERIALS

Table 1: Search strategy for Embase (Embase 1974 to 2017 December): accessed December 17th 2017

#	Searches	Results
1	exp hospital organization/	35859
2	exp hospital pharmacy/	13732
3	exp computer assisted drug therapy/	893
4	compounding.mp.	5216
5	exp automation/	97636
6	exp computer system/	24626
7	exp organizational efficiency/	1147
8	1 or 2 or 4	53656
9	3 or 5 or 6 or 7	121902
10	8 and 9	1022
11	((automat* or robot*) adj2 (dispens* or distrib* or vend*)).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]	1143
12	BCMA.mp.	693
13	((bar code or barcode) adj4 (assist* or admin*)).mp.	228
14	10 or 11 or 12 or 13	2880
15	limit 14 to yr="2000 -Current"	2336

Table 2: Data extraction table from the SR

A Pharmacy DET 190718.xlsx

Table 3: Quality assessment

Author and year	Country	Study design	Selection bias	Study design	Confounders	Blinding	Data collection methods	Withdrawals and dropouts	Global rating
Anonymous, 2014	US	UBA	+	+	+	NA	+	NA	+
Alonso, 2011	Spain	UBA	+	+	+	NA	+	NA	+
Alvarez Diaz, 2010	Spain	PC	+	+	+	NA	+	NA	+
Ardern-Jones, 2009	UK	UBA	+	+	+	NA	+	NA	+
Barra, 2017	US	UBA	+	+	+	NA	+	NA	+
Portelli 2018	Italy	UBA	+	+	+	NA	+	NA	+
Beard, 2013	UK	UBA	+	+	+	NA	+	NA	+
Bepko, 2009	US	UBA	+	+	+	NA	+	NA	+
Caldwell, 2015	US	UBA	+	+	+	NA	+	NA	+
Chapuis, 2010	France	UBA	+	+	+	NA	+	NA	+
Chapuis, 2015	France	UBA	+	+	+	NA	+	NA	+
Clou, 2017	France	UBA	+	+	+	NA	+	NA	+
Cochran, 2016	US	PC	+	+	+	NA	+	NA	+
Cottney, 2014	UK	UBA	+	+	+	NA	+	NA	+
Cousein, 2014	France	UBA	+	+	+	NA	+	NA	+
De-Carvalho, 2017	Brazil	UBA	+	+	+	NA	+	NA	+
Douglas, 2017	US	UBA	+	+	+	NA	+	NA	+
Fanning, 2016	Australia	UBA	+	+	+	NA	+	NA	+
Gomez de Travecedo, 2015	Spain	PO	+	+	+	NA	+	NA	+

Author and year	Country	Study design	Selection bias	Study design	Confounders	Blinding	Data collection methods	Withdrawals and dropouts	Global rating
Helmons, 2012	US	UBA	+	+	+	NA	+	NA	+
Hitti, 2012	US	UBA	+	+	+	NA	+	NA	+
Hussey, 2014	US	UBA	+	+	+	NA	+	NA	+
James, 2013	UK	UBA	+	+	+	NA	+	NA	+
Jimenez Munoz, 2011	Spain	UBA	+	+	+	NA	+	NA	+
Kunkel, 2016	Germany	PO	+	+	+	NA	+	NA	+
Lo, 2014	US	UBA	+	+	+	NA	+	NA	+
McCarthy , 2016	US	UBA	+	+	+	NA	+	NA	+
Mehta, 2016	Australia	UBA	+	+	+	NA	+	NA	+
Noparatayaporn (2016), 2016	Thailand	UBA	+	+	+	NA	+	NA	+
Noparatayaporn (2016 A), 2016	Thailand	UBA	+	+	+	NA	+	NA	+
Noparatayaporn (2017), 2017	Thailand	UBA	+	+	+	NA	+	NA	+
Oldland, 2015	US	UBA	+	+	+	NA	+	NA	+
O'Neil, 2016	US	UBA	+	+	+	NA	+	NA	+
Palttala, 2013	NR	PO	+	+	+	NA	+	NA	+
Radparvar, 2016	NR	UBA	+	+	+	NA	+	NA	+
Recuero Galve, 2016	Spain	PO	+	+	+	NA	+	NA	+
Risor, 2017	Denmark	UBA	+	+	+	NA	+	NA	+

Author and year	Country	Study design	Selection bias	Study design	Confounders	Blinding	Data collection methods	Withdrawals and dropouts	Global rating
Risor, 2017	Denmark	UBA	+	+	+	NA	+	NA	+
Rodriguez-Gonzalez, 2012	Spain	PO	+	+	+	NA	+	NA	+
Roman, 2016	Australia	UBA	+	+	+	NA	+	NA	+
Silverstein, 2010	US	UBA	+	+	+	NA	+	NA	+
Skalafouris, 2015	France	PO	+	+	+	NA	+	NA	+
Smidt, 2017	Unclear	PO	+	+	+	NA	+	NA	+
Summerfield, 2011	US	UBA	+	+	+	NA	+	NA	+
Sutra, 2015	France	PO	+	+	+	NA	+	NA	+
Temple, 2010	US	UBA	+	+	+	NA	+	NA	+
Ward, 2012	US	UBA	+	+	+	NA	+	NA	+
Weeks, Unclear	Australia	UBA	+	+	+	NA	+	NA	+

Abbreviations: CBA, controlled before-after study; prospective cohort study; PO, prospective observational; RSS, randomised simulation study; UBA, uncontrolled before–after study. ++, strong; +, Moderate; -, weak.

Table 4: Overview of the results for pharmacy-based automation technologies versus manual dispensing

Author, year, country	Technology intervention: Comparison	Setting	Year system Installed	Outcomes	
				Clinical	Economic
Bepko 2009 UK (55)	ROBOT-Rx: ADS vs manual dispensing	Inpatient private acute care hospital	2005	• Average error rate pre-intervention was 2.9% with higher rates (up to 4.8%) when staffing was reduced on weekends. • The medication variance rate pre-intervention was 6.1 per 100 doses billed	Estimated cost of preventable ADE due to; • Prescribing: $549,276 • Transcribing: $169,008 • Dispensing: $154,924 • Administration: $535,192 Estimated total annual savings: $1,408,400
Caldwell 2015 (24) US	Omnicell®: ADS vs manual dispensing	Inpatient, five large US hospital sites	NR	NR	• First doses filled took 111 s less per dose. • First doses filled cost US $0.23 vs $1.93 per dose (resulted in eight times lower first dose cost when dispensed from the ADC). • Missing doses took 64 s less • Returns took 25 s per dose less • Time savings associated with using ADCs accounted for a total decrease of 35 labour hours per week, which resulted in a savings of US $64,300 annually.
James 2013 (33) UK	ARX Rowa™ Speedcase: ADS vs manual dispensing	Inpatient, 40 patient beds in two adjoining patient care areas	2008	• The rate of prevented dispensing incidents was significantly lower post automation: 0.28% (147/52,808) vs 0.64% (235/36,719), p<0.0001) • No difference (p=0.277) between the categories of error types of dispensing incidents • A positive association existed between workload and prevented dispensing incidents both pre- (r=0.13, p = 0.015) and post-automation (r = 0.23, p<0.001).	• Median dispensary workload pre-automation (9.20 items/person/h) vs post-automation (13.17 items/person/h, p< 0.001)
Noparataya porn 2016a (39)	Brand NR: ADS vs manual dispensing	Inpatient, large academic hospital	NR	NR	• The total costs of the inpatient service under 100% manual and ADM systems dispensing 22.8% of inpatient

Author, year, country	Technology intervention: Comparison	Setting	Year system Installed	Outcomes	
				Clinical	Economic
Thailand					prescriptions were 82.7 and 89.8 million baht/year, respectively. • The unit cost of inpatient prescriptions using the ADM system was 60.34 baht/prescription, which accounted for 8.5% higher than 55.59 baht/prescription of the traditional manual system. • The proportions of labour cost (LC):material cost (MC):capital cost (CC) for the manual and ADM systems were 87.8:12.1:0.1 and 88.0:9.3:2.8, respectively. • The sensitivity analysis result illustrated that the lower unit cost could be achieved if the ADM system covered at least 75% of all prescriptions. At the 75% coverage, the unit cost was 53.95 baht/prescription and the proportion of LC:MC:CC was 83.6:13.3:3.1.
Noparataya porn 2016b (37) Thailand	Brand NR: ADS vs manual dispensing	Inpatient, large academic hospital	2014	NR	• Cost of investment over 10-years was $US 15,782,608 for manual system and $US 17,632,232 for ADM system. • Recently ADM system covered 220 types of tablets • ADM covered only 22.83% of all prescriptions. • The sensitivity analysis showed that if we covered 75% of all prescriptions by ADM, cost of investment over 10 years was $US 15,737,803 thus we could save $US 44,805, $US 1,894,429 when compared with the manual system and ADM system, respectively.
Noparataya porn 2017 (38) Thailand	YS-TR-406FDS: ADS vs manual dispensing	Inpatient, large academic hospital	2012	NR	• By adding pharmacist roles on screening and verification under the ADM system, the ADM system required 117.61 FTEs of pharmacist time vs 46.84 before. • Replacing counting and filling medication functions by ADM has decreased the number of pharmacy technicians to 55.38 FTEs vs 132.66 before. • After the modified ADM system cancelled the return unused medication process, FTEs requirement for

Author, year, country	Technology intervention: Comparison	Setting	Year system Installed	Outcomes	
				Clinical	Economic
					pharmacists and pharmacy technicians decreased to 69.78 and 51.90 FTEs, respectively.
Skalafouris 2015(49) France	Rowa™ Vmax, Rowa™ Technologies: Management strategy for medication units free of secondary packaging (MUF-SP) vs no management strategy	Inpatient	NR	NR	• 1576 drug units were returned to the pharmacy from the wards. • 40.6% were MUF-SP. Of these units, 45% were eligible for the RDU and saved €615.43 (86% of the price of the MUF-SP). • 22 different drugs were recycled, of which 19 were antibiotics. • The estimated average time required to generate the whole system was 108 s per item and cost €0.84 per item (including staff and consumables costs). The total cost of the process was €19.14.
Summerfield 2011 (63) US	TUG pharmacy delivery robot: Robot vs manual dispensing	Inpatient-delivery to ICU units	2003	NR	• Number of days available: overall unavailable time when robotic delivery systems could not be used: 3.4%– 5.1% • 45% of the unavailable time was due to UMMC infrastructure problems, with the most common issues related to elevators and the wireless network. • Reasons for the robot related unavailable time (17%) were the power supply (i.e., charging dock functionality) and cart issues (e.g., keypad functionality). • Mean ± SD time from order receipt to label printing dropped from 26 ± 7.8 minutes to 15.1 ± 8.3 minutes throughout the data collection period. • Mean ± SD order preparation time decreased from 13.1 ± 3.9 minutes to 8.9 ± 2.2 minutes ($p < 0.001$) from pre-implementation to postimplementation, suggesting that the technicians used the saved delivery time to prepare medications.

Author, year, country	Technology intervention: Comparison	Setting	Year system Installed	Outcomes	
				Clinical	**Economic**
					• Mean ± SD order preparation time at two years postimplementation dropped to 7.4 ± 4.1 minutes. • Mean ± SD idle time for medications to be delivered (the time from medication checking by the pharmacist to the time the medications left the pharmacy) was reduced from 27.3 ± 8.2 minutes to 23.1 ± 5.8 minutes in the STC (pre-implementation to postimplementation).
Temple 2010 (52) US	MedCarousel®: ADS vs manual dispensing	Inpatient	2005	• After implementing CDT, the average accuracy rate for all refill dispense requests increased from 99.02% to 99.48%.	• Pre-implementation time studies revealed that technicians completed refill requests in 62 minutes vs postimplementation time 53 minutes (mean ± SD number of doses restocked was similar 1444 ± 215) • The estimated labour savings comparing the pre-postimplementation time totalled 2.6 FTEs. • A net reduction of 2.0 technician FTEs was achieved. • The average turnaround time for stat medication requests using CDT was 7.19 minutes, and the percentage of doses filled in less than 20 minutes was 95.1%. • The inventory carrying cost was reduced by $25,059.
Weeks NR (66), Australia	Rowa™ Vmax, Rowa™ Technologies: ADS vs manual dispensing	Inpatient and outpatient	2014	NR	• Post ADS there was a significant reduction in outpatients dispensing time (16.93 mins, p=0.03) and outpatient prescription processing time (266 mins, p=0.00) • Based on 7 months data remote pharmacist recalls would save $ 13,200 pa against a forecast $20,000 pa • Forecast pharmacy expired stock reductions did not achieve a reduction of $17,000 but increased by $6000.

Abbreviations: ADC, automated dispensing cabinet; ADE, automated dispensing error; ADS, automated dispensing system; ADM automated dispensing machine; CDT, carousel dispensing technology; FTE, full-time equivalent; MUF-SP, Medication Units Free of Secondary Packaging; NR, not reported; SD, standard deviation.

Table 5: Overview of the results for ward-based automation technologies versus manual dispensing

Author year, country	Technology intervention: Comparison	Setting	Year Installed	Outcomes	
				Clinical	Economic
Anonymous 2014 (22) US	CardinalASSIST® ADS: labour and inventory management system vs no system	Unclear	NA	• 70% fewer medication errors associated with implementation of the system.	• A potential cost avoidance of more than $1.7 million associated with the implementation of the system (time-frame unclear).
Ardern-Jones 2009 (53) UK	Medi365, Mediwell: ADS vs manual dispensing	ED	2005	NR	• Nursing staff spent approximately 10.9% of their time on work activities related to medicines pre-automation and 12% post-automation (p=0.234) [7 month time-frame]. • The median time to acquire a dose of medication decreased from 139.5 s pre-automation to 44 s post automation (p<0.0001). • A mean saving of 46.5 min/week identified as nursing staff were no longer involved in stock replenishment.
Portelli 2018 (67) Italy	Pyxis MedStation® 3500: ADS vs manual	Surgical unit (14 operating rooms)	2014	• The number of registry corrections reduced from 232 in the pre-Pyxis period to 10 in the post-Pyxis period (a reduction of 95% over an 8 month time period).	• The number of operating room staff required to undertake single activities related to the compilation of registries, drug stock, and expiration dates check was lower in the post-Pyxis period versus the pre-Pyxis period. • The savings in staff time associated with the implementation of Pyxis estimated to correspond to savings of €4,120 and €3,730 for operating room staff and hospital pharmacy staff respectively over the 8-month time period. • During the post-Pyxis period mean operating room stock quantities were reduced for all drugs compared with the pre-Pyxis period (approximately 50% reduction); estimated that

Author year, country	Technology intervention: Comparison	Setting	Year Installed	Outcomes	
				Clinical	Economic
					the reduction in stock quantities corresponded to a saving of approximately €22,300, while the impact of drug wastage avoidance was reported to be modest at €650.
Chapuis 2010 (57) France	OmniRx, Omnicell®: ADS vs manual dispensing	ICU	NR	• Total opportunities for error (TOE) were reduced in the intervention unit (13.5%) compared to the control unit (18.6%) post-intervention ($p<0.05$) while no significant difference was observed before implementation of the ADS (20.4% in the intervention unit vs.19.3% in the control unit). • ADS led to a significant decrease in preparation errors from 3.8% to 0.5% ($p=0.017$) • The ADS did not decrease picking and administration errors • Storage errors substantially decreased in the intervention unit (96% reduction; $p<0.01$) and the control unit (58% reduction, $p<0.01$). • Most errors (84%) were classified as causing no harm (categories C and D).	NR
Chapuis 2015 (56) France	OmniRx, Omnicell®: ADS vs manual dispensing	ICU	NR	NR	After ADS implementation: •Nurses spent less time on medication-related activities (mean 14.7 hours saved per day/33 beds).

Author year, country	Technology intervention: Comparison	Setting	Year Installed	Outcomes	
				Clinical	Economic
					• Pharmacy technicians spent more time on floor-stock activities (mean 3.5 additional hours per day across the three ICUs). • Cost of drug storage was reduced by €44,298 and the cost of expired drugs was reduced by €14,772 per year across the three ICUs. • Five years after the initial investment, the global cash flow was €148,229 and the net present value of the project was positive by €510,404.
Clou 2017 (25) France	Brand NR: ADS vs manual dispensing	Inpatient, critical access hospitals	NR	• Post ADS implementation (after one year) the traceability rate was reported as excellent (100%)	• The introduction of ASD allowed a qualitative and quantitative decrease in stocks, with a reduction of 30% for purchased medical devices and 15% for implantable medical devices in deposit-consignment. • Cost-benefit analysis showed a rapid return on investment. • Real stock decrease (purchased medical devices) equivalent to 46.6% of investment.
Cottney 2014 (27) UK	Brand NR: ADS vs manual dispensing	Inpatients, single-ward in a UK mental health hospital	NR	The implementation of ADC led to: • a 1.7% (95% CI: 0-3.5) reduction in error rate (p=0.065) • a reduction in the mean dose administration time of 0.57 mins (95% CI: 0.17-0.97) [p=0.006]	NR
De-Carvalho 2017 (58) Brazil	Pyxis®: ADS vs manual dispensing	ICU of a private tertiary hospital	2013	• A non-statistically significant decrease in the mean number of events between pre- (2.25± SD 2.19 events/month) and post-	• The time spent on activities performed by nurses and administrative assistants decreased post implementation vs. a reported increase for

Author year, country	Technology intervention: Comparison	Setting	Year Installed	Outcomes	
				Clinical	**Economic**
				implementation (1.46±1.39 events/month) of the ADD system reported (p=0.32). • No significant difference in ADEs occurring during drug dispensing (1.88 pre- vs. 1.23 post-intervention, p=0.34) and administration (0.38 pre- vs. 0.23 post-intervention, p=0.65). • A significant decrease (71%) in urgent requests was observed after implementing the ADD system when assessing the number of requests and the need for central pharmacy services during both periods • The number of products returned to the central pharmacy decreased by 30% during the ADD post-implementation period.	pharmacy assistants, resulting in a total reduction of 6.5 work hours per day • Total cost of the ADD system included the cost of the device (R$ 198,065.88; USD 85,153) and costs associated with cabinet-making and remodelling services (R$ 8,000.00; USD 3,439.40). • The reduction in personnel costs totalled R$ 33,598 (USD 14,444) per year during the first year post introduction of the ADD system. • Reduction in personnel costs ○ 2014, R$ 35,480 (USD 15,254) ○ 2015, R$ 37,690 (USD 16,204) ○ 2016, R$ 41,942 (USD 18,032) ○ 2017, R$ 44,702 (USD 19,218) Therefore, the initial investment paid off in 5 years, considering only personnel savings
Douglas 2017 (29) US	Brand NR: ADS vs prior ADCS	Medical-surgical orthopaedic and oncology units	2012	• Median reduction of 40% across all units between scheduled and actual administration time for the pre- vs. post ADC implementation period (p <0 .0001). • Reduction in medication time reduced for the following specialities (pre- vs post-implementation: ○ Medical-surgical unit, 14 to 11 minutes (p= < .0001) ○ Oncology, 23 vs 2 minutes (p= < .0001) ○ Orthopaedic, 30 vs 3 minutes (p= < 0.0001).	NR

Author year, country	Technology intervention: Comparison	Setting	Year Installed	Outcomes	
				Clinical	Economic
Fanning 2016 (59) Australia	Omnicell®: ADS vs manual dispensing	ED	2014	• 1139 medication selections and preparations reported pre-intervention vs. 864 post-intervention • Implementation of ADCs in the new ED resulted in a 64.7% reduction in medication selection and preparation errors (post intervention 1.96% versus post intervention 0.69%, respectively, P=0.017). • All medication error types were reduced in the post intervention study period. • There was a non-significant impact on medication error severity, as all errors detected were categorised as minor (class 1 or 2).	NR
Helmons 2012 (31) US	Pyxis® medstations: wholesaler-to ADS direct refill program vs no program	Inpatient-designated areas of a 386-bed medical centre	2009	• Data collected pre-and post-implementation were similar, except that medications were more frequently stored in a single-drug pocket during the post-implementation period (73% versus 51%, p< 0.0001). • ADC refill errors decreased by 77% post-implementation, from 62 errors per 6829 refilled pockets (0.91%) to 8 errors per 3855 refilled pockets (0.21%) (p< 0.0001).	• There were three instances of expired medications before vs. one expired medication after implementation of the program.
Hitti 2012 (60) US	Brand NR: ADS vs manual dispensing	ED	2008	NR	• Order to antibiotic administration time was reduced by 29 min post-intervention (55 min vs. 26 min, 95% CI 12.5–45.19). • Mean door-to-antibiotic time reduced by 70 min (167 min vs. 97 min, 95% CI 37.53–102.29).

Author year, country	Technology intervention: Comparison	Setting	Year Installed	Outcomes	
				Clinical	Economic
					• The percentage of severely septic patients receiving antibiotics within 3 hours of arrival to the ED increased from 65% pre-intervention to 93% post-intervention.
Hussey 2014 (32) US	Omnicell®: ADS vs manual dispensing	Inpatient, 40 patient beds in two adjoining patient care areas	2013	• Total number of patient-specific medication units dispensed over a 2-month period from the central pharmacy decreased from 6489 to 4408 units (32% decrease post inventory optimisation).	• Total cabinet inventory increased by 8% from 526 items to 567 items post-optimisation. • When comparing the separate 2-month periods, post-inventory optimisation cost on the ADCs was reduced from $11963.05 to $6562.79 (45% reduction in costs on cabinets). • The number of medication stock outs increased from 1.52 items per day to 1.56 items per day over the separate 2-month periods.
Lo 2014 (35) US	NR: Adding IV antibiotics to ADS vs manual dispensing	Inpatient and outpatients	2012	• Reduction in total dispensing time not associated with a significant decrease in mortality (8% versus 4%, p=0.33) or LOS (10 ± SD 12 days versus 12 ± SD 13 days, p=0.39).	• Significant 1.7-hour reduction in the mean ± SD order-to-administration time (4.5 ± 4.1 vs. 2.9 ± 2.5 hours, p = 0.009) for piperacillin–tazobactam first doses with the use of ADCs. • Subgroup analyses showed significant reduction in the mean ± SD scan-to-administration time (3.3 ± 3.4 vs. 1.7 ± 1.5 hours, p=0.001) and release-to-administration time (2.4 ± 2.4 vs. 1.4 ± 1.5 hours, p=0.034) with ADC. • Mean ± SD time from order to scan did not differ significantly between the pre- and post-ADC groups (1.7 ± 1.9 hours vs. 1.2 ± 2.0 hours, p=0.817)
McCarthy 2016 (36) US	Omnicell®: Optimisation	Inpatient	2013	NR	Implementation of ADC: • reduced pharmacy technician labour requirements (estimated at $2,728 annually)

Author year, country	Technology intervention: Comparison	Setting	Year Installed	Outcomes	
				Clinical	Economic
	method vs no optimisation				• substantially reduced the overall weekly stockout percentage (from 3.2% pre- vs. 0.5% eight months post-optimisation) • associated with an improved mean medication turnaround time, and estimated cost avoidance of $19,660 attributed to the reduced potential for product expiration.
Mehta 2017, Australia (61)	Brand NR: ADS vs manual dispensing	ICU	NR	• Medication picking accuracy (percentage errors) improved for manual and robotic counts (1.47% and 0.74% respectively).	Post -implementation of ADC: • Mean time processing and picking stock per pack reduced by 25% post-implementation (12 sec vs. 8 sec). • Time spent per pack for delivery and refilling decreased by one fifth post-implementation. • Significant reduction in time spent by pharmacist for checking controlled drugs e.g. morphine (12 mins vs. 5 mins). • Mean frequency of stock-outs per month decreased by over 50% (27.33 vs. 12).
O'Neil 2016 (41) US	Pyxis®: Optimisations of ADS vs no optimisation	Perioperative and labour and delivery setting	2014	• Mean vend:fill ratios before and after optimisation were 4.43 and 4.46, respectively.	• Total number of medications stocked in the eight machines reduced from 1273 in a designated two-month pre-optimisation period to 1182 in a designated two-month post-optimisation period, yielding a carrying cost saving of $44,981.
Radparvar 2016 (43) NR	Brand NR: ADS inventory management system vs baseline	Surgical intensive care unit and cardiac	NR	NR	• Negligible changes reported in monthly vend:fill ratios and stock-out percentages. • Mean number of medications with loads and unloads >2 per month decreased from 10 at baseline to 5 -analysis.

Author year, country	Technology intervention: Comparison	Setting	Year Installed	Outcomes	
				Clinical	Economic
		acute care unit			• Mean number of expiring medications per month decreased from 57 at baseline to 44 post-analysis.
Roman 2016 (62) Australia	Pyxis® Medstation: ADS vs manual dispensing	ED	2012	NR	• Mean time to retrieve any medication was 30.3 seconds (SD 47.4) in the pre- vs. 36.0 seconds (SD 25.1) in the post-implementation period (+5.7 seconds; p<0.01) • Results from qualitative staff survey indicated that knowledge of stock on the Imprest system improved in the post-implementation survey (p=0.03) and that ADMs were associated with a reduced time selecting medications (p<0.01).
Ward 2012 (64) UK	Pyxis® Medstation 3500: ADS vs manual dispensing	ED	NR	• A similar proportion of patients received correct dosing of vancomycin pre- and post-implementation (44.8% vs. 41.2% respectively, p=0.770. • Patients with an incorrect dose were most often under dosed. Before intervention, 15/16 (93.8%) incorrectly dosed patients were under dosed and after intervention 16/20 (80.0%) of incorrectly dosed patients were under dosed (p=0.477).	• Before intervention, 0% patients received vancomycin within 60 minutes from bed placement to drug administration vs. 14.7% post-intervention (p=0.040).

Abbreviations: ADC, automated dispending cabinet; ADD, automated dispensing device; ADE, automated dispensing error; ADS, automated dispensing system; ADSM, Automated dispensing system for medical devices; ED, emergency department; ICU, intensive care unit; IV, intravenous; LOS, length of stay; NR, not reported.; SD standard deviation.