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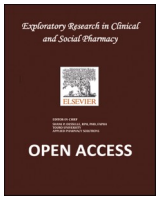


# Automated dispensing cabinets and the effect on omitted doses of ward stock medicines; can implementation reduce delays to first dose antimicrobials?

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ABSTRACT

Omitted doses are a subset of medication administration errors which have the potential to cause severe harm. Sepsis is a clinical condition where dose omissions or delays in medicines administration can be fatal. Automated dispensing cabinets (ADCs) provide a medicines management solution which keeps track of stock in real time and can automatically generate orders, reducing the likelihood of medication stockouts. This study aims to assess the impact of ADC implementation on the rate of omitted doses due to unavailability of ward stock medicines. Secondary aims are to investigate the effect of ADCs on omitted doses of first dose antimicrobials. Due doses data was compiled from the electronic prescribing and medicines administration (EPMA) system for ten wards pre-ADC implementation between July and September 2022 and was compared with data post-ADC implementation between July and September 2023. Omitted doses were selected and filtered for those marked 'drug not available'. Ward stock lists were used to determine which omitted doses were for medicines held as ward stock. A secondary analysis filtered this data further to isolate omitted doses of ward stock medicines which were systemically administered antimicrobials. The overall number of prescribed doses during the pre-implementation period was comparable to those in the post-implementation period. There was a total of 393 omitted doses of ward stocked medicines due to unavailability pre-ADC implementation, and 817 post-ADC implementation. This represents an omission rate due to unavailability of ward stock medicines as a percentage of all prescribed doses, of 0.08 % pre-ADC and 0.18 % post-ADC implementation. Statistical analysis showed no difference ($p = 0.1655$). There was also no statistical difference in omitted doses of ward stocked antimicrobials pre vs post-ADC implementation ($p = 0.3363$). It has been identified that a potential way to reduce rates of omitted doses is by optimising stock stored in each cabinet. This research is encouraging and may warrant further data collection once stock optimisation has occurred.

## 1. Introduction

Medicines prescribing is the most common healthcare intervention.[1] Half of all adults in the United Kingdom, and two thirds of adults in the United States are estimated to be taking at least one prescription medicine.[2,3] Unfortunately, it is estimated that 6–7 % of hospital admissions are medication related, with two thirds of these as a result of medication errors.[4] A study from the Netherlands has found that 16 % of hospital readmissions within 30 days of discharge are medication related, with 40 % of these being potentially preventable.[5] Medication errors are a significant contributor to patient morbidity, mortality, post-discharge disability, and healthcare costs.[6] This umbrella term covers errors arising at any point within the medication use pathway, from the prescribing and dispensing of a medicine, through to administration, monitoring and appropriate follow up. Medication administration errors (MAEs) are those occurring at the point at which the patient receives the medicine, the consequences of which range in severity. One type of MAE is wrong timing, categorised as being either early, late or omitted altogether.

Dose omissions are a critical subset of MAEs, many go undetected or with negligible consequence, while others can be fatal. Concerns over the impact of omitted and delayed doses are not new. The dangers caused by omissions or delays in patient treatment across hospitals were highlighted in a National Patient Safety Agency alert released back in

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2010.[7] Despite this, omission and delays with doses for critical medicines continues to occur frequently in the hospital setting.[8] A study published in 2019 examined ten years of patient safety incidents in England and Wales, to improve understanding of fatal MAEs. 31.4 % of these MAE related deaths were due to medication omissions.[9]

Antimicrobials are a high-risk medicine group, where omissions can be critical. Sepsis is a medical emergency, where swift and appropriate antimicrobial initiation is essential for survival. It is well documented that when initiation is delayed, the risk of mortality increases.[10] The Surviving Sepsis Campaign, most recently updated in 2021, continues to recommend initiation of broad spectrum antimicrobials within the first hour of sepsis recognition.[11] A retrospective study reviewed records of patients with sepsis and associated hypotension, who had antimicrobials initiated within an hour of onset of hypotension. This found a survival rate to hospital discharge of only 79.9 %. For every additional hour of delay, survival dropped an average of 7.6 %.[12] There can be no doubt that quick access to antimicrobials is essential for hospitals, especially those providing acute care.

Hospitals and healthcare systems globally are constantly searching for ways to improve patient safety, improve efficiency and to reduce spend. A range of technology-based interventions have been targeted at different points of the medication use pathway. These include the introduction of electronic prescribing and medicines administration systems (EPMA), web-based decision support solutions aimed at reducing prescribing errors; the implementation of dispensing robots within pharmacy aimed at improving the speed of dispensing and patient safety through reduction of selection and look-alike errors. Additionally, the deployment of closed loop barcode medicines administration (BCMA) workflows and automated dispensing cabinets (ADCs) aimed at reducing MAEs have been widely adopted.[13]

ADCs are an electronic medicines management solution whereby medications are held in a securely locked cabinet, where the user is guided to the correct medicine using by flashing lights following the on-screen selection of the medicine. ADCs are commonly used either on inpatient wards, or centrally within the pharmacy department.[14] They can provide benefits by improving access to medication in patient care areas, medication security, medication tracking capabilities and inventory control. A reduction of medication selection errors has also been found compared with traditional storage solutions such as locked cupboards.[15]

Another perceived benefit of ADCs is the reduction of omitted doses.[16] This is because ADCs keep track of stock in real time and can automatically trigger orders when the quantity of an item falls below a pre-determined level, thus reducing the chance of stock running out on wards. A recent systematic literature review reported that there was a paucity of evidence linking the improved availability of medication through the utilisation of ADCs with impact on omitted or delayed doses.[14] The majority of papers included in this review presented positive conclusions regarding the impact of ADCs on omitted doses[15–21] however, only two directly attributed missed doses to medicines unavailability[13,17] Martin et al. explored the impact on omitted doses after introduction of an ADC alone and reported a 17 % decrease in the rate of omitted doses.[17] In contrast, Franklin et al. measured the impact of introducing EPMA, ADCs and BCMA simultaneously, and saw a small increase in the rate of omitted doses.[13] There is therefore a current gap in the literature investigating the effect of ADC implementation in hospitals with existing EPMA solutions.

A large teaching hospital in London has recently implemented ADCs across most inpatient wards. This provided an opportunity to evaluate the effect of ADC implementation on omitted doses due to unavailability of ward stock medication, in a setting where an interfaced EPMA software solution was in situ. The secondary aim was to investigate the proportion of omitted doses specifically associated with first dose omissions of systemic antimicrobials, pre- and post-ADC implementation.

## 2. Method

### 2.1. Study setting

This study was conducted at the main site of a large London teaching hospital in the United Kingdom with 1041 beds. This study was considered a service evaluation by the local pharmacy research and audit group. Ethics approval was not deemed to be necessary. The hospital used a typical UK medicine distribution system in which commonly used medications were kept in clinical rooms on each ward as stock. These ward stock medicines were distributed by the central pharmacy, which was open from 09:00 a.m. to 19:30 p.m. Monday through Friday and 09:00 a.m. to 17:00 p.m. on weekends and bank holidays. Outside of these operating hours, a resident pharmacist is contactable to facilitate the supply of emergency medications as needed. Medicines prescribed for a patient that was not on the ward's stock list were dispensed by the pharmacy on a per-patient basis. These medicines as well as those brought in from patients' homes, were stored in patients' own medicine lockers by the bedside. Controlled drugs were stored in a wall mounted, locked safe within the clinical rooms. Mobile medication carts also held a subset of the ward stock; primarily oral medication. Nurses completing a medication round were often required to visit multiple locations to retrieve all of the medicines required for each patient. Electronic prescribing and medications administration software was in use across all clinical inpatient wards.

From February to July 2023, a fleet of 45 ADCs were installed on inpatient wards. Cabinets were interfaced with EPMA software, and cabinets were used in ‘profile mode’. Effectively, a profiled ADC is one that requires nursing staff to select a medicine from a patient-specific list at the cabinet interface and obtain that medication once it has been prescribed and verified by a pharmacist. The medications stored in ADCs constituted each ward's stock list. A review of each ward's stock list was undertaken by the relevant clinical pharmacist as part of the implementation process with input from nursing ward managers. The number of different medicines and their quantities did not change significantly pre- and post-ADC implementation. Controlled drugs were moved into lidded bins within the ADCs, which required an additional nursing witness to unlock and obtain. Medication carts were retired. Any medicines dispensed specifically for a patient, or patients' own medicines from home, continued to be stored in bedside lockers.

Both pre- and post-ADC implementation, the stores and distribution staff within the pharmacy department were responsible for the replenishment of ward stock medicines. Prior to ADC implementation, a pharmacy assistant would visit each ward when a stock top-up is scheduled; check physical stocks and levels against the ward stock list to generate a restock request. Post-ADC implementation, this manual step is eliminated as the cabinets keep track of stock quantities in real time. On scheduled stock top-up days, the cabinet automatically generates a restock request to a shared pharmacy email inbox for processing.

From the list of clinical wards where an ADC had been deployed across the hospital, ten were selected for inclusion in this study; three haematology wards, three hepatology wards, and four medical wards. An eligible ward was defined as a unit where ADC deployment had occurred at least three months prior to October 2023, when a new hospital-wide EPMA system replaced the old one.

### 2.2. Data collection and analysis

An omitted dose was defined as any dose marked on the electronic medication administration record as ‘not given’. Prescribing and medicines administration data for omitted doses were extracted from the EPMA system relating to a three-month period from July, August and September 2022 pre-ADC and compared with July, August and September 2023 post-ADC to reduce the occurrence of seasonal variation of medication use. ‘Once only’ stat doses were included as well as maintenance doses. The following data fields were extracted for omitted

doses: ward name, medication name, prescribed dose, route of administration, scheduled date and time, and the reason documented for non-administration. The reason for omission was then filtered for 'medicine not available' and all fields manually searched for any free typed entries with the same meaning. Data for the total number of prescribed medicine doses for the equivalent time periods was also obtained from the EPMA system using Allscripts structured query language (SQL) to generate the reports. All data was exported to Microsoft excel for analysis.

To determine whether an omitted dose was a ward stock item, two pharmacists also independently reviewed the omitted doses list against the relevant ward stock list to validate the proportion of omitted doses due to ward stock unavailability. An omitted dose was deemed to be ward stock if it was available on the stock list or if it was available in an alternative strength on the stock list that did not require the patient to take more than three tablets to make up the required dose. For each ward, pivot tables in Microsoft Excel were created to ascertain the frequency of omissions for specific medicines, and the number of unique omitted medicines, and the number with three or greater omissions were recorded.

Of the many classes of time-critical medicines, antimicrobials were selected as the class upon which to perform additional analysis. Secondary analysis was undertaken on a subset of omitted doses due to stock unavailability on systemically administered antimicrobials to identify the proportion of first dose omissions. Systemic administration was defined as doses given by either the intravenous or oral route. EPMA for individual patients were used to identify whether an omitted dose was the first dose of the treatment course on the ward. The outcome was recorded in Microsoft excel. It was beyond the scope of this research to assess the indication and appropriateness of antimicrobial prescribing e.g. if a patient had been on prophylactic oral aciclovir pre-admission but their first dose on the ward was omitted due to unavailability, this dose would have been included in the count as a first dose. Two pharmacists also independently reviewed EPMA records to validate the proportion of first dose omissions for systemic antimicrobials.

The overall prevalence of omitted doses due to 'medicine not available' was calculated by dividing the number of omitted doses due to medicine not available by the total number of medication doses prescribed during the same period. In addition, the proportion of omitted doses that occurred outside of normal working hours, was also assessed.

Statistical analysis was conducted using RStudio version (2023. 12.0 + 396).[18] A Mann-Whitney *U* test was conducted to determine whether there was a difference in the prevalence of omitted doses due to ward stock unavailability across all clinical specialties pre- and post-ADC implementation. The Mann-Whitney U test was chosen as it is suitable for assessing significance between groups of data, when the data is found to be non-parametric.

## 3. Results

Across all ten wards, the SQL generated reports identified 479,153 medication doses pre, and 463,399 medication doses prescribed post-ADC implementation. Of these, 393 and 817 doses of ward stock medicines were omitted due to unavailability before and after ADC implementation respectively. This represents an omission rate due to unavailability of ward stock medicines as a percentage of all prescribed doses, of 0.08 % pre-ADC and 0.18 % post-ADC implementation. Omitted doses due to unavailability of ward stock pre- and post-ADC implementation are shown by clinical area in Table 1. 80.1 % (315/393) of the omitted doses occurred outside of normal pharmacy working hours pre-ADC implementation and 83.8 % (685/817) of omitted doses occurred outside of normal pharmacy working hours post ADC implementation. As shown in Table 1, the number of unique omitted ward stock medicines, and those with three or more omissions indicates the range of medicines contributing to the total number of omissions. The wards with the highest number of medicines with three or more omissions were Medical 4, Haematology 2 and Medical 2, all during the post-ADC implementation period.

**Table 1**
Total number of omitted doses of ward stocked medicines due to unavailability, pre-ADC and post-ADC implementation, by specialty.

| Ward | Total number of omitted doses of ward stock medicines due to unavailability | | Number of different medicines causing omissions | | Number of different medicines causing three or more omissions | |
|---|---|---|---|---|---|---|
| Ward | Pre-ADC | Post-ADC | Pre-ADC | Post-ADC | Pre-ADC | Post-ADC |
| Haematology 1 | 39 | 49 | 19 | 22 | 5 | 5 |
| Haematology 2 | 66 | 94 | 30 | 32 | 7 | 15 |
| Haematology 3 | 29 | 14 | 10 | 10 | 3 | 1 |
| Hepatology 1 | 33 | 41 | 11 | 21 | 2 | 4 |
| Hepatology 2 | 12 | 48 | 7 | 26 | 1 | 7 |
| Hepatology 3 | 20 | 16 | 12 | 13 | 2 | 0 |
| Medical 1 | 61 | 119 | 17 | 13 | 7 | 6 |
| Medical 2 | 50 | 215 | 19 | 36 | 4 | 14 |
| Medical 3 | 8 | 52 | 5 | 23 | 0 | 4 |
| Medical 4 | 76 | 169 | 33 | 40 | 6 | 16 |
| **Total** | **393** | **817** | **N/A** | | **N/A** | |

### 3.1. Statistical analysis

The Mann-Whitney U test result indicates that there is no significant difference in the prevalence of omitted doses due to unavailability of medicines pre- and post- ADC implementation across all clinical specialties, W = 31, *p*-value = 0.1655. Fig. 1 displays a boxplot which also indicates no difference but highlights the skewed data of the post implementation number of omitted doses. Mann Whitney *U* tests were also utilised to assess whether there was any difference when comparing individual specialties, pre vs post-ADC implementation. The results showed that there was no statistical difference for any specialty with $p > 0.05$ for all of them.

### 3.2. Omitted systemic antimicrobials

There were 17 antimicrobial doses omitted pre-ADC implementation and 24 doses omitted post-ADC implementation. This represents a rate of 0.003 % of all doses prescribed in the pre-ADC period and 0.005 % post-ADC implementation. A Mann-Whitney *U* test showed that this difference was not significant, W = 22.5, *p*-value = 0.3363. Pre-ADC implementation, all 17 omitted doses of ward stock antimicrobials were oral doses six (35.2 %) of which were first doses. The first dose antimicrobial omissions pre-ADC consisted of oral fluconazole ($n = 2$), aciclovir ($n = 1$), co-trimoxazole (n = 1), nitrofurantoin (n = 1) and trimethoprim ($n = 1$). Post-ADC, 4 out of 24 omitted antimicrobials (16.6 %) were intended for intravenous administration with the rest

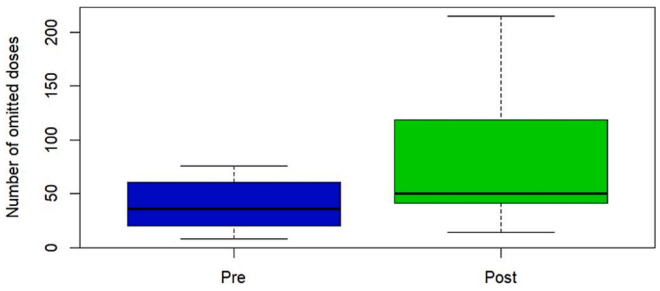


**Fig. 1.** Box plot showing the incidence of omitted doses of ward stocked medicines due to unavailability, pre- and post-ADC implementation.

intended for oral administration. The first dose antimicrobial omissions post-ADC included oral trimethoprim tablets ($n = 2$) and vancomycin infusion (n = 1).

## 4. Discussion

This study is unique in that it measures the impact of ADCs implementation on omitted doses due to ward stock unavailability when ADCs are interfaced with the hospital EPMA system. This therefore bridges a gap in the existing literature. This is important in the context of digital transformation across the National Health Service (NHS) whereby different hospitals are at varying stages of digital maturity where approximately half are known to have an EPMA platform in use.[19] Technical infrastructure and interoperability between systems to allow for the seamless flow of information and ease of use, is of utmost importance.

Omission of antimicrobials accounted for a very small proportion of all omissions. The most frequently omitted antimicrobials pre-ADC implementation were fluconazole and aciclovir. All but one of these doses were for patients on haematology words. Given both fluconazole and aciclovir are commonly used for fungal and viral prophylaxis respectively, in the context of immunosuppression secondary to chemotherapy for haematological malignancies, it is quite likely that few, if any of these doses were being used to treat active infections.[20]

There was only one intravenously prescribed first dose antimicrobial which was omitted. This was a dose of vancomycin, prescribed to a patient on a hepatology ward. As this was the only intravenously prescribed dose, it is therefore the most likely omission within this data set to have potentially had a clinically severe consequence. It was beyond the scope of this review to further investigate indication and outcome. A 2014 study investigated the effect of adding piperacillin/tazobactam to ward based ADCs, on the average time from prescribing to administration.[21] Prior to adding the stock to the ADCs, the piperacillin/tazobactam was only procurable from the inpatient pharmacy. The results were positive and showed a significant reduction in the average time from prescription to administration, however this methodology is not directly comparable to the current study as the specific medicines available on the ward did not change significantly pre vs post-ADC implementation.[21] Due to the low data yield, further research in the field would be required to draw more robust conclusions.

The introduction of ADCs had limited effect on reducing the overall rate of omitted doses due to ward stock unavailability when assessed across multiple clinical specialties in this study. Although an unexpected result when considering perceived benefits described in literature, this aligns with findings published by Franklin et al. where the implementation of ADCs on a surgical ward did not show a reduction in missed doses due to unavailability.[15] Martin et al. measured the effect of ADCs on a medical ward and a neurosurgical ward on the rate of missed doses due to unavailability and found a 17 % reduction however it was not reported whether this was a statistically significant result.[17]

While this study focused on exploring the prevalence of omitted doses due to ward stock unavailability, in-house omission rates are noted to be low to begin with when compared to published literature available in the UK setting. Franklin et al. reported an omission rate due to unavailability of 1.6 % of opportunities for error before, and 2.1 % of opportunities for error after implementation of EPMA, ADCs and BCMA in a UK hospital.[13] A 2020 study investigated the prevalence and nature of medication omissions during a six-day data collection window, across two mental health hospitals in the UK. It reported 18,664 doses were prescribed, with 540 doses omitted, due to unavailability of the medicine. This equates to a rate of 2.9 %.[22] A quality improvement study set in Australia was published in 2014, where a steering group comprising nursing and pharmacy staff created a time critical medication list and an audit tool, in response to the growing body of evidence regarding prevalence of medication omissions. They sought to reduce omissions through audit, education and feedback. Eleven hospitals participated and contributed, with 17,361 doses audited. There were 116 omissions due to unavailability (0.7 %) of all prescribed doses.[23]

When the rate of omissions is low, naturally it becomes more challenging to reduce further. That said, the unintentional omission of a dose of medication is not entirely innocuous and results from this study indicate that first dose antimicrobials omissions can still occur when omission rates are low, with the potential for clinically significant consequences. The currents study had a dose omission rate due to unavailability of 0.08 % pre-ADC implementation, and 0.17 % post-ADC implementation. While this does represent an increase, both the pre- and post-ADC rates are noticeably lower than those of the three previously described studies.

When considering the timing of omissions, most omitted doses were noted to occur outside of normal pharmacy working hours in both the pre- and post-ADC intervention groups. This points towards a need to better promote and communicate to nursing staff how to obtain medicines required out of hours. This would include establishing where the medicine is likely to be available in other clinical areas which can be undertaken via the ADC; a process for which there is a Standard Operating Procedure (SOP). Where this is not possible, the resident on-call pharmacist should be contacted to obtain a supply.

For any ADC implemented there is a need to consider ongoing stock optimisation and rationalisation to ensure that inventory requirements for clinical areas are appropriately reviewed. The optimal balance is not easy to find, due to space limitations of ADCs, and risk of expiry and therefore financial loss if excess stock is held. Commonly, inventory levels are estimated by calculating mean usage over time. Clinical areas with a high number of different medicines causing three or more omissions over a three-month period, would benefit from a stock list review. A core function of ADCs is to prevent running out of stock by triggering an order when inventory is low. While it has been hypothesised that a subsequent stock optimisation may produce a further reduction in omitted doses, O'Neil et al. undertook stock optimisation of medicines contained in ADCs and concluded that it did not result in a significant reduction in out of stock events compared with pre-optimisation.[24] Trends in ward medicines usage are often dynamic, and can change with guideline updates, stock availability, seasonal conditions and prescribing trends. The optimal frequency of stock optimisation is likely to vary between different clinical areas as a result. More research in this field over a longer period may help to inform with this.

It is important to acknowledge that there are many causes of medication errors and ADCs are not the panacea for all. For example, ADCs reduce the risk of selecting the wrong medicine through guiding light technology but would not reduce the risk of administration to the wrong patient. Introducing new technology can improve certain aspects but can also bring its own set of potential risks. For example, if the wrong medication is loaded into the incorrect location within an ADC, it could still lead to a selection error. With this in mind, it is imperative to also recognise risks associated with automation bias and complacency.[25] Over-reliance on technology can also be risky and it is vital that users still perform their own checks to ensure accuracy and prevent mistakes. Technology use should complement, not replace user involvement. It should never be used in isolation, as individual judgement and oversight remain essential for ensuring accuracy and safety.

Interoperability with existing technologies such as EPMA is an important risk consideration for ADC implementation. Effective interoperability can help to streamline processes making them more efficient and preventing the requirement for duplicate information entry, for example, selection of patient and medication. While there is evidence to suggest that the workflow is safest when EPMA, ADCs and BCMA are used together, the net effect of nuances in technology infrastructure, the quality of the interface build, and digital maturity across different healthcare organisations make predicting the impact of ADCs on dose omissions more challenging.[13]

Comprehensive risk assessment must be undertaken prior to considering ADC implementation. Gaps in training may result in

medication errors such as omissions, which may be of particular risk out of hours when there are fewer staff available to provide support. There may be planned or unplanned downtime episodes or interface issues which may inhibit a nurse's ability to retrieve medicines at the correct time. This is not an exhaustive list of risks but merely highlights the need for consideration.

### 4.1. Limitations

Several limitations have been identified for this study. Firstly, although there is a documented process for formal ward stock list review and amendments, trained pharmacy stores staff could have adjusted ADC stock lines and levels outside the formal review process throughout the study. The stock lists from September 2023 were used to ascertain whether omitted doses were ward stock in both the pre = and post-ADC data collection period. The retrospective nature of data collection in this study could have meant that inventory changes were made following implementation and particular stock lines optimised before the planned cycle. This could have led to omitted doses being marked as ward stock, which weren't stock at the time of omission, and vice versa. However, reviewing inventories within ADC is an ongoing practice and did not appear to significantly impact the results where the number of stock lines per clinical area remained consistent pre- and post ADC implementation.

Secondly, the observation period was short therefore only a small number of clinical specialties were eligible for inclusion, impacting the sample size available and user knowledge in the post intervention group. We were unable to extend the data collection period due to the implementation of a new hospital-wide change in EPMA system in early October 2023. More research in the field with larger observation sample size and even wider range of specialties should be considered to further substantiate findings from this study.

Thirdly, where SQL reporting was used to generate the data for the total number of prescribed medicine doses for the study periods, not all of the required information was included, most notably the number of doses of antimicrobial medications prescribed was missing. Future studies should consider inclusion of all relevant data fields. In addition to omissions, delayed doses are another important type of medication administration error. Most published literature focusses on dose omissions only.[14] This study did not seek to capture delayed doses and has therefore been added as another limitation. Reports taken from EPMA systems which capture both the prescribed time and the actual administration time of each dose, should allow for the investigation of delayed doses as long as a predetermined delay window has been defined. This is a known gap in literature which would be of value to explore in the future.

## 5. Conclusion

This is the first of type study that measured the impact of ADCs implementation on omitted doses due to ward stock unavailability when interfaced with the hospital EPMA solution. With baseline omission rates low, results indicate that there is no significant difference in the rate of omitted doses of ward stock medicines due to unavailability post-ADC implementation. There was minimal change to the frequency of omitted ward stock antimicrobials. ADCs require ongoing stock optimisation to take place at regular intervals to ensure operational efficiency; further research to determine the optimal frequency of stock optimisations would help inform practice going forward. Interoperability with existing digital infrastructure is essential for risk reduction and it should be kept in mind that ADC implementation will impact only a subset of medication errors. This adds to the currently limited but growing body of evidence regarding benefits of ADCs and should assist decision makers in healthcare systems when considering ADC implementation.

## CRediT authorship contribution statement

**Emma Jeffrey:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Áine Walsh:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. **Kit Lai:** Writing – original draft, Supervision, Project administration, Methodology, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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