Exploratory Research in Clinical and Social Pharmacy 12 (2023) 100335

Contents lists available at ScienceDirect

Exploratory Research in Clinical and Social Pharmacy

journal homepage: www.elsevier.com/locate/rcsop

Enhancing the clinical pharmacy service of a large teaching hospital: Development of a new clinical prioritisation tool

Rebecca Clarke [a,b], Maeve Colleran [a], Gail Melanophy [a], Margaret Bermingham [b,*]

[a] Pharmacy Department, St James's Hospital, Dublin 8, Ireland
[b] Pharmaceutical Care Research Group, School of Pharmacy, University College Cork, Cork, Ireland

ARTICLE INFO

Keywords:
Pharmacy
Pharmacy service
Hospital
Clinical pharmacy information systems
Pharmacists

ABSTRACT

Background: The number and complexity of patients being admitted to hospitals is rising and some patients may not receive a full clinical pharmacy review or be reviewed as regularly as needed during their inpatient stay. This is a risk factor for medication errors. Clinical prioritisation identifies patients who are high-risk and most in need of a pharmacist review, targeting finite pharmacy resources to patients who will benefit the most.
Objectives: Assess and enhance clinical prioritisation within a hospital pharmacy department.
Methods: The study was conducted in a large urban academic teaching hospital. A cross-sectional survey of clinical pharmacists in the hospital was conducted to establish the patient clinical criteria they prioritise in their work. A clinical prioritisation tool was developed based on survey findings and was integrated into an existing electronic pharmacy care interface. A pre- and post-intervention study was conducted, consisting of data collection for five days pre- and five days post-implementation of the tool. Quantitative data were analysed using descriptive and inferential statistics. Qualitative data were analysed by thematic analysis.
Results: Of 39 eligible pharmacists, 37 (95%) responded to the survey. The top-rated prioritisation criteria, including medicines reconciliation tasks and high-risk medicines, helped to inform the content of the clinical prioritisation tool. Post-intervention, there were more Level 1 complex patients reviewed by pharmacists and fewer Level 3 stable patients compared to pre-intervention. Tool sensitivity ranged from 51 to 88%, depending on the experience of the pharmacist using the tool. High levels of satisfaction with clinical prioritisation were reported by those using the tool.
Conclusion: This newly developed clinical prioritisation tool has the potential to support pharmacists in identifying and reviewing patients in a more targeted manner than practice prior to tool development. Continued development and validation of the tool is essential, with a focus on developing a fully automated tool.

1. Introduction

The number and complexity of patients being admitted to hospitals is on the rise without a corresponding increase in the number of clinical pharmacists employed.[1] As a result, some patients may not receive a full clinical pharmacy review or be reviewed as regularly as needed during their inpatient stay.[1] This is a known risk factor for medication errors.[1]

The goal of clinical pharmacy prioritisation tools is to identify patients who are high-risk and most in need of a pharmacist review, and in doing so, target finite pharmacy resources to the patients who will benefit from them the most.[2] Several prioritisation tools have been developed in recent years for use in a general adult inpatient setting.[3–9]

There is great heterogeneity in the reported tools with differences in terms of the health system in which they were developed, study design, outcomes measures, prioritisation criteria used, and validation methods reported. The Medicines Optimisation Assessment Tool[5] and tools reported by Hickson et al.,[6] Falconer et al.,[4] and Martinbiancho et al.[7] were electronic tools whereas the Adult Complexity Tool for Pharmaceutical Care (ACTPC)[3] along with tools developed by Roten et al.[8] and Kaufmann et al.[9] reported using paper-based tools. Most tools were designed to assess a patient against pre-defined prioritisation criteria and to categorise their level of risk to optimise the delivery of pharmaceutical care. A range of prioritisation criteria were identified among the tools, the most common being high-risk medicines,[3–9] polypharmacy,[3–5,7–9] certain clinical conditions,[3–7,9] renal or hepatic impairment,[3–5,7–9] age,[3–5,7,9] laboratory results,[3–5,8] and medicines

* Corresponding author at: School of Pharmacy, University College Cork, Cork, Ireland.
E-mail address: margaret.bermingham@ucc.ie (M. Bermingham).

https://doi.org/10.1016/j.rcsop.2023.100335
Received 19 July 2023; Received in revised form 20 September 2023; Accepted 20 September 2023
Available online 21 September 2023

requiring therapeutic drug monitoring.[3–6] Overall, the ACTPC contained the most prioritisation criteria ($n = 20$) and was described by its authors as potentially the most comprehensive tool available when it was published in 2021.[3] Possible benefits of such prioritisation tools proposed include improvements in patient safety and greater efficiency for pharmacy teams.[3–9] Prioritisation tools may enhance safety by detecting patients at risk of drug-related problems or medication errors,[3–6,8,9] and by ensuring that complex patients are reviewed by a pharmacist of appropriate expertise at suitable time intervals.[3,6,7] Prioritisation tools, more widely adopted in other healthcare disciplines such as nursing, can improve the overall quality of patient care,[10,11] some clinical prioritisation tools are limited by a lack of reported tool validation.[3,6]

Such tools may also optimise workflow through the de-prioritisation of low-risk patients,[5]the allocation of low-risk patients to suitably trained pharmacy technicians,[3] in training and supporting new or junior members of staff,[3] and through ease of use.[4] Therefore, time and resource savings are possible for pharmacy departments. For instance, Falconer et al. demonstrated a mean time saving of one hour per day of pharmacists' time as a result of using their fully automated clinical prioritisation tool.[4]

The aim of this study was to conduct a survey among clinical pharmacists in a large academic hospital to evaluate how they prioritise patients and what criteria they use to support their clinical prioritisation, to design a clinical prioritisation tool suitable for use in the study setting, and to assess the impact of the tool through a pre- and post-intervention study.

2. Methods

2.1. Ethical approval

Ethical approval was granted by the St James's Hospital / Tallaght University Hospital Joint Research Ethics Committee in February 2022, submission number 749. All participants provided informed consent.

2.2. Study design and setting

This study was comprised of two parts. Part 1 consisted of an anonymous cross-sectional survey of clinical pharmacists designed to evaluate methods of clinical prioritisation. The survey included questions regarding what criteria pharmacists rely on to prioritise patients, what information was most important in prioritising patients and how prioritisation methods could be improved in this hospital. Results of this survey were then used to support the development of a clinical prioritisation tool, consisting of an algorithm and upgraded pharmacy care organiser electronic interface. Part 2 involved a pre- and post-intervention study that was performed to assess the impact of the newly developed clinical prioritisation tool on pharmacist activity.

St James's Hospital employs an electronic patient medication administration record (EPMAR). The only exceptions to its use are prescriptions for insulin and some systemic anti-cancer therapies (SACT), which remain paper based. Different electronic prescribing systems are also used by the intensive care unit (ICU) and haematology-oncology specialties in the hospital. The EPMAR includes a clinical pharmacy interface, called the pharmacy care organiser, which helps to support pharmacists' clinical prioritisation. The pharmacy care organiser groups patients by ward and lists key information for each patient including demographics, an outstanding medicines reconciliation task, length of stay, the number of medicines not yet verified by a pharmacist, prescription of antimicrobials, prescription of anticoagulants, International Normalised Ratio levels, blood glucose levels, creatinine clearance, and prescription of certain high-risk medicines. The pharmacy care organiser list of high-risk medicines is based on international standards,[11] and has been further tailored for local use. A notes section is also available in the pharmacy care organiser allowing pharmacists to document information for follow-up or handover for each patient.

The inclusion criterion for both parts of the study was pharmacists employed within the clinical pharmacy department in the study hospital. The exclusion criteria were (i) pharmacists not working on general medical or surgical wards, such as those in the ICU or haematology-oncology pharmacists, as the new prioritisation tool would not be applicable to their electronic systems, and (ii) pharmacists working in non-patient-facing roles such as informatics. The primary researcher (RC), though meeting the eligibility criteria, was also excluded.

2.3. Data collection and storage

The questionnaire was developed based on an instrument previously published by Falconer et al.[12] and was adapted to account for the needs of the current setting. Expert peer review was conducted by the study team, all of whom were pharmacists, and a draft survey was piloted among 10% of clinical pharmacists in the study hospital ($n = 4$) to ensure face and content validity. The final questionnaire consisted of fifteen quantitative questions relating to clinical prioritisation criteria, two qualitative questions to gather opinions and ideas relating to clinical prioritisation, and three demographic questions. The survey instrument is available in Supplemental Materials. For clinical prioritisation criteria, pharmacists were asked to select what factors would prompt them to prioritise a patient including information on the pharmacy care organiser, medications, disease states, or patient-related factors. Where there was an option to select multiple criteria, participants were asked to choose their top five. Pharmacists were asked to select their grade of work, years of experience in hospital pharmacy, and years using the EPMAR or other electronic system in the demographics section. The survey was administered electronically using Survey Monkey® (www.surveymonkey.com). The survey was emailed to all eligible basic grade (entry level), senior and chief (lead) pharmacists in the pharmacy department ($N = 39$) on 30th March 2022. It remained open for two weeks until the 13th of April.

Anonymous survey results were stored in a password protected Microsoft Excel® spreadsheet on the hospital's internal server within the pharmacy department. Paper data collection forms from the pre- and post-intervention study were gathered at the end of each day and transcribed electronically to Microsoft Excel® before being disposed of in the confidential waste. This Excel® spreadsheet was password protected and saved securely on an internal server. No patient data were collected. Study data will be stored securely for five years, after which time they will be deleted.

2.4. Development of the clinical prioritisation tool

The prioritisation tool consisted of an algorithm designed to guide pharmacists in assessing and assigning patient priority levels. The Adult Complexity Tool for Pharmaceutical Care (ACTPC-2) was used as the basis for developing the prioritisation tool with permission from the ACTPC-2 research team.[3] The ACTPC-2 was chosen as it was considered the most comprehensive and relevant to the study setting of existing tools, though too detailed for the needs of the study hospital. Survey results and peer review from senior pharmacists, chief pharmacists and medication safety pharmacists in the hospital led to modification and refinement of the tool to produce the final version. Specifically, based on high importance ratings in the survey, high risk medicines, drug-drug or drug-disease interactions with an adverse effect, abnormal lab results relating to medication, certain disease states, and certain patient factors were classed as Level 1 or high priority in the prioritisation tool if not done so already in the ACTPC-2. Polypharmacy and older age were also defined using survey results.

Prior to the post-intervention study the tool was piloted among four pharmacists to ensure that it was relevant and efficient to use in practice. The pharmacy care organiser was then upgraded in conjunction with informatics pharmacists to include a new functionality for clinical prioritisation, to incorporate the clinical prioritisation tool into the

pharmacy care organiser workflow, and to highlight patients transferred from the ICU to ward level as these patients were automatically deemed to be high priority. The upgraded pharmacy care organiser, including the prioritisation tool, was finalised and made available to pharmacists just before the post-intervention study.

2.5. Pre- and post-intervention study

The pre- and post-intervention study each consisted of five days of data collection over a two-week period in June – July 2022. This timeline was chosen due to time allowances within the pharmacy department. Purposive sampling was used to identify 10 pharmacists to take part in the pre- and post-intervention study. Five senior pharmacists and five basic grade pharmacists working in different clinical specialties, including cardiology, respiratory medicine, microbiology, hepatology, stroke medicine, surgery, care of the older person, acute medical admissions, and general medicine, were invited to take part to be as diverse and representative as possible of the wider clinical pharmacy department. It was anticipated that this number of pharmacists, representing different grades and clinical specialties would generate sufficient data to address the study aim.

Data collection forms, presented in Supplemental Materials, were designed through peer review to capture desired information on pharmacists' clinical workflow during the intervention study. The pre-intervention data collection form captured information including (i) time spent on clinical prioritisation on that day, (ii) each pharmacist's level of satisfaction with clinical prioritisation ranked using a Likert scale, with options high, medium or low satisfaction, and (iii) the reasons why they chose to prioritise a patient using an alphabetised list of options provided, captured in free-text format. This list was modelled on the criteria within the final prioritisation tool. A comments box was offered for pharmacists to note any other information of relevance on each day of the intervention study. Quantitative data collected included the number of medicines reconciliations and clinical reviews completed, the order in which patients were reviewed, and time spent on clinical prioritisation each day. Pharmacists recorded a priority level of 1, 2, or 3, for each patient reviewed. In this case, 1 was the highest priority level, 2 was moderate priority and 3 was low priority. The post-intervention data collection form included all information captured by the pre-intervention form. In addition, on the post-intervention form, pharmacists were asked if the tool helped their clinical prioritisation decisions.

The relevant form was completed by pharmacists each day of the pre- and post-intervention data collection periods. During the pre-intervention study pharmacists were asked to complete their forms while undertaking their usual methods of clinical prioritisation, and for the post-intervention study the form was completed while having access to the clinical prioritisation tool. Additionally, post-intervention, while pharmacists used the clinical prioritisation tool to record a priority level of 1, 2, or 3 for each patient reviewed, priority levels were also retrospectively assigned by a member of the research team (RC) who applied the tool based on the reason for clinical prioritisation selected on the data collection form by the pharmacist.

2.6. Data analysis

All quantitative data were analysed using Microsoft Excel® or IBM SPSS®. Categorical data were presented as frequencies and percentages. Means and standard deviations were calculated for the time spent on prioritisation. Chi-squared tests were used to analyse the differences in the number of priority level 1, 2, and 3 patients reviewed pre- and post-intervention. Spearman's rho correlation was used to investigate the relationship between the order in which patients were prioritised and their clinical priority level. A Fisher r-to-z transformation was applied to the results to assess the significance of the difference between pre- and post-intervention correlation coefficients. Cohen's kappa statistic was calculated to analyse the level of agreement between priority levels assigned by the researcher using the clinical prioritisation tool and those assigned by pharmacists post-intervention. The sensitivity of the tool was computed from the cross-tabulation table resulting from this analysis. A paired *t*-test was applied to assess the differences in time spent on prioritisation pre- and post-intervention. The threshold for statistical significance throughout the study was 0.05.

Thematic analysis was performed to identify themes within survey responses to qualitative questions, namely methods to improve prioritisation and ideas for improvement, as well as for any comments noted by pharmacists relating to prioritisation on their pre- and post-intervention data collection forms.

3. Results

Thirty-seven pharmacists responded to the survey, response rate of 95%. Respondents were senior (60.6%), basic grade (30.3%), and chief pharmacists (9%). The majority had 4 years or more of hospital pharmacy experience (76%), and 3 years or less of using the EPMAR or other electronic system (61%). Results of the qualitative survey questions are presented in Table 1. Respondents identified medicines reconciliation tasks, high risk medicines, unverified medicines not yet reviewed by a pharmacist, pharmacist notes, and prescription of antimicrobials as the most important features of the pharmacy care organiser. Methadone, insulin, SACT, medication for Parkinson's Disease, and clozapine were considered the most high-risk medications listed in the pharmacy care organiser, and pharmacists also considered antiepileptic drugs, anticoagulants and antimicrobials to be high risk medications in their practice. Pharmacists identified acute and chronic kidney disease, infection, neurological disorders, and unstable illness as key disease states requiring clinical prioritisation, while pregnancy and breastfeeding, drug misuse, poor historian, suspected non-adherence, and recent hospitalisation were key social factors.

Themes identified by the qualitative survey questions are presented in Table 2. Methods of clinical prioritisation used by pharmacists and not presented in the survey included the use of patient referrals from other healthcare professionals and checking medication order lists to identify patients on high-risk or unusual medicines. Common suggestions to improve clinical prioritisation were to enhance the pharmacy care organiser by incorporating a clinical prioritisation tool and allowing pharmacists to assign a priority to their patients.

A clinical prioritisation tool was designed based on the outcomes of the preceding survey. The clinical prioritisation tool categorised patients into three levels: Level 1, highly complex or unstable patient; Level 2, moderately complex patient; and Level 3, stable or non-acute patient (Fig. 1). Each level is defined by prioritisation criteria and specifies the ideal frequency of pharmacist review. The footnote emphasises that a patient's priority level may change; that duties such as patient education or medicines information queries must also be completed daily; and that the tool does not replace clinical judgement. The pharmacy care organiser was upgraded to incorporate the new tool in a *Clinical Pharmacy Review* column which displays a patient's assigned priority level. Two new tasks were added to the pharmacy care organiser also, these were (i) a *Clinical Pharmacy Review* task through which a pharmacist can view the clinical prioritisation tool and assign the patient priority level, and (ii) the *Critical Care Step-down* task that highlights patients transferred from the ICU to ward level. An anonymised screenshot of the upgraded pharmacy care organiser, with the integrated clinical prioritisation tool, is given in Fig. 2.

Pre-intervention, over a five-day period, pharmacists reviewed 531 patients and conducted 168 medicines reconciliations. Post-intervention, over a five-day period, pharmacists reviewed 516 patients and conducted 159 medicines reconciliations (Fig. 3). There was a statistically significant increase in the number of Level 1 patients reviewed pre-intervention compared to post-intervention (220 patients vs. 238 patients, $p < 0.05$).

A larger positive correlation between the order of review and patient

Table 1
Top clinical prioritisation criteria and sub-criteria identified by pharmacists.

Criteria	Sub-criteria	Positive response (%)
Top five features of the pharmacy care organiser which help you to prioritise patients.	Medicines reconciliation task	89
	High risk medicines	78
	Unverified medicines	78
	Pharmacist notes	70
	Antimicrobials	59
Top five high risk medications or classes of medications.	Methadone	89
	Insulin	86
	Systemic anticancer therapy	81
	Carbidopa/levodopa (± entacapone), co-beneldopa	81
	Clozapine	76
Top five medications or medication classes you consider high risk.	Parkinson's disease medications	89
	Insulin	73
	Antiepileptics	70
	Anticoagulants	68
	Antimicrobials	68
	Systemic anticancer therapy	68
What number of unverified medicines would you consider high risk?	>5 unverified medicines	32
Do you prioritise patients where you identify a drug-drug or drug-disease interaction with a suspected toxic or subtherapeutic effect?	Yes, prioritise	95
Do you prioritise patients where you identify a drug-drug or drug-disease interaction where there is no suspected toxic or subtherapeutic effect?	No, do not prioritise	60
What degree of polypharmacy do you consider high priority?	>10 medicines	46
What number of co-morbidities would you consider high priority?	No, do not prioritise	57
Top five conditions that you consider high priority.	Acute kidney injury	81
	Infection	57
	Chronic kidney disease (eGFR <30 mL/min)	43
	Neurological disorders	43
	Any unstable disease	43
Do you prioritise your patient for review if they have abnormal lab results related to or affecting medication?	Yes, prioritise	97
Do you prioritise your patient for review if they have abnormal lab results not related to or affecting medication?	Yes, prioritise	51
Do you prioritise a patient for review if they have transferred to your ward from Intensive Care Unit or High Dependency Unit?	Yes, prioritise	97
At what age threshold would you prioritise an older adult?	≥65 years old	41
Top five patient-related or social risk factors that you consider high priority.	Pregnancy and/or breastfeeding	92
	Drug misuser	84
	Poor historian / confused	81
	Suspected non-adherence	65
	Recent hospitalization (readmission within 30 days of discharge)	51

priority level was shown for 70.0% of pharmacists post-intervention, consisting of 80.0% of basic grade and 60.0% of senior pharmacists. Statistically significant increases in the strength of the positive correlation were shown for 57.1% of these pharmacists ($p < 0.05$), while the correlation disimproved for 30.0% pharmacists post-intervention.

Reasons given by pharmacists as to why patient priority level did not influence the order of review included: (i) prioritising patients with outstanding interventions from previous days; (ii) preferentially reviewing a patient on referral from the medical or nursing team; (iii) prioritising patients not recently reviewed by a pharmacist; and (iv) medicines reconciliation tasks.

Table 2
Qualitative questions 16 and 17, thematic analysis.

Question	Themes emerging
Do you use any other criteria or method, not mentioned in the survey, to help your clinical prioritisation?	• Referrals from other healthcare professionals • Handover from a pharmacist colleague • Admissions information • Medication order lists • Information gleaned during ward visit. • Clinical criteria not included in survey options e.g., COVID-19 positive, dialysis, burns.
What ideas do you have to enhance clinical prioritisation methods for pharmacists in St James's Hospital?	• Automated electronic prioritisation • Improved referral systems • Suggestions for enhancing the pharmacy care organiser • Link up electronic systems across the hospital • Implement a clinical prioritisation tool • Expand pharmacy services

Post-intervention, basic grade pharmacists reviewed 222 patients. Their assigned priority levels matched those of the researcher in 188 (84.7%) cases (substantial $\kappa = 0.652$, $p < 0.001$). Senior pharmacists reviewed 319 patients and their assigned priority level matched that of the researcher in 212 (66.5%) cases (moderate $\kappa = 0.427$, $p < 0.001$). The sensitivity of the tool for each priority level was also determined, using the pharmacist-assigned levels as the reference standard (Table 3).

Among basic grade pharmacists, the greatest number of disagreements between the clinical prioritisation tool and pharmacist-assigned priority levels involved patient age ≥ 65 years ($n = 19$, 35.8% cases), while for senior pharmacists, the greatest disagreement occurred in patients with serious acute infections ($n = 57$, 50.4%).

The mean time spent on clinical prioritisation each day was similar between basic grade and senior pharmacists, and there was no significant difference in the time spent pre- or post-intervention. Basic grade pharmacists spent 12.8 ± 1.3 min pre-intervention and 12.6 ± 1.5 min post ($p = 0.85$), while senior pharmacists spent 15.4 ± 3.4 min pre-intervention and 12.4 ± 2.0 min post ($p = 0.14$). Post-intervention, a mean time saving of 6.5 min per pharmacist per week was observed ($p = 0.63$).

Pharmacists recorded how satisfied they were with their clinical prioritisation each day pre- and post-intervention (Fig. 4). Post-intervention, the number of high levels of satisfaction recorded increased from 6 to 15, while the number of low ratings reduced from 14 to 4.

Themes emerging from comments relating to low satisfaction levels included that satisfaction is influenced by: (i) a high workload; (ii) limited time on the ward; (iii) competing work commitments; (iv) disruptions to planned prioritisation; and (v) having to follow-up on outstanding pharmacy interventions. High satisfaction levels were associated with: (i) more manageable workloads; and (ii) the pharmacist's prioritisation activities proceeding as planned.

Pharmacists agreed that the clinical prioritisation tool helped them to prioritise on 29 of the 50 post-intervention days (58%). Basic grade pharmacists reported that the tool helped them on 64% of days and senior pharmacists reported that the tool helped them on 52% of days. Reasons given by pharmacists as to why the tool did not help were: (i) the clinical pharmacy review task did not flag for patients who were admitted before the pharmacy care organiser upgrade; (ii) a desire for

Priority Level	Prioritisation Criteria	Action
1 **Highly Complex Patient or Acute/Unstable Condition**	▪ Patient in an unstable condition and has a chronic disease e.g. Parkinson's disease, epilepsy, HIV, TB, porphyria ▪ Unstable acute condition, e.g. NSTEMI/STEMI, ADHF, thyroid crisis ▪ Acute serious infection, e.g. meningitis, sepsis, endocarditis ▪ Unstable renal/hepatic impairment ▪ Pregnant or breastfeeding ▪ Organ transplant ▪ Polypharmacy (≥10 meds) ***with*** complex regimens, e.g. drug-drug/drug-disease interaction ▪ Drug-drug or drug-disease interaction(s) ***with*** a toxic or sub-therapeutic effect ▪ High risk meds ▪ Meds requiring TDM ***with*** a toxic or sub-therapeutic effect ▪ Admission due to ADR/medication error ▪ Abnormal lab results related to/affecting medication(s) ▪ New ICU step-down	First priority for review Review every 24 -48 hrs [Mon – Fri]
2 **Moderately Complex**	▪ Stable and/or chronic disease, e.g. CKD, CLD, Parkinson's, epilepsy, IHD, CCF, HIV ▪ Age ≥ 65 (excluding MedEI wards) ▪ Bodyweight very low (< 50 kg) or high (>100 kg) ▪ History of severe medication allergy ▪ Recent admission (within 1/12) ▪ Swallow issues, medicines by enteral feeding tube or NPO ▪ Polypharmacy (≥ 10 meds) without complex regimen, e.g. drug-drug/drug-disease interaction ▪ Newly prescribed or restricted antimicrobial ▪ Palliative care patient ▪ Drug-drug or drug-disease interaction ***without*** toxic / sub-therapeutic effect ▪ Meds requiring TDM but ***without*** toxic / sub-therapeutic effect ▪ Abnormal lab results ***not*** related to/affecting medication(s)	Review after Level 1 patients Review every 48-72 hrs [Mon – Fri]
3 **Stable, Non-Acute Patient**	No Level 1 or Level 2 criteria met	Review after Level 2 patients if time permits Review 1- 2 times weekly [Mon – Fri]

Priority level may change; this tool does not replace clinical judgement. All other clinical duties *e.g. Medicines Reconciliation tasks, handovers, patient education, and nurses/doctors queries* should be prioritised appropriately

Fig. 1. Clinical prioritisation tool developed for the study, based on survey of clinical pharmacists.

more time to use the tool to adjust to the new workflow; (iii) the tool being less helpful for newly admitted patients who do not yet have a priority level assigned by a pharmacist; and (iv) the majority of patients in the pharmacist's care having the same priority level.

4. Discussion

This study assessed pharmacist views on clinical prioritisation criteria, developed a clinical prioritisation tool, integrated this tool into an existing electronic pharmacy care interface, and evaluated the tool among a sample of pharmacists. The newly developed clinical prioritisation tool demonstrated targeted delivery of pharmaceutical care to higher-risk patients. The tool was well received by pharmacists who reported positive feedback on its utility and improved satisfaction with their clinical prioritisation activities following its implementation.

The pharmacist survey informed the prioritisation criteria included in the clinical prioritisation tool. The top-rated criteria of age $\geq$ 65 years and high-risk medicines mirror known risk factors associated with medication-related harm and pharmaceutical interventions as reported in a systematic review by Suggett and Marriott.[13] These results also align with the top criteria identified in previous reports of clinical prioritisation tools,[3–9] as well as those selected by a majority of respondents to a survey by Falconer et al.[12] Specific target levels for clinical parameters were not included in the tool developed in the present study to maintain simplicity and to allow for individual clinical judgement. Others have recommended that clinical prioritisation tools should be concise in order to be practical and easy to use,[14] which the authors believe this tool achieves.

The suggestion of means of clinical prioritisation beyond an electronic tool, such as referrals from other healthcare staff, reinforces the concept that prioritisation is multifactorial and that prioritisation tools should support rather than replace clinical expertise.[12,15,16] Several pharmacists highlighted the potential value of a fully automated tool integrated into the hospital electronic system. This differs from the tool developed which is stored electronically on the pharmacy care organiser, but still requires a pharmacist to assess and assign priority levels themselves.

There was a significant increase in Level 1 patients clinically reviewed post-intervention compared to pre-intervention, with a greater increase among basic grade pharmacists than among senior pharmacists. One possible explanation for this could be that senior pharmacists are more experienced in clinical prioritisation and have established methods for prioritising compared to basic grade pharmacists. These results suggest a more targeted delivery of pharmaceutical care, aligning with the findings of Falconer et al. who cited an increase in the number of high-risk patients reviewed following implementation of their Assessment of Risk Tool.[4] Additionally, the reduction in Level 3 patients recorded by pharmacists may demonstrate another benefit of prioritisation tools only proposed by Geeson et al. in terms of potential time and resource savings arising from the de-prioritisation of low-risk patients.[5]

The lack of an assigned priority level at the time of medicines reconciliation for newly admitted patients was highlighted by pharmacists involved in the intervention study. This may have influenced correlation results, as 89% of pharmacists surveyed said that they prioritise medicines reconciliation tasks. While the appropriate patients should be selected for medicines reconciliation also, newly admitted patients could be prioritised over higher-risk existing patients as a priority level is assigned only after the reconciliation or initial clinical review is completed. Therefore, until a fully automated prioritisation tool can be implemented, the tool may be less suited to newly admitted patients.

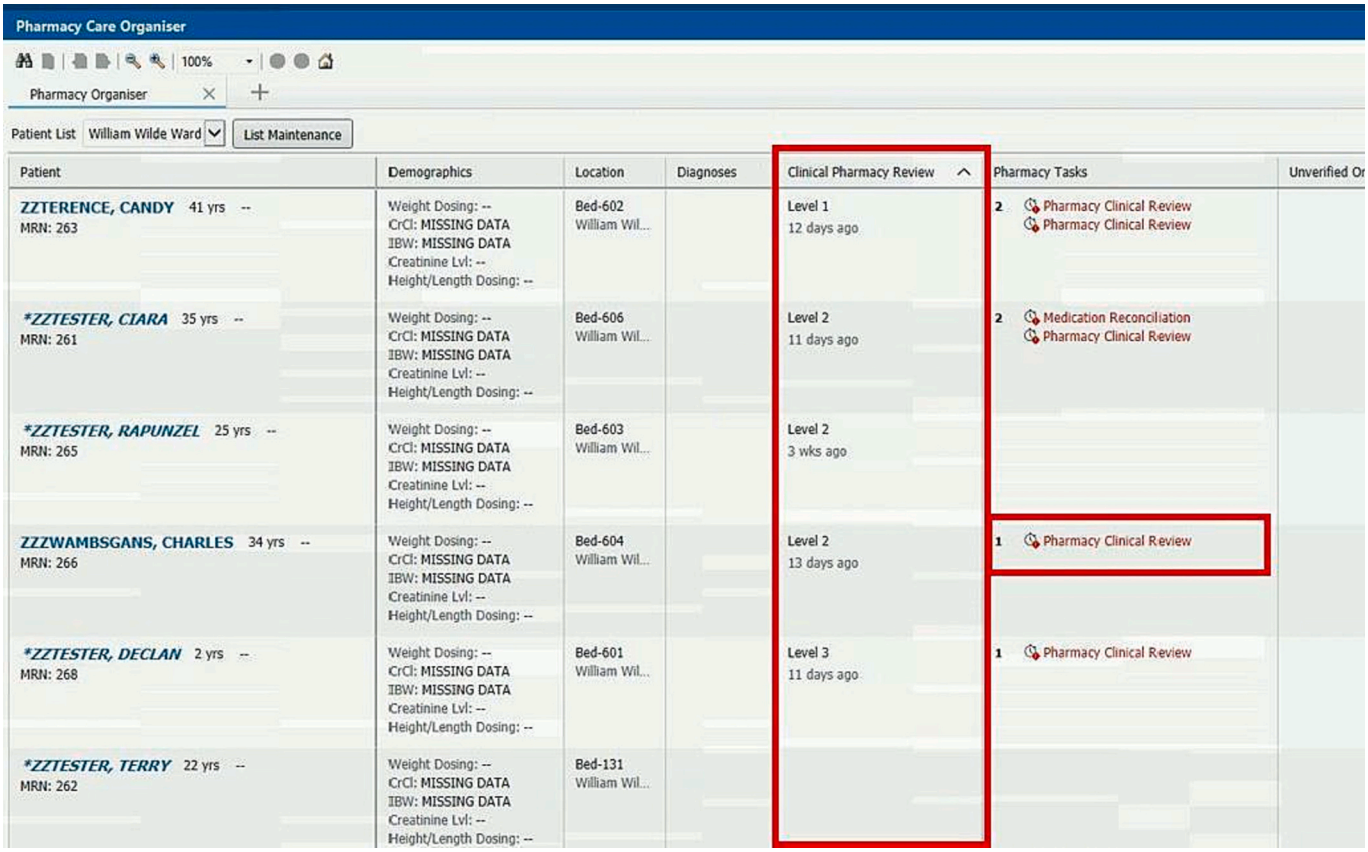

Fig. 2. Anonymised screenshot of upgraded pharmacy care organiser, with newly integrated clinical prioritisation features highlighted.

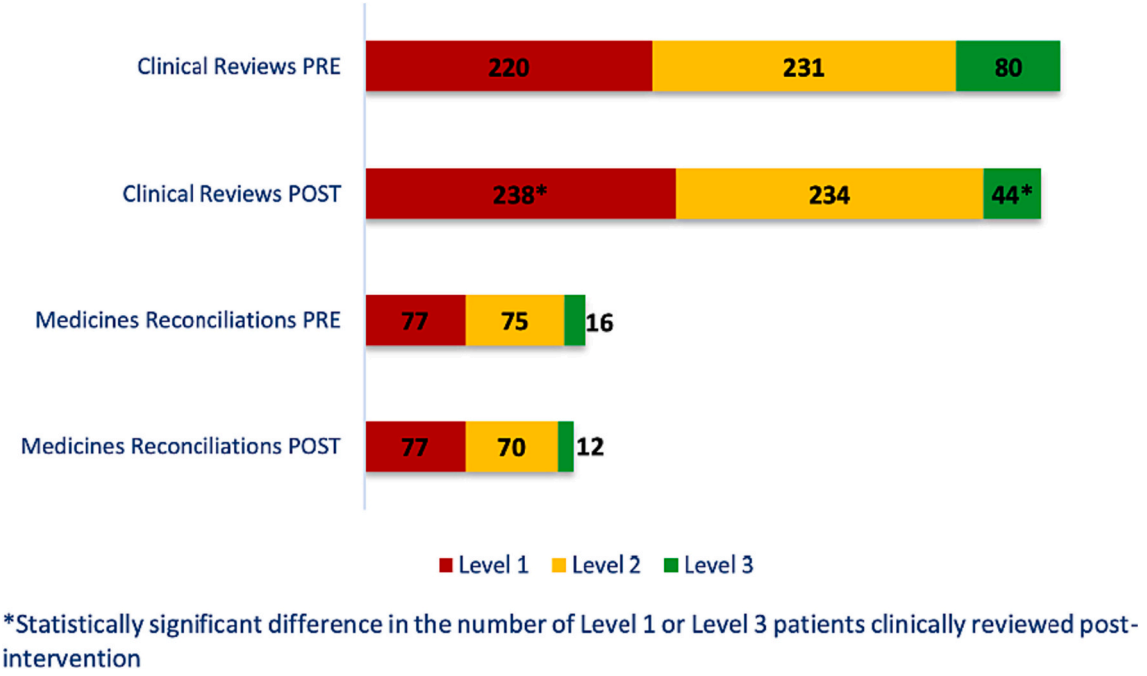

Fig. 3. Comparison of the number of medicines reconciliations and clinical reviews conducted by pharmacists pre- and post-implementation of clinical prioritisation tool.

The strength of agreement between pharmacists and the clinical prioritisation tool in terms of assigned priority levels was substantial for basic grade and moderate for senior pharmacists. There was stronger agreement with the clinical prioritisation tool in the present study compared with another instrument, the Pharmaceutical Assessment Screening Tool (PAST).[6,16] Hickson et al. calculated fair agreement when comparing patient-acuity levels assigned by the researchers applying the PAST versus those assigned by pharmacists.[6] Saxby et al.

Table 3
Sensitivity of the tool in identifying Level 1, 2, or 3 patients compared to pharmacist-assigned priority levels.

	Tool sensitivity (%)		
	Level 1	Level 2	Level 3
Basic grade pharmacist	71.4 (85/119)	93 (80/86)	76.5 (13/17)
Senior pharmacist	88.3 (113/128)	50.6 (83/164)	63 (17/27)

reported slight agreement.[16] Both Hickson et al. and Saxby et al. concluded a lack of agreement among pharmacists with the tool which warranted further review of their tool's prioritisation criteria.[6,16] Potential reasoning for the greater agreement seen in the present study includes the larger sample size. The prioritisation tool developed could be considered more agreeable as it contains more but less specifically defined criteria ($n = 25$) than the PAST ($n = 17$).[6]

There were two main reasons for review on which the tool and pharmacists disagreed when assigning priority levels, namely older age and serious infection. Most deviations relating to serious infection arose from the COVID-19 ward, and while the pharmacist assigned a variety of priority levels to their patients, serious infection is always allocated Level 1 priority by the clinical prioritisation tool. The differing levels assigned for older age patients may have arisen as other reasons not documented by the pharmacist, such as unstable renal function, could have influenced the level assigned in this patient group. Other studies have explained deviations between tool and pharmacist agreement due to differences in pharmacists' perceptions of pharmaceutical complexity, their level of experience, and instances where a higher level was assigned than recommended by the tool to serve another purpose, such as a reminder to prioritise particular tasks.[6,16] Ongoing review and modification of the clinical prioritisation tool involving all clinical pharmacists could ensure that it is consistently applied in practice.

The tool showed a high probability of detecting true Level 1, 2, or 3 patients for basic-grade pharmacists, though sensitivity varied more widely in the senior pharmacist dataset. Similar results were demonstrated for two other clinical prioritisation tools. Roten et al.[8] and Geeson et al.[5] demonstrated tool sensitivity of 85.1% and 66% - 90%, respectively, though their outcome measure, the detection of drug-related problems, differed from the present study. Sensitivity was determined over specificity in this study as the benefits of the tool in correctly categorising patients were deemed to outweigh potential negative effects of including false positives. Likewise, there are several examples in the literature where sensitivity may be prioritised over specificity when the goal is to identify patients with specific characteristics in a population.[17] Gaining consensus from all clinical pharmacists on the tool and its content is recommended and may enhance its sensitivity. Roten et al. similarly concluded that refinement of the clinical prioritisation criteria within their tool could yield a higher degree of sensitivity.[8] Increasing the number of observations in a further study could also improve the reliability of sensitivity results, as fewer Level 3 patients were reviewed compared with Level 1 or Level 2 patients post-intervention.

Basic grade pharmacists spent a similar amount of time each day prioritising clinical duties on average pre- and post-intervention. There was a mean time saving of 6.5 min per pharmacist per week, with senior pharmacists spending a mean of 3 min less per day on prioritisation post-intervention. The Assessment of Risk Tool developed by Falconer et al. was the only other tool identified that reported time saved as an outcome measure, with one hour saved daily or an 80% time saving relative to the time taken before tool implementation.[4] Considering that the mean time spent by a senior pharmacist in the present study on prioritisation each day pre-intervention was 15.4 min, 3 min represents a time saving of just 19%. This difference may be because the electronic Assessment of Risk Tool was fully automated, assigning priority levels without the need for pharmacist review. Additionally, in the present study, the prioritisation tool was newly introduced to pharmacists for the post-intervention study which consisted of five days of data collection only. Pharmacists using the Assessment of Risk Tool familiarised themselves with the tool over an 8-month study period.[4]

Pharmacists' satisfaction levels with prioritisation improved post-intervention, with an increase in high satisfaction levels reported and a reduction in low levels of satisfaction. Pharmacists' comments relating to more manageable workloads and a lack of interruption to their planned prioritisation may explain these results.

This study is one of a limited number of studies detailing the development, implementation, and impact of an electronic clinical prioritisation tool targeting adult patients in a hospital pharmacy setting. The tool itself was designed using a thorough literature, peer, and expert review process. The resulting product is simple yet extensive, developed for and trialed in a large and diverse mixed medical and surgical adult inpatient population. As a result, it is likely to translate well and be acceptable to other pharmacy departments in similar settings looking to adopt such a prioritisation tool.

There are limitations to this study. The researcher was the sole data collector which is a possible source of bias. An independent double-check of electronic data transcription from paper data collection forms by another researcher could have minimised this. Secondly, the pre- and post-intervention study was not controlled given the changing nature and turnover of patients in the hospital setting. Therefore, variety in the number and distribution of Level 1, 2, and 3 patients on any given week may account for differences in results, irrespective of the prioritisation tool. Issues highlighted by pharmacists such as high workload demands during the study could also have adversely impacted results. The duration of the pre- and post-intervention study was short which limits its reliability. A longer duration could have enabled pharmacists to become more familiar with the prioritisation tool, produced a larger dataset, and reduced the impact of variability arising from differing patient demographics or other confounders. Therefore, it is difficult to assess the true impact of the tool at this time. Lastly, as the prioritisation tool was designed and implemented for use on general adult inpatient wards

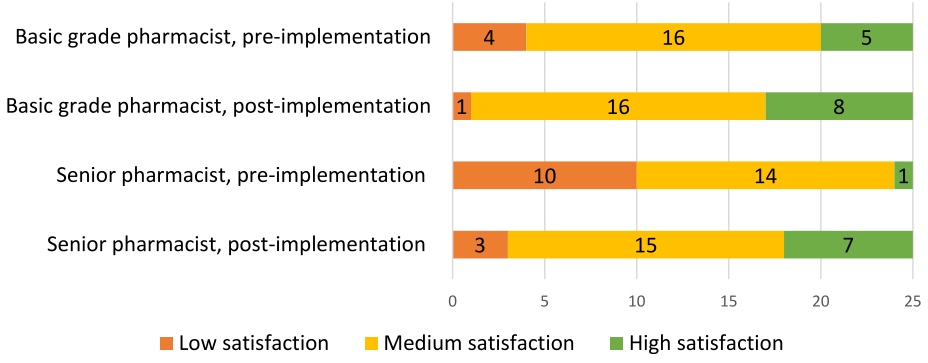

Fig. 4. Pharmacist satisfaction with their clinical prioritisation activity during the pre- and post-implementation study period.

only, the tool and study findings may not be generalisable to specialist settings such as haematology-oncology areas which were excluded from the study.

Overall, this research represents the beginning of a new and more standardised method of prioritisation and workflow for clinical pharmacists in the study hospital. A survey to gather more in-depth qualitative feedback from pharmacists involved in the pre- and post-intervention study is planned, any issues raised will be addressed, and a standard operating procedure developed so as to ensure appropriate and consistent use of the tool. Future work could include adapting the tool with the support of haematology-oncology pharmacists to suit their needs and patient cohorts. A longer study could be conducted to assess the true quantitative impacts of the tool like potential time savings and any corresponding economic impacts. Ultimately, the hope is that the tool would be automated so that priority levels could be assigned by the EPMAR system in real-time. This would give clinical pharmacy managers the oversight to better plan and manage workload. A fully automated prioritisation system could also expand the utility of the tool to newly admitted patients.

5. Conclusion

The clinical prioritisation tool developed shows the potential to enable pharmacists to identify and clinically review patients in a more targeted manner than practice prior to tool development. Preliminary results demonstrated a significant reduction in the number of Level 3 and an increase in Level 1 patients reviewed, as well as a stronger positive correlation between the order of review and patient priority level for several pharmacists following tool implementation. Further validation studies will be required both internally and externally.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors have no conflict of interest to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rcsop.2023.100335.

References

1. Office of the Chief Professional Officers (Chief Pharmaceutical Officer), Medical Directorate. Transformation of Seven Day Clinical Pharmacy Services in Acute Hospitals. NHS England. London, United Kingdom [updated 2016, Sept, cited 2023, Sept 18]. Available from https://www.england.nhs.uk/wp-content/uploads/2016/09/7ds-clinical-pharmacy-acute-hosp.pdf; 2016.
2 Lewis P. Right patient, right time, right pharmacist: the time for clinical prioritisation tools? *Eur J Hosp Pharm*. 2017;24(6). pp. 314–314.
3 Alshakrah MA, Steinke DT, Tully MP, et al. Development of the adult complexity tool for pharmaceutical care (ACTPC) in hospital: a modified Delphi study. *Res Social Adm Pharm*. 2021;17(11):1907–1922.
4 Falconer N, Nand S, Liow D, et al. Development of an electronic patient prioritization tool for clinical pharmacist interventions. *Am J Health-Syst Pharm*. 2014;71(4):311–320.
5 Geeson C, Wei L, Franklin BD. Development and performance evaluation of the Medicines Optimisation Assessment Tool (MOAT): a prognostic model to target hospital pharmacists' input to prevent medication-related problems. *BMJ Qual Saf*. 2019;28(8):645–656.
6 Hickson RP, Steinke DT, Skitterall C, et al. Evaluation of a pharmaceutical assessment screening tool to measure patient acuity and prioritise pharmaceutical care in a UK hospital. *Eur J Hosp Pharm*. 2017;24(2):74–79.
7 Martinbiancho J, Zuckermann J, Mahmud S, et al. Development of risk score to hospitalized patients for clinical pharmacy rationalization in a high complexity hospital. *Lat Am J Pharm*. 2011;30(7):1342–1347.
8 Roten I, Marty S, Beney J. Electronic screening of medical records to detect inpatients at risk of drug-related problems. *Pharm World Sci*. 2010;32(1):103–107.
9 Kaufmann CP, Stämpfli D, Mory N, et al. Drug-associated risk tool: development and validation of a self-assessment questionnaire to screen for hospitalised patients at risk for drug-related problems. *BMJ Open*. 2018;8(3), e016610.
10. Rischbieth A. Matching nurse skill with patient acuity in the intensive care units: a risk management mandate. *J Nurs Manag*. 2006;14(5):397–404.
11 O'Keeffe M. Practical steps for applying acuity-based staffing. *Am Nurse Today*. 2016;11:30–34.
12 Falconer N, Barras M, Cottrell N. How hospital pharmacists prioritise patients at high-risk for medication harm. *Res Social Adm Pharm*. 2019;15(10):1266–1273.
13 Suggett E, Marriott J. Risk factors associated with the requirement for pharmaceutical intervention in the hospital setting: a systematic review of the literature. *Drugs - Real World Outcomes*. 2016;3(3):241–263.
14 Alvarez-Risco A, Alves da Costa F, JWF Van Mil, eds. *The Pharmacist Guide to Implementing Pharmaceutical Care*. 1st ed. Springer International Publishing : Imprint: Springer; 2019, 2019.
15 Abuzour AS, Hoad-Reddick G, Shahid M, et al. Patient prioritisation for hospital pharmacy services: current approaches in the UK. *Eur J Hosp Pharm*. 2021;28(e1):e102–e108.
16 Saxby KJE, Murdoch R, McGuinness J, et al. Pharmacists' attitudes towards a pharmaceutical assessment screening tool to help prioritise pharmaceutical care in a UK hospital. *Eur J Hosp Pharm*. 2017;24(6):315–319.
17 Chubak J, Pocobelli G, Weiss NS. Tradeoffs between accuracy measures for electronic health care data algorithms. *J Clin Epidemiol*. 2012;65(3):343–349.