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ORIGINAL ARTICLE

Intervention fidelity and process outcomes of the IMMENSE study, a pharmacist-led interdisciplinary intervention to improve medication safety in older hospitalized patients

Jeanette Schultz Johansen MPharm[1] | Kjell H. Halvorsen MPharm, PhD[1] | Kjerstin Havnes MPharm[1] | Hilde Ljones Wetting MPharm, PhD[2] | Kristian Svendsen MPharm, PhD[1] | Beate Hennie Garcia MPharm, PhD[1,2]

[1]UiT The Arctic University of Norway, Tromsø, Norway

[2]Hospital Pharmacy of North Norway Trust, Langnes, Norway

Correspondence
Jeanette Schultz Johansen, Department of Pharmacy, UiT The Arctic University of Norway, Tromsø 9037, Norway.
Email: jeajoh@uit.no

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Abstract

What is known and Objective: The majority of hospitalized older patients experience medication-related problems (MRPs), and there is a call for interventions to solve MRPs and improve clinical outcomes like medical visits. The IMMENSE study is a randomized controlled trial investigating the impact of a pharmacist-led interdisciplinary intervention on emergency medical visits. Its multistep intervention is based on the integrated medicines management methodology and includes a follow-up step with primary care. This study aims to describe how the intervention in the IMMENSE study was delivered and its process outcomes.

Methods: The study includes the 221 intervention patients in the per-protocol group of the IMMENSE study. Both intervention delivery, reasons for not performing interventions and process outcomes were registered daily by the study pharmacists in a Microsoft Access® database. Process outcomes were medication discrepancies, MRPs and how the team solved these.

Results and discussion: A total of 121 (54.8%) patients received all intervention steps if appropriate. All patients received medication reconciliation (MedRec) and medication Review (MedRev) (step 1 and 2), while between 10% and 20% of patients were missed for medication list in discharge summary (step 3), patient counselling (step 4), or communication with general practitioner and nurse (step 5). A total of 437 discrepancies were identified in 159 (71.9%) patients during MedRec, and 1042 MRPs were identified in 209 (94.6%) patients during MedRev. Of these, 292 (66.8%) and 700 (67.2%), respectively, were communicated to and solved by the interdisciplinary team during the hospital stay.

What is new and Conclusion: The fidelity of the single steps of the intervention was high even though only about half of the patients received all intervention steps. The impact of the intervention may be influenced by not implementing all steps in all patients, but the many discrepancies and MRPs identified and solved for the patients could explain a potential effect of the IMMENSE study.

KEYWORDS
aged, hospitalization, integrated medicines management, pharmacists, randomized controlled trial

1 | WHAT IS KNOWN AND OBJECTIVE

Providing optimal medication therapy to patients becomes more challenging with increasing age and morbidity. The majority of hospitalized older patients experience medication-related problems (MRPs), defined as events or circumstances involving medication therapy that actually or potentially interferes with desired health outcomes.[1,2] MRPs can cause serious harm followed by increased morbidity and healthcare costs, and older patients are particularly vulnerable.[3-5] Interventions to identify, prevent and solve MRPs are consequently warranted. Since medication reviews (MedRevs) alone have failed to show improved clinical outcomes,[6,7] interventions should preferably be multifaceted and multi-disciplinary.[7-9] This is the case for the integrated medicines management (IMM) model, a systematic approach that integrates the services medication reconciliation (MedRec), MedRev, patient counselling and correct dissemination of medication information at transition points, holding the clinical pharmacist as a key team member.[10,11] It is recognized that these might be common practices already in some countries. In 2012, the Norwegian hospital pharmacies decided to build their developing clinical services on the IMM model.[12] In Norway, as in many European countries, clinical pharmacy is still a novel role for hospital pharmacists[13]. Pharmacists performing MedRec, MedRev and patient educations as members of interdisciplinary ward teams is not a part of standard care in most hospitals.

The IMMENSE (Interdisciplinary collaboration across secondary and primary care to improve medication safety in the elderly) study is a two-armed randomized controlled trial (RCT) aiming to increase medication safety in older adults over 70 years (ClinicalTrials.gov Identifier: NCT02816086).[14] The intervention comprises an interdisciplinary team collaboration, applying the IMM methodology,[10,15] in addition to post-discharge communication with primary care, see Figure 1. Its primary endpoint is the rate of emergency medical visits (acute readmissions and visits to emergency departments) in intervention vs. control patients 12 months post-discharge.

The multistep intervention in the IMMENSE study aims to improve the complex process of medicines optimization and target different organizational levels. It requires trained pharmacists working in close collaboration with other health professionals and patients, and there will likely be many factors influencing the outcomes of the trial. Information about these factors is necessary to evaluate, interpret and understand the trial results and subsequently implement the intervention in routine practice or design improved interventions.[16] Information about whether the intervention was delivered according to protocol, often defined as fidelity, is important.[17] Process outcomes describe the MRPs identified and how these were solved due to the implementation of the intervention. Together, fidelity and process outcomes can be seen as potential mediators of the relationship between the intervention and its outcomes.[16,18]

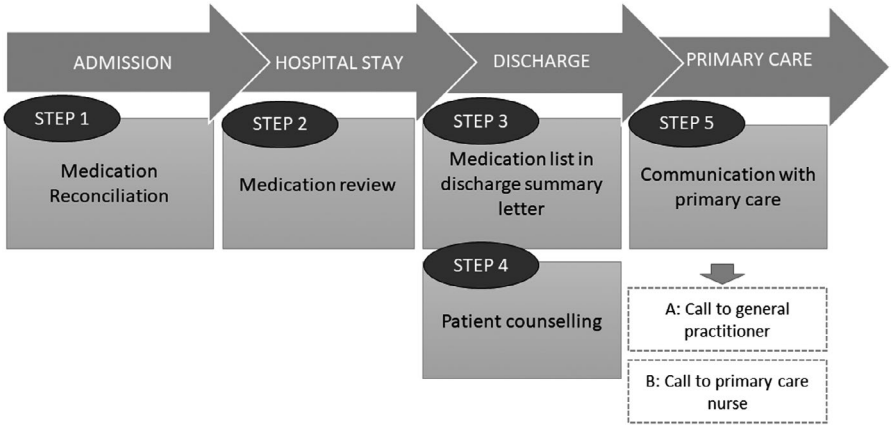

FIGURE 1 Intervention delivered in the IMMENSE (Interdisciplinary collaboration across secondary and primary care to improve medication safety in the elderly) study. Figure adapted from figure 2 in reference [12]

In this study, we aim to describe the IMMENSE study's intervention fidelity and process outcomes (see Table 1 for specific research questions).

2 | METHODS

2.1 | Study design

This study analyses data collected in The IMMENSE study, a two-armed RCT including patients from September 2016 to December 2019, finalizing follow-up in December 2020. The main results are expected in 2022.

2.2 | Setting and intervention

The IMMENSE study was conducted at two medical wards at the University hospital of North Norway.[14] Study ward A was a specialized geriatric acute care ward, with a pharmacist present every weekday from 8 am to 3.30 pm. Study ward B was a general internal medicine ward in a smaller hospital with a pharmacist present every other weekday from 8 am to 3.30 pm. Patients were randomized 1:1 to an intervention or control group. A full description of the intervention can be found in the published protocol.[14] Briefly, the intervention comprised five steps: (1) medication reconciliation (MedRec) at admission, (2) medication review (MedRev) during the hospital stay, (3) a comprehensible and patient-friendly medication list with explanations in discharge summary (draft made by the pharmacist), (4) patient counselling at discharge with updated medication list and (5) post-discharge phone calls to primary care (see Figure 1). Detailed standard operational procedures guided all steps. Control group patients received standard care, that is care *without* a pharmacist in the team.

2.3 | Participants

The IMMENSE study included patients aged 70+ years, as described in the study protocol.[14] Of the 516 included patients, 259 were randomized to the intervention group. The present study includes the 221 intervention patients in the per-protocol group, 181 from study ward A and 40 from study ward B.

2.4 | Data collection

The study pharmacists documented patient information and interventions delivered per patient in a Microsoft Access® study database, in addition to process outcomes (medication discrepancies and MRPs) and results from team discussions. Reasons for not delivering the intervention steps were also recorded. In addition, the pharmacists documented all patient counselling and communication with primary care in the patients' medical records.

2.5 | Intervention fidelity

We used the study database to identify which intervention steps had been delivered to each patient or whether there were protocol deviations when adapting the intervention in real life. For example, the protocol states that the patient's general practitioner should be contacted within 1 week of discharge, but this was not always possible. The full intervention coverage was calculated as the number of patients where the study pharmacist had self-declared delivering intervention steps, also including steps not delivered when not relevant to patients according to the study protocol. For this study, step five was dichotomized as following: a) call to general practitioners and b) call to primary care nurses.

2.6 | Process outcome assessment

A medication discrepancy was defined as an inconsistency between the medication list in the hospital and the medication list obtained by the study pharmacist after a structured MedRec process. Medication discrepancies were categorized applying categories developed and used in the Norwegian IMM procedure, with some local adaptions (Table 2). MRPs identified during MedRev, and considered by pharmacists to be relevant for team discussion, were categorized by applying the validated classification system for MRPs developed by Ruths et al.[19] Recommendations to solve MRPs were classified into 15 categories developed by the research team (Table 2). Outcomes from discussions within the interdisciplinary team were categorized as following: i) recommendation implemented, ii) MRP to be communicated to general practitioners, iii) recommendation not implemented by physician or rejected by patient, iv) implementation status unknown or missing.

2.7 | Data analysis and statistics

We used IBM® SPSS Statistics version 26 and Microsoft® Excel 2019 for data management and analysis. Results are described with numbers, means and standard deviations (SDs). The median, interquartile range (IQR) and minimum and maximum values have been applied for non-normally distributed data.

2.8 | Ethical approval

The IMMENSE study has approval from the Norwegian Centre for Research Data and the Norwegian Data Protection Authority to collect, store and link research data. Informed consent was

TABLE 1 Research questions for this study, table inspired by Kempen et al[24]

	Research questions
Intervention fidelity	What percentage of intervention group patients received the different intervention steps as defined in the study protocol?
	What were the reasons for protocol deviation?
	Is there a difference in fidelity between the two study wards?
Process outcomes	In what percentage of patients did the study pharmacist identify medication discrepancies?
	In what percentage of patients did the study pharmacist identify MRPs?
	What number and types of discrepancies were identified during MedRec?
	What number and types of MRPs were identified during MedRev?
	What proportion of discrepancies were discussed in the interdisciplinary team?
	What types of recommendations were made to solve MRPs?
	What was the outcome of the medication-related discussions in the interdisciplinary team?

obtained from patients or from next of kin when patients were not competent to consent.

3 | RESULTS

3.1 | Study population

Of the 221 patients, 63.3% were females, the mean age was 83.4 (SD 6.3), and the median length of hospital stay was five days (IQR: 3–8.5, range 0–48). Before MedRec, the median number of medications used regularly and as needed were 6 (IQR:4-9, range 0-23) and 2 (IQR:0-3, range 0-11). At discharge, only 49 patients (22.2%) self-administered medications.

3.2 | Intervention fidelity

A total of 121 (54.8%) patients received the full intervention, which was higher in study ward A (58.6%) compared to study ward B (37.5%). Most patients (34.8%) not receiving the full intervention missed only one step (see Figure 2)

Step 1–2. All patients (n = 221) received MedRec and MedRev.

Step 3. A medication list according to the study protocol was present in the discharge summary for 177 patients (80.1%), indicating that physicians used the pharmacist drafts as intended. In 36 patients, the medication list had elements in line with the pharmacist draft but did not fully adhere. The medication list for eight patients was not in line with the study protocol.

Step 4. A patient counselling session (including next of kin for some patients) was performed in 112 patients (50.7%). For 86 patients, patient counselling was not performed because they were not in charge of their medications at discharge. Consequently, 10.5% of the study population did not receive medication counselling when they should have. Only 62 (55.3%) patients received a written medication list as part of the counselling session.

Step 5a. The pharmacists communicated medication changes, the reason for the change, and follow-up issues, including unsolved MRPs, in a phone call to the general practitioner for 153 patients (69.2%). In 28 patients, there were no changes in medications or follow-up issues justifying a call to the general practitoner. Consequently, this step was not delivered for 18.1% of patients. The study protocol states that general practitioners should be contacted within 1 week from discharge, which was achieved for 108 patients (48.9%). The median time from discharge to contact was four days (IQR 2–9, range −1, 34). The primary reason for the delayed contact was difficulties in reaching the physicians.

Step 5b. The pharmacists or the hospital nurses communicated medication changes and monitoring needs to the primary care nurses for 112 and 38 patients (68%), respectively. For 49 patients, no primary care nurse was involved in medication handling, and no follow-up call was necessary. Consequently, 10% of patients missed this step.

3.3 | Process outcomes

3.3.1 | Medication discrepancies during MedRec

The pharmacists identified 437 medication discrepancies (median 1, IQR 0–3, range 0–10) in 159 patients (71.9%), see Table 2. Of the discrepancies, 92.9% were presented to and discussed with the physician, and changes were made in the medication charts for 292 discrepancies (66.8%). The discrepancies involved 164 different medications, most frequently paracetamol and zopiclone involved in 34 and 21 discrepancies, respectively.

TABLE 2 Prosses outcomes identified in the study patients ($N = 221$)

Outcome description	Number identified	Number of patients involved, *n* (%)
DISCREPANCIES DURING MEDICATION RECONCILIATION	437	159 (71.9)
Medication omission	191	101 (45.7)
Regular use	88	
Pro re nata or temporary use	102	
Medication no longer in use	89	52 (23.5)
Frequency/dosing incorrect	82	56 (25.3)
Strength incorrect	41	33 (14.9)
Timing incorrect	22	21 (9.5)
Administration form incorrect	9	9 (4.1)
Medication mix-up (wrong medication name)	3	3 (1.4)
MRPs DURING MEDICATION REVIEW	1042	209 (94.6)
1. Medication Choice	537	181 (81.9)
a) Need for additional medication	158	
b) Unnecessary medication	197	
c) Inappropriate medication choice	182	
2. Dosage	210	124 (56.1)
a) Too high	119	
b) Low dose	53	
c) Sub-optimal dosing scheme	9	
d) Sub-optimal formulation	29	
3. Adverse drug reaction	63	51 (23.1)
4. Interaction	83	60 (27.1)
5. Medication use	29	25 (11.3)
a) Administered by health personnel	5	
b) Administered by the patient	24	
6. Other	120	78 (35.3)
a) Need for/lack of monitoring of effect and toxicity	61	
b) Lack of or unclear documentation of the medication chart /prescription	28	
c) Other	31	

3.3.2 | Medication-related problems during MedRev

A total of 1042 MRPs (median 4, IQR 2–6, range 0–28) were identified in 209 patients (94.6%), see Table 2. The most prevalent MRPs were related to medication choice, identified in 181 patients (81.9%), and dosage, identified in 124 (56.1%) patients. A total of 700 MRPs (67.2%) were solved in the interdisciplinary team in hospital as recommended by the pharmacist, while 239 MRPs (22.9%) were communicated to primary care because the general practitioner was in a better position to initiate and follow-up on changes. For the MRPs discussed with the general practitioner in step 5, 46 were solved, 11 were not solved, and for 182, actions taken by the general practitioner are unknown. Figure 3 shows the distribution of agreement with the different solutions to MRPs proposed by the pharmacist. The medications most frequently involved in MRPs included zopiclone (37 MRPs), paracetamol (35 MRPs), pantoprazole (35 MRPs), polyethylene glycol (30 MRPs) and iron preparations (30 MRPs).

4 | DISCUSSION

4.1 | Intervention fidelity

This study shows an overall fidelity of the IMMENSE intervention of 54.8%, where only one step was missing for most patients not receiving the entire intervention. It is not known which part of the intervention (if any) is the most effective, consequently the implication of missing one or more steps on the trial outcome is unknown. For the single steps, all were delivered to over 80% of patients. An

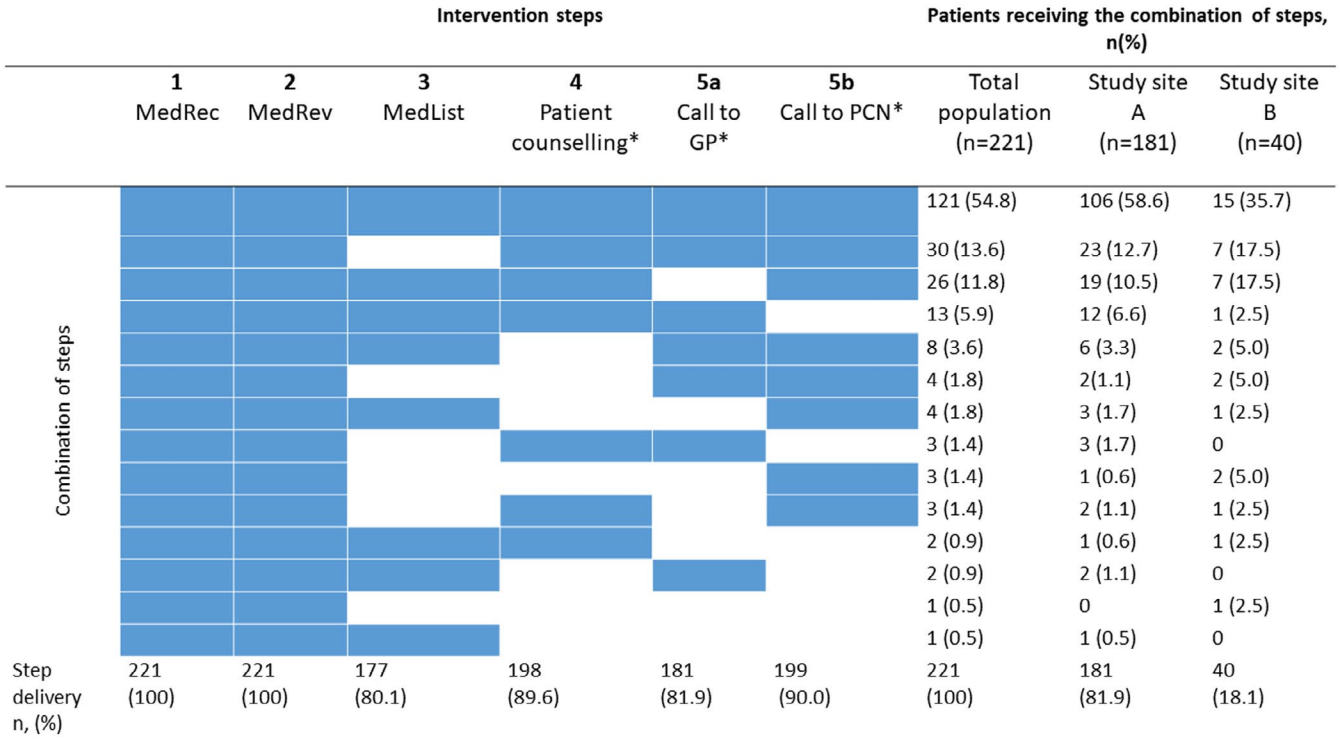

FIGURE 2 Intervention step delivery in the total population and at the two study wards. GP; General practitioner, MedRec; medication reconciliation, MedRev; Medication Review, MedLIst; Medication list at discharge, PCN; primary care nurse *Step delivery includes patients who were delivered the intervention and patients where an intervention was not indicated according to the protocol (ie patients with no primary care nurse)

overall fidelity of 54.8% is in line with other studies showing fidelity of 53–67% of similar complex interventions,[20,21] while many studies do not report overall fidelity.[9,10,22,23]

The study pharmacists performed MedRec and MedRev (step1&2) more frequently than the other steps, which has also been reported by others.[21,24] This may be because the pharmacist can perform both MedRec and MedRev independently of the team if electronic medical records and patients are available. The other steps are associated with more implementation barriers due to dependency of other team members and collaboration partners. For example, handing out written medication lists during patient counselling in step 4 was challenging as lists were often not finalized by the physicians when the pharmacist found time to speak with patients. However, we identified a high proportion (80.1%) of discharge summaries with medication lists according to the study protocol, showing a high fidelity of step 3. Timing of the delivery of the medication list may not be essential to the study results in this study population, as long as appropriate lists were transferred to primary care.

Patient counselling in step 4 was feasible in few patients due to cognitive disabilities and patients not handling medications themselves post-discharge. This may make communication with primary care (step 5) more important, contrary to findings in other patient populations showing patient counselling to be essential in similar interventions.[9] During analysis, we split step five into two sub-steps to clearly show how the intervention was carried out, which also reduces overall fidelity. The challenge of getting in contact with the general practitioner further reduced the fidelity of this step. Still, the pharmacists reached the general practitioner in 153 of the 193 patients with medication follow-up issues, 108 patients within the protocol-defined week. This is high compared with a Danish study by Ravn Nilsen et al.,[9] where the general practitioner was contacted/reached in 55.0% of patients. The authors did not report on time to reach, although their goal was within three working days.

Regarding differences between the study wards, we identified a lower fidelity in study ward B, which was expected as they did not have a full-time pharmacist at the ward. In addition, there was a higher turnover of patients in this ward (data not shown), reducing the opportunity for the pharmacists to follow-up patients.

4.2 | Factors influencing intervention delivery

We believe that slow patient recruitment in the study gave the pharmacists more time to work with individual patients compared to routine practice, which may have increased fidelity. An observational time and motion study on how the IMMENSE pharmacists spent their time identified that pharmacists used on average 3.5 hours performing clinical tasks per intervention patient, 14% of this time communicating with healthcare workers and patients.[25] It is important to note that this does not necessarily reflect the time needed to complete the clinical tasks, but when no new patients are available, more thoroughly performed MedRevs are possible.

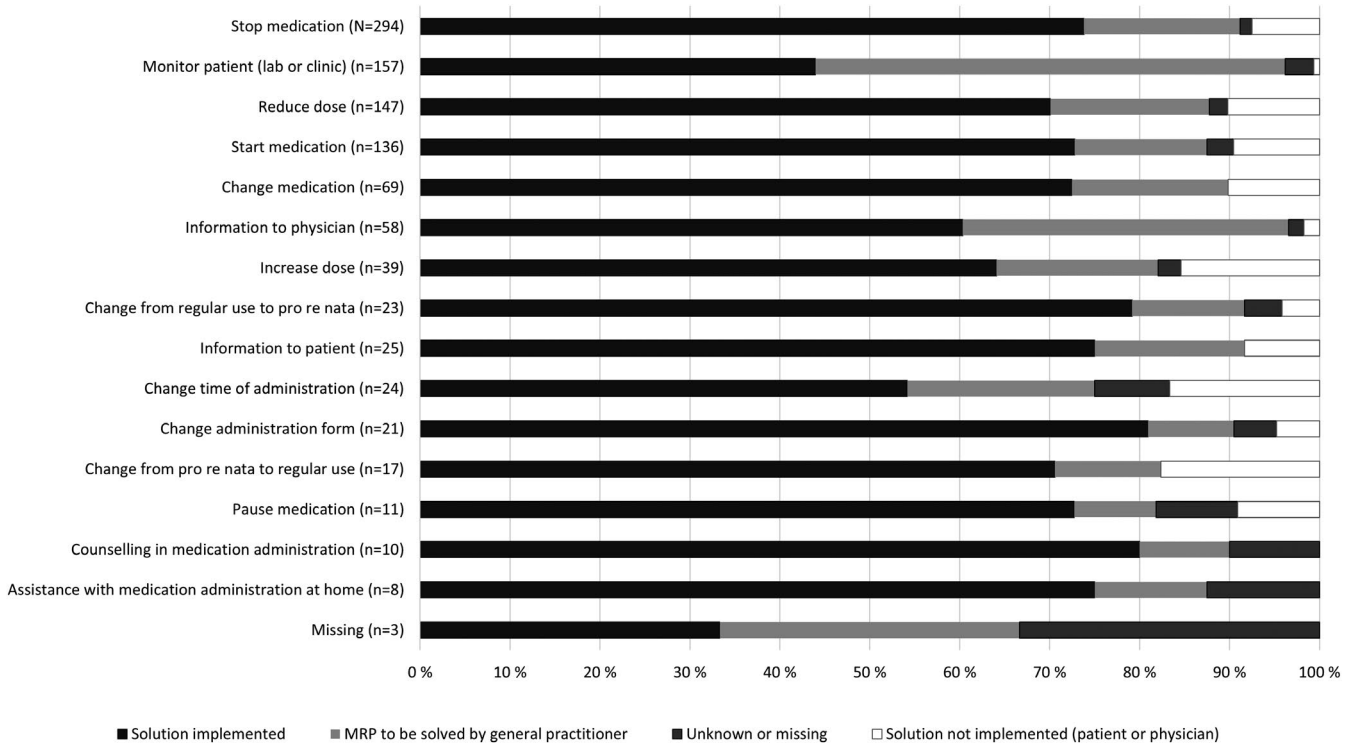

FIGURE 3 Implementation of suggested solutions to medication-related problems (MRPs) after discussion in the interdisciplinary team during the IMMENSE study ($N = 1042$)

Kempen et al. studied facilitators and barriers of ward-based pharmacist intervention in Sweden. They identified unclear roles and responsibilities of the pharmacists, the need to build personal relationships, being present at the ward, and the need for more clinical competence in pharmacists as some of the barriers to performing the intervention.[26] Similar barriers are likely to be present in our study. Having a pharmacist as an integrated team member was new both to the healthcare teams, pharmacists, patients and primary care. After study completion, both study wards have engaged clinical pharmacists in 50% positions working according to the IMM method, indicating that the other team members appreciated the pharmacist input.

4.3 | Process outcomes

The study pharmacists clearly contributed to optimizing medication use, identifying a median of one medication discrepancy and four MRPs per patient in the intervention arm. The number and frequency of discrepancies are in line with other Norwegian studies applying the IMM methodology identifying discrepancies in 70–84% of medical inpatients.[27-29] The number and frequency of MRPs are also in line with previous Norwegian and Scandinavian studies, where MRPs have been identified in 80–100% of hospitalized internal medicines patients,[2,21,23,30] in the range of 2–9 MRPs per patient.[2,22,24,30-32] The number and type of MRPs per patient vary across studies with similar interventions,[21,22,32,33] likely because of the lack of consensus concerning the classification of MRPs.[34] One outlier is the number of MRPs identified in a recently published study by Lea et al.[21] They tested IMM working procedures in an intervention similar to IMMENSE and identified 3826 MRPs in 193 intervention patients giving a mean of 19.7 MRPs per patient.[21] However, only 43% of the identified MRPs were discussed in the multidisciplinary team. Still, the difference from our findings is surprising given the similarity of the interventions and the patient populations. It may be caused by other factors like differences in pharmacist competence, adherence to the IMM procedures, and reporting and classification of MRPs.

The interdisciplinary team appreciated the pharmacist recommendations, as almost 70% were agreed upon. The high agreement rate is in line with other hospital pharmacist intervention studies in Scandinavia, showing agreement rates of 57–75%.[9,20-23,31] A reason for the high agreement in the IMMENSE study may be that the pharmacists discussed MRPs and solutions face-to-face in the interdisciplinary team, in addition to documenting in patients' records. This has been shown to increase agreement rates over written recommendations alone.[35,36]

It is to be expected that 23% of the MRPs identified by the pharmacists were communicated to the general practitioner rather than solved during hospitalization, as the general practitioners are in a better position to monitor patients when the patients are stable in their normal environment. For example, withdrawing sedative medication needs to be done over time in collaboration with the patients.[37] In addition, while optimizing medication use, it is preferable to make medication changes one by one, leaving time to monitor and evaluate the change.[38]

4.4 | Strength and limitations

By collecting and interpreting fidelity and process outcome data before the primary objectives of the IMMENSE study are analysed, we intend to give an unbiased presentation of some factors which may impact the results. The main strength of this study is the prospective day-to-day data collection in the study database as we capture the pharmacist interventions in real time and not through retrospective review, written notes and journal documents. In addition, we used a validated MRP classification system developed for a Norwegian setting and familiar to the study pharmacists.[19]

A significant limitation is that we have only measured what the study pharmacists have entered in the study database, not the quality of the intervention delivered, consequently capturing only the intervention dose delivered.[18,39] To achieve a complete fidelity description, a pre-planned process evaluation should have been performed applying a mix methods approach to measure the quality of intervention delivery, identify barriers to effective implementation, and adoptions to the context at the different study wards.[16]

Another limitation is the clinical relevance of both medication discrepancies and MRPs, as they are clearly not equally relevant. For example, paracetamol was one of the medications most often involved in MRPs and discrepancies. Although improving paracetamol use hopefully will benefit the patient, the use of paracetamol in regular doses is not frequently linked to hospitalizations.[4,40] Evaluating clinical relevance would have strengthened the interpretations of this study.

5 | WHAT IS NEW AND CONCLUSION

In the IMMENSE study, 54.8% of the patients received the full intervention, where only one step was missing in most patients not receiving the entire intervention. MedRec and MedRev were the only steps delivered to all patients. Fidelity was lower at one study ward, showing the need for the pharmacist to be continuously present in order to implement similar interventions. The impact of the intervention may be influenced by not implementing all steps in all patients, but the many discrepancies and MRPs identified and solved for patients could explain a potential effect of the IMMENSE study.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Jeanette Schultz Johansen https://orcid.org/0000-0001-7052-5142

REFERENCES

1. Pharmaceutical Care Network Europe The PCNE Classification V 9.1. Pharmaceutical Care Network Europe Foundation. https://www.pcne.org/working-groups/2/drug-related-problem-classification. Updated 10.05.2020. Accessed July 05, 2021.
2. Blix HS, Viktil KK, Reikvam A, et al. The majority of hospitalised patients have drug-related problems: results from a prospective study in general hospitals. *Eur J Clin Pharmacol*. 2004;60(9):651-658. doi:10.1007/s00228-004-0830-4
3. Pirmohamed M, James S, Meakin S, et al. Adverse drug reactions as cause of admission to hospital: prospective analysis of 18 820 patients. *BMJ*. 2004;329(7456):15-19. doi:10.1136/bmj.329.7456.15
4. Oscanoa TJ, Lizaraso F, Carvajal A. Hospital admissions due to adverse drug reactions in the elderly. A meta-analysis. *Eur J Clin Pharmacol*. 2017;73(6):759-770. doi:10.1007/s00228-017-2225-3
5. Al Hamid A, Ghaleb M, Aljadhey H, Aslanpour Z. A systematic review of hospitalization resulting from medicine-related problems in adult patients. *Br J Clin Pharmacol*. 2014;78(2):202-217. doi:10.1111/bcp.12293
6. Huiskes VJ, Burger DM, van den Ende CH, van den Bemt BJ. Effectiveness of medication review: a systematic review and meta-analysis of randomized controlled trials. *BMC Fam Pract*. 2017;18(1):5. doi:10.1186/s12875-016-0577-x
7. Dautzenberg L, Bretagne L, Koek HL, et al. Medication review interventions to reduce hospital readmissions in older people. *J Am Geriatr Soc*. 2021;69(6):1646-1658. doi:10.1111/jgs.17041
8. Van der Linden L, Hias J, Walgraeve K, Flamaing J, Tournoy J, Spriet I. Clinical pharmacy services in older inpatients: an evidence-based review. *Drugs Aging*. 2020;37(3):161-174. doi:10.1007/s40266-019-00733-1
9. Ravn-Nielsen LV, Duckert ML, Lund ML, et al. Effect of an in-hospital multifaceted clinical pharmacist intervention on the risk of readmission: a randomized clinical trial. *JAMA Intern Med*. 2018;178(3):375-382. doi:10.1001/jamainternmed.2017.8274
10. Scullin C, Scott MG, Hogg A, McElnay JC. An innovative approach to integrated medicines management. *J Eval Clin Pract*. 2007;13(5):781-788. doi:10.1111/j.1365-2753.2006.00753.x
11. Eriksson T. Results from a project to develop systematic patient focused clinical pharmacy services. The Lund Integrated Medicines Management model. *Eur J Hosp Pharm*. 2014;21(2):121-124. doi:10.1136/ejhpharm-2013-000332
12. Andersen AH, Wekre LJ, Sund JK, Major ALS, Fredriksen G. Evaluation of implementation of clinical pharmacy services in Central Norway. *Eur J Hosp Pharm*. 2014;21(2):125-128. doi:10.1136/ejhpharm-2013-000425
13. Horák P, Peppard J, Sýkora J, Miharija Gala T, Underhill J, Gibbons N. EAHP European Statements baseline survey 2015: results. *Eur J Hosp Pharm*. 2016;23(2):69-75. doi:10.1136/ejhpharm-2016-000889
14. Johansen JS, Havnes K, Halvorsen KH, et al. Interdisciplinary collaboration across secondary and primary care to improve medication safety in the elderly (IMMENSE study): study protocol for a randomised controlled trial. Vitenskapelig artikkel. *BMJ Open*. 2018;8:e020106. doi:10.1136/bmjopen-2017-020106
15. Bergkvist A, Midlov P, Hoglund P, Larsson L, Eriksson T. A multi-intervention approach on drug therapy can lead to a more

appropriate drug use in the elderly. LIMM-Landskrona Integrated Medicines Management. *J Eval Clin Pract*. 2009;15(4):660-667. doi:10.1111/j.1365-2753.2008.01080.x
16. Moore GF, Audrey S, Barker M, et al. Process evaluation of complex interventions: Medical Research Council guidance. *BMJ*. 2015;350:h1258. doi:10.1136/bmj.h1258
17. Rabin BA, Brownson RC, Haire-Joshu D, Kreuter MW, Weaver NL. A glossary for dissemination and implementation research in health. *J Public Health Manag Pract*. 2008;14(2):117-123. doi:10.1097/01.PHH.0000311888.06252.bb
18. Carroll C, Patterson M, Wood S, Booth A, Rick J, Balain S. A conceptual framework for implementation fidelity. *Implement Sci*. 2007;2:40. doi:10.1186/1748-5908-2-40
19. Ruths S, Viktil KK, Blix HS. [Classification of drug-related problems]. *Tidsskr nor Laegeforen*. 2007;127(23):3073-3076. Klassifisering av legemiddelrelaterte problemer.
20. Bladh L, Ottosson E, Karlsson J, Klintberg L, Wallerstedt SM. Effects of a clinical pharmacist service on health-related quality of life and prescribing of drugs: a randomised controlled trial. *BMJ Qual Saf*. 2011;20(9):738-746. doi:10.1136/bmjqs.2009.039693
21. Lea M, Mowé M, Molden E, Kvernrød K, Skovlund E, Mathiesen L. Effect of medicines management versus standard care on readmissions in multimorbid patients: a randomised controlled trial. *BMJ Open*. 2020;10(12):e041558. doi:10.1136/bmjopen-2020-041558
22. Gillespie U, Alassaad A, Henrohn D, et al. A comprehensive pharmacist intervention to reduce morbidity in patients 80 years or older: a randomized controlled trial. *Arch Intern Med*. 2009;169(9):894-900. doi:10.1001/archinternmed.2009.71
23. Graabaek T, Hedegaard U, Christensen MB, Clemmensen MH, Knudsen T, Aagaard L. Effect of a medicines management model on medication-related readmissions in older patients admitted to a medical acute admission unit – a randomized controlled trial. *J Eval Clin Pract*. 2019;25(1):88-96. doi:10.1111/jep.13013
24. Kempen TGH, Cam H, Kälvemark A, et al. Intervention fidelity and process outcomes of medication reviews including post-discharge follow-up in older hospitalized patients: process evaluation of the MedBridge trial. *J Clin Pharm Ther*. 2020;45(5):1021-1029. doi:10.1111/jcpt.13128
25. Havnes K, Lehnbom EC, Walter SR, Garcia BH, Halvorsen KH. Time distribution for pharmacists conducting a randomized controlled trial – an observational time and motion study. *PLoS One*. 2021;16(4):e0250898. doi:10.1371/journal.pone.0250898
26. Kempen TGH, Kälvemark A, Sawires M, Stewart D, Gillespie U. Facilitators and barriers for performing comprehensive medication reviews and follow-up by multiprofessional teams in older hospitalised patients. *Eur J Clin Pharmacol*. 2020;76(6):775-784. doi:10.1007/s00228-020-02846-8
27. Lea M, Barstad I, Mathiesen L, Mowe M, Molden E. Effect of teaching and checklist implementation on accuracy of medication history recording at hospital admission. *Int J Clin Pharm*. 2016;38(1):20-24. doi:10.1007/s11096-015-0218-9
28. Nilsson N, Lea M, Lao Y, et al. Medication discrepancies revealed by medication reconciliation and their potential short-term and long-term effects: a Norwegian multicentre study carried out on internal medicine wards. *Eur J Hosp Pharm*. 2015;22(5):298-303. doi:10.1136/ejhpharm-2015-000686
29. Aag T, Garcia BH, Viktil KK. Should nurses or clinical pharmacists perform medication reconciliation? A randomized controlled trial. *Eur J Clin Pharmcol*. 2014;70(11):1325-1332. doi:10.1007/s00228-014-1741-7
30. Hellström L, Eriksson T, Bondesson Å. Prospective observational study of medication reviews in internal medicine wards: evaluation of drug-related problems. *Eur J Hosp Pharm*. 2021;28(Suppl 2):s128-s133. doi:10.1136/ejhpharm-2020-002492
31. Bergkvist Christensen A, Holmbjer L, Midlov P, et al. The process of identifying, solving and preventing drug related problems in the LIMM-study. *Int J Clin Pharm*. 2011;33(6):1010-1018. doi:10.1007/s11096-011-9575-1
32. Bondesson A, Eriksson T, Kragh A, Holmdahl L, Midlöv P, Höglund P. In-hospital medication reviews reduce unidentified drug-related problems. *Eur J Clin Pharmacol*. 2013;69(3):647-655. doi:10.1007/s00228-012-1368-5
33. Kempen TGH, Bertilsson M, Hadziosmanovic N, et al. Effects of hospital-based comprehensive medication reviews including post-discharge follow-up on older patients' use of health care: a cluster randomized clinical trial. *JAMA Network Open*. 2021;4(4):e216303. doi:10.1001/jamanetworkopen.2021.6303
34. Basger BJ, Moles RJ, Chen TF. Application of drug-related problem (DRP) classification systems: a review of the literature. *Eur J Clin Pharmacol*. 2014;70(7):799-815. doi:10.1007/s00228-014-1686-x
35. Bedouch P, Tessier A, Baudrant M, et al. Computerized physician order entry system combined with on-ward pharmacist: analysis of pharmacists' interventions. *J Eval Clin Pract*. 2012;18(4):911-918. doi:10.1111/j.1365-2753.2011.01704.x
36. Pound MW, Miller SM. Written versus oral recommendations made by pharmacy students during internal medicine rotations. *Ann Pharmacother*. 2007;41(5):772-776. doi:10.1345/aph.1H668
37. Pottie K, Thompson W, Davies S, et al. Deprescribing benzodiazepine receptor agonists. *Evid Based Clin Pract Guideline*. 2018;64(5):339-351.
38. Duncan P, Duerden M, Payne RA. Deprescribing: a primary care perspective. *Eur J Hosp Pharm*. 2017;24(1):37-42. doi:10.1136/ejhpharm-2016-000967
39. Gearing RE, El-Bassel N, Ghesquiere A, Baldwin S, Gillies J, Ngeow E. Major ingredients of fidelity: a review and scientific guide to improving quality of intervention research implementation. *Clin Psychol Rev*. 2011;31(1):79-88. doi:10.1016/j.cpr.2010.09.007
40. Howard RL, Avery AJ, Slavenburg S, et al. Which drugs cause preventable admissions to hospital? A systematic review. *Br J Clin Pharmacol*. 2007;63(2):136-147. doi:10.1111/j.1365-2125.2006.02698.x

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