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RESEARCH ARTICLE

Pharmacist-led medicine use review in community pharmacy for patients on warfarin

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Abstract

Background Medicine use review by pharmacists has the potential to improve anticoagulation therapy management in patients on warfarin. *Objective* To develop, implement and evaluate a pharmacist-led medication use review service for patients on warfarin. *Setting* Six community pharmacies in Malta. *Method* Patients (N = 100) aged 18 or older and on warfarin were recruited through pre-selected community-pharmacies. These patients were then invited to attend two sessions: a review session (t_1) and a follow-up session after 2 months (t_2). During the medication use review session, medication reconciliation was performed (a) to detect drug-related problems using the DOCUMENT classification system, (b) to develop an individualised care plan for each patient and (c) to recommend an action for each identified problem for physician, pharmacist or patient consideration. At t_2, the degree of acceptance of the recommendations was determined by assessing the number of drug-related problems for which action was taken to address the problem. International normalisation ration (INR) control was evaluated by calculating the percentage Time in Therapeutic Range (TTR) at t_1 and t_2 using the Rosendaal linear interpolation method. *Main outcome measures* Frequency and type of drug-related problems detected; percentage of accepted recommendations; and INR control. *Results* A total of 481 drug-related problems were identified; 40% (n = 190) were related to warfarin treatment. Need for monitoring (30%; n = 145), lack of compliance (20%; n = 97) and need for patient education (19%; n = 90) were the top three problems identified. There was a significant correlation between frequency of the problems and number of chronic medications (Spearman Correlation 0.583, $p < 0.001$), number of comorbidities (Spearman Correlation 0.327, $p = 0.001$) and older age (Spearman Correlation 0.285, $p = 0.04$). A total of 475 recommendations were followed-up; 49% (n = 234) were referred for consideration by the physician. The percentage of recommendations accepted (84%; n = 397) was significantly higher than the percentage of recommendations not accepted (16%; n = 78) ($p < 0.001$). The time in therapeutic range improved significantly from 68.7% at t_1 to 79.8% at t_2 ($p = 0.01$). *Conclusions* The high percentage of accepted recommendations and the improvement in INR control indicate that a pharmacist-led medication use review service in community pharmacy contributes to improving anticoagulation therapy management in patients on warfarin.

Keywords Anticoagulation · Community pharmacist · Drug related problems · INR Control · Medicine use review · Pharmaceutical care plan

Impact on practice

- Medication use reviews are useful for patients at high risk for drug-related problems. Older age, polypharmacy, multimorbidity and high risk medication such as warfarin are associated with a larger number of problems.
- Provision of advanced patient-oriented services may be achieved by developing a clinical practitioner framework for advanced clinical community pharmacist practitioners .

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- Implementation of a pharmacist-led medication use review service in community pharmacy contributes to optimising anticoagulation therapy management in patients on warfarin therapy.

Introduction

Warfarin is considered a high-risk drug due to its narrow therapeutic window and is associated with potentially serious drug-related problems (DRPs) [1–5]. DRPs are events or circumstances involving drug therapy that may interfere with desired health-related outcomes [6]. DRPs impact treatment effectiveness and quality of life and may result in higher morbidity and mortality [6, 7]. DRPs related to warfarin may lead to hospitalisation mainly due to bleeding complications [8, 9]. The complexity of warfarin management makes patients on warfarin ideal candidates for medicine use review (MUR) [10–12].

MUR is a structured patient-centred service, where the pharmacist performs an individualised, holistic and structured evaluation of a patient's therapy to detect DRPs and develops a pharmaceutical care plan to optimise medication use and improve health-related outcomes [12, 13]. Studies in different settings have highlighted the benefits of pharmacist-led MUR in terms of therapeutic, safety and humanistic endpoints, including improvement in prescribing, patient knowledge, treatment adherence, quality of life, treatment outcomes and patient confidence in administering medications, as well as reduction in the number of DRPs, polypharmacy, overuse or misuse of medications and medication costs [6, 9, 12, 14–24]. Very few studies have assessed pharmacist-led MUR services targeting patients on anticoagulation therapy in community pharmacy [9, 17].

In Malta, the community pharmacist is not so involved in direct anticoagulation therapy management. INR testing is performed by physicians and nurses at government outpatient clinics and not in community pharmacy and dose adjustments are performed by physicians, in a number of instances through a telephone call to the patient. In 2007, dispensing of chronic medications on the Maltese national health service scheme was decentralised from government outpatient clinics to private community pharmacies, where patients select a private community pharmacy to collect their government-entitled free chronic medications, including warfarin, from the same pharmacy. This decentralisation enhanced contact between the community pharmacist and the patient and created a niche for community pharmacists to become more involved in the management of chronic diseases, including patients on anticoagulation therapy.

To-date there is no infrastructure for the provision of MUR services in Malta, hence developing and implementing a MUR framework was attempted in this study.

Aim of the study

The aims of the study were to develop, implement and evaluate a pharmacist-led MUR service in community pharmacy for patients on warfarin, to identify and describe types of DRPs in patients on warfarin and to determine factors influencing the number of DRPs.

Ethics approval

Approval to conduct the study was granted by the University of Malta Research Ethics Committee.

Methods

Study design

A pre-post single-arm study design was used to evaluate the impact of a pharmacist-led MUR over a nine-month period (April–December 2016). The study design was tested for feasibility and practicality on ten patients recruited by convenience sampling.

Study setting

The study was performed within a chain of twelve community pharmacies, and patients were recruited from six of them. The selected pharmacies had the highest number of patients registered to collect their government-entitled free chronic medications from this chain of community pharmacies, and had the availability of a private accessible area within the pharmacy where the MUR session could be performed.

Study population

One hundred patients aged 18 or older and who presented a warfarin prescription in the last 3 months were included in the study. Exclusion criteria were pregnancy, patients on pharmacotherapy for dementia and patients suffering from antiphospholipid syndrome; the latter two were identified by checking the patient's medical record and medication history.

Patient recruitment

Eligible patients were invited to participate by the managing pharmacists of the six community pharmacies with an invitation letter outlining the aim of the study, what

participation in the study entailed, benefits of participation and highlighting that participation was voluntary. The first hundred patients interested to participate were asked to give their contact details to the managing pharmacists to be used by the researcher to set an appointment with the patient. After providing written consent, patients were invited to attend two sessions with the pharmacist researcher at the community pharmacy: a MUR session (t_1) and a follow-up session (t_2).

Intervention

Development and validation of 'Anticoagulation and Medication Profile'

An 'Anticoagulation and Medication Profile' was developed (a) to record patient medical history and medications, (b) to provide written advice on warfarin treatment, and (c) to facilitate communication between different health professionals (see Supplementary Material 1). The profile was designed in a booklet format and was divided into seven sections to document patient details, medical and drug history, list of reconciled medications, pharmaceutical care plan (including DRPs detected during medication reconciliation), recommendations to address DRPs, person responsible to consider the recommendations and outcome. A section to document important information on warfarin therapy and a warfarin dosing calendar to be used as a compliance aid were included. The United Kingdom 'NHS Medicine Use Review Form' [25] and the 'MedsCheck and Diabetes MedsCheck consumer report template' [26] developed by the Pharmaceutical Society of Australia were used to guide development of the 'Anticoagulation and Medication Profile'.

This tool was validated using a two-round consensus technique by a panel of twelve experts (two cardiologists, a neurologist, a general practitioner, two community pharmacists, two clinical pharmacists, two pharmacists working in academia and two lay persons, one of whom was previously on warfarin therapy). This exercise assessed the relevance and the level of agreement with the content of each section on a 5-item Likert scale. The feedback returned by the expert panel was assessed to validate the 'Anticoagulation and Medication Profile' (refer to Data analysis). The 'Anticoagulation and Medication Profile' was translated from English to Maltese language and back translated to English by a qualified linguistic translator after validation.

Review and selection of classification system for DRPs

Classifications of DRPs adopted in literature were identified and reviewed for applicability to this scenario [27–36]. The DOCUMENT classification system [34] was selected since it was designed to be used in the community pharmacy setting, is well-constructed, easy to use and addresses both the detection of DRPs and the recommendations to resolve the DRPs [36, 37]. This tool is comprehensive and focuses on prescribing, dispensing, medication administration, patient knowledge, compliance to therapy and need for monitoring. The DOCUMENT system consists of eight main categories broadly defining DRPs and thirty subcategories specifically defining the type of DRP. The main categories are: (1) Drug selection (D), (2) Over or underdose (O), (3) Compliance (C), (4) Undertreated (U), (5) Monitoring (M), (6) Education and information (E), (7) Not classifiable (N) and (8) Toxicity or adverse reaction (T) [34].

Intervention: MUR session

A framework to enable standardisation of the MUR and follow-up sessions was developed (Fig. 1). During the MUR session (t_1) the patient's medical history and current medications were documented by the pharmacist

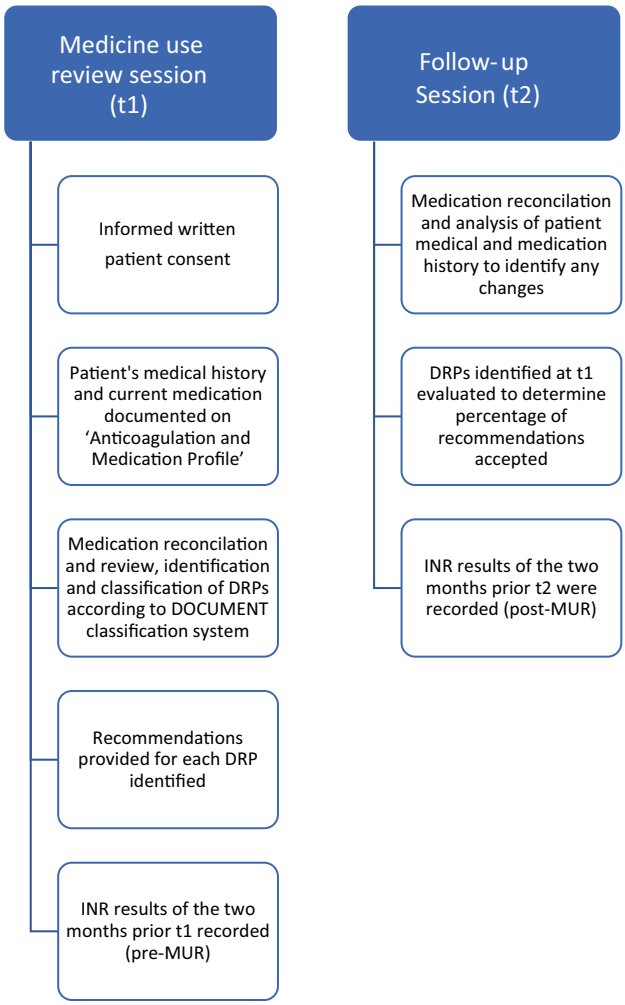

Fig. 1 Framework of the medicine use review and follow-up session

researcher on the 'Anticoagulation and Medication Profile', and medication reconciliation and medication review were performed to assess the appropriateness of prescribed drugs. An INR test was performed on each patient using a point- of-care INR testing device (*CoaguChek® XS system, Roche Diagnostics*). Patients who obtained an INR result within their target therapeutic range were advised to continue taking the same dose of warfarin and to attend for the next scheduled INR testing appointment at a government outpatient clinic. Since pharmacist prescribing is not yet permitted in Malta, patients with an out-of-range result were referred for immediate further physician assessment at a government clinic.

The compiled medical history and medications list were evaluated and comprehensively reviewed by the pharmacist researcher to identify DRPs. Medications were assessed to identify potential side-effects, contraindications, drug–drug interactions and need for routine monitoring. The Beers Criteria [38], the Screening Tool of Older Persons' Potentially Inappropriate Prescriptions (STOPP), and the Screening Tool to Alert doctors to Right Treatment (START) criteria [39] were used to identify potentially inappropriate medication and presence of potentially omitted medications, while drug informatics sources including the British National Formulary (2016) [40] and Summary of Product Characteristics (SmPCs) were consulted as evidence-based resources for DRP identification. Patient understanding of treatment rationale and adherence to treatment were also assessed.

Each identified DRP was classified in a category and sub-category of the DOCUMENT classification system and was documented on the 'Anticoagulation and Medication Profile'. A recommendation was provided by the pharmacist researcher with the aim to manage the DRP to be addressed by the caring physician, the community pharmacist or the patient, and was also classified according to the DOCUMENT classification system [34].

DRPs that were addressed through counselling and provision of information by the pharmacist researcher during the MUR session included issues on non-adherence, concerns about side-effects and need for education and information. The recommendations related to changes in medication and need for monitoring required physician intervention, hence the patients were advised to contact their family physician to discuss the recommendations. Patients requiring adherence aids or who had problems related to the dispensing process and access to medications were referred to their community pharmacist. Recommendations which required an action by the patient to modify practices to improve treatment management and to resolve the identified DRPs were explained to the patient. The patients were encouraged to keep the profile updated after visiting the family physician and/or community pharmacist and to bring it to the follow-up session (t_2).

Follow-up session

The follow-up session (t_2) was performed by the pharmacist researcher two months after the MUR session. The 'Anticoagulation and Medication Profile' was reviewed and medication reconciliation and medication review were performed again. Any changes in medication were documented for each patient. All the recommendations provided during the MUR session (t_1) for the DRPs identified were assessed. The degree of acceptance of the pharmacist researcher's recommendations was evaluated by determining the number of DRPs for which the recommendation to address the DRP was accepted and action taken to solve or monitor the problem. DRPs which were not solved since the recommendation provided was not accepted or not implemented within the study period were also documented.

INR results

INR results of the 2 months prior to t_1 were recorded at t_1 and INR results of the 2 months prior to t_2 were recorded at t_2. The INR results were used to estimate percentage Time in Therapeutic Range (TTR) using the Rosendaal linear interpolation method [41, 42]. The percentage duration spent below therapeutic range, within therapeutic range and above therapeutic range was calculated at t_1 and t_2. Pre- and post- MUR TTR were compared to assess the impact of pharmacist-led service on INR control.

Study outcomes

The outcomes were the type and frequency of DRPs detected during the MUR session, percentage of recommendations accepted during the follow-up period and INR control measured at both time-points (t_1 and t_2).

Data analysis

Data was analysed using IBM SPSS Statistics 24. For validation of the 'Anticoagulation and Medication Profile', a mean score out of 5 was calculated for each section. Sections were considered valid if a mean score of 4.5 or higher was obtained. Sections with a mean score less than 4.5 were amended. A second validation round was performed with the same expert panel and consensus on the final version of the profile was reached with all sections obtaining a mean score greater than 4.5.

For analysis of patient data, categorical variables were reported as frequencies and percentages and continuous variables as mean ± standard deviation (range). The Spearman Correlation Test was used to determine the association between the number of DRPs and the number of medications, the number of comorbidities and age. The difference

of two proportions z-test was used to compare the percentage of recommendations accepted and not accepted. A 0.05 significance level was adopted for the statistical analysis.

Data collected during the MUR was analysed to determine the frequencies of the DRP categories and recommendations. During the follow-up session each DRP was classified as recommendation accepted, if action was taken according to the pharmacist's recommendation to solve the DRP, or not accepted, if the recommendation by the pharmacist was not accepted and no action was taken. The impact of the pharmacist-led MUR was determined according to the percentage of recommendations that were accepted by the physician, community pharmacist and/or the patient at follow-up.

Results

The mean age of the 100 patients was 70.5 ± 10.3 years {33–89}, 56% patients were male and 71% were taking warfarin for atrial fibrillation. Patient characteristics are described in Table 1. Point-of-care INR testing performed at t_1 identified 40% of patients with an INR value outside their target therapeutic range. At t_2, 1 patient withdrew from the study and 2 patients switched to a direct oral anticoagulant, hence comparison of INR control pre- and post-MUR and evaluation of the recommendations at t_2 was reported for 97 patients.

A total of 481 DRPs were identified at t_1 (mean 5 ± 1.8, range 0–9 DRPs per patient). There was a significant correlation between the number of DRPs and a higher number of chronic medications (Spearman Correlation 0.583, $p < 0.001$), comorbidities (Spearman Correlation 0.327, $p = 0.001$) and older age (Spearman Correlation 0.285, $p = 0.04$). Need for monitoring (30.1%, n = 145), lack of compliance (20.2%, n = 97) and need for patient education (18.7%, n = 90) were the top three DRPs identified (Fig. 2). Need for laboratory monitoring (60%, n = 87) and need for non-laboratory monitoring were the subcategories with the largest number of DRPs identified. Cardiovascular drugs were responsible for 84% (n = 404) of the DRPs. Forty percent (n = 190) of the DRPs were related to warfarin treatment, with a mean of 2 warfarin related-DRPs per patient (range 0–4 DRPs per patient). The top warfarin-related DRP was the need for education and information on anticoagulation (43.2%, n = 82).

For each DRP identified, a recommendation was provided (N = 481, mean 5 ± 1.8, range 0–9 recommendations per patient). Provision of information (37.6%, n = 181) was the most recommended intervention (Table 2). The highest number of recommendations (48.6%, n = 234) were referred for consideration by the physician. The referred recommendations predominantly addressed issues related to monitoring (37.2%, n = 87) and drug selection (32.1%, n = 75). The pharmacist researcher addressed 24.1% (n = 116) of the recommendations during the MUR session and these were mostly related to provision of patient education (77.6%, n = 90).

Of the 481 DRPs identified at t_1, 475 (98.8%) were analysed during the follow-up session (t_2). Of those, 397 (83.6%, mean = 4 per patient) were accepted by the caring healthcare professional or patient. The percentage of accepted recommendations (83.6%, n = 397) was significantly higher than the percentage of recommendations that were not accepted (16.4%, n = 84) ($p < 0.001$). The top three accepted recommendations were related to 'Monitoring' (35.6%, n = 169), 'Change in treatment' (16.8%, n = 80) and

Table 1 Patient sociodemographics and clinical data (N = 100)

Characteristic	Number of patients
Gender	
Male	56
Female	44
Age in years	
30–39	1
40–49	2
50–59	9
60–69	31
70–79	34
> 80	23
Indication for warfarin	
Atrial fibrillation	71
Heart valve replacement	13
Deep vein thrombosis	10
Ischaemic heart disease	3
Pulmonary embolism	3
Duration of warfarin treatment	
3–6 months	12
7 months–11 months	7
1 year–5 years	27
More than 5 years	54
Number of comorbidities (excluding warfarin indication)	
0	5
1	16
2	44
3	22
> 4	13
Number of medications	
1–3	13
4–6	45
7–9	29
10–11	6
> 12	7

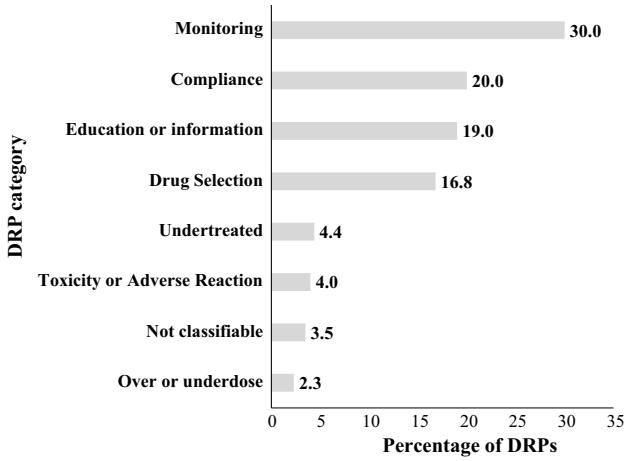

Fig. 2 Type of drug-related problems identified in the study population (N = 481) [34]

'Compliance' (13.1%, n = 62). Of the 232 recommendations referred for physician consideration, 82.9% (n = 192) were accepted and action was taken (Table 3). Eighty changes in treatment regimens were performed by the physicians following recommendations by the pharmacist researcher during the MUR session; 30 (37.5%) drug discontinuations, 21 (26.3%) dose reductions, 17 (21.3%) drug additions, and 12 (15.0%) dose increments. The number of prescribed medications decreased by 2.1% from t_1 to t_2. The DOCUMENT [34] subcategories 'drug interactions' (2.3%, n = 11), 'smoking cessation' (2.1%, n = 10) and 'no indication apparent' (2.1%, n = 10) were the ones with the highest number of non-accepted recommendations.

Percentage of TTR improved significantly from t_1 to t_2 (68.7 to 79.8%, respectively; z score 2.586; $p = 0.010$).

Discussion

In this study a pharmacist-led MUR service in community pharmacy for patients on warfarin was developed, implemented and evaluated. Ninety-seven patients attended both time points (MUR session and follow-up) during which medication reconciliation to detect DRPs was performed, an individualised care plan was developed, and recommendations for each DRP were provided and followed-up. The high percentage of accepted recommendations and the improvement in INR control indicate that a pharmacist-led MUR service in community pharmacy contributed to improving anticoagulation therapy management of patients on warfarin.

MUR formalises the counselling role of community pharmacists, enhances pharmacist professional status and presents an opportunity for pharmacists to be more involved in patient medication management [22, 43]. During the MUR session, the pharmacist researcher addressed educational gaps by providing verbal and written counselling. Face-to-face intervention improves communication and allows healthcare professionals to provide targeted education according to a patient's individual needs [44, 45]. MURs

Table 2 Recommendations classified according to DOCUMENT classification system (N = 481)

DRP category	Number (%) of DRPs	DRP subcategory	Number (%) of DRPs
Provision of information	181 (37.6)	Education or counselling session	155 (32.2)
		Recommended dose administration aid	26 (5.4)
Monitoring	148 (30.8)	Monitoring: laboratory	92 (19.1)
		Monitoring: non-laboratory	56 (11.6)
Referral required	142 (29.5)	Refer to physician: close assessment of risk–benefit ratio of treatment	64 (13.3)
		Refer to prescriber: start new drug	20 (4.6)
		Refer to prescriber: change dosage	19 (4.0)
		Refer to prescriber: confirm dosage	18 (3.7)
		Refer to prescriber: Stop drug	12 (2.5)
		Refer to prescriber: change drug	4 (0.8)
		Refer to prescriber: change instruction of use	2 (0.4)
		Other: outpatient anticoagulation clinic	2 (0.4)
		Other: nutritionist	1 (0.2)
Change of therapy	10 (2.1)	Other: drug stopped	7 (1.5)
		Dose decrease	1 (0.2)
		Drug change	1 (0.2)
		Drug formulation change	1 (0.2)

DRP drug related problem [34]

Table 3 Accepted recommendations at follow-up (N = 397)

Considered by	Total number (%) of recommendations	Number (%) of accepted recommendations	z-score	*p* value
Physician (prescriber)	232 (48.8)	192 (82.8)	14.11	< 0.001 (S)
Pharmacist researcher during MUR	114 (24.0)	83 (72.8)	6.89	
Patient	99 (20.8)	96 (97.0)	13.22	
Community Pharmacist	27 (5.7)	24 (88.9)	5.72	
Other				
(Outpatient anticoagulation clinic, nutritionist)	3 (0.6)	2 (66.7)	0.82	0.412 (NS)
Total	475 (100)	397 (83.6)	20.70	< 0.001 (S)

S significant ($p < 0.05$), *NS* not significant ($p > 0.05$)

may be considered as an opportunity for continuous provision of patient education by pharmacists [9, 12].

A total of 481 DRPs were detected, with a mean of 5 DRPs per patient. Ninety percent of patients in the present study had at least 1 warfarin-related DRP, with a mean of 2 warfarin-related DRPs per patient. The high prevalence of DRPs detected indicates the need for individualised patient assessment, medication review and development of pharmaceutical care plans to identify and address DRPs in patients on warfarin. The mean number of DRPs detected per patient in this study population lies within the range of DRPs detected in studies carried out in different countries and settings, where the mean number of DRPs per patient identified ranged from 1 to 9 [7, 19, 46–51]. The variance in the number of detected DRPs in these studies may be due to differences in the characteristics of the study populations, severity of conditions, prescribed medications, healthcare settings and type of DRP classification system used. The top DRPs identified in this study were need for monitoring (30%), lack of compliance (20%) and need for patient education (19%), and are consistent with DRPs identified in other studies [34, 51–54].

The mean age of the patients participating in the study (70.5 years) suggests that warfarin is predominantly prescribed in the older population. From this study it was observed that a higher number of DRPs was significantly associated with a higher number of medications and comorbidities and older age. Patients on multiple drug therapies and with frequent changes in treatment have a higher probability of experiencing DRPs [55–59]. Polypharmacy increases the risk of drug–drug interactions, adverse drug reactions and may lead to decreased treatment adherence and quality of life [59–63].

In Malta, patients on warfarin regularly attend anticoagulation clinics for INR monitoring and collect their chronic medications from the same community pharmacy. The high frequency of DRPs detected could imply that although patients attend for routine INR testing at government clinics and have frequent contact with the community pharmacist when they collect their entitled chronic medications, DRPs may still be overlooked since the focus of physicians at anticoagulation clinics is primarily to sustain INR within therapeutic range, with no dedicated consultation to assess and review patient treatment with other medications [64]. Implementation of a community pharmacist-led MUR service provides the opportunity to detect and address DRPs and to facilitate prevention of DRPs. MUR has great potential in patients at increased risk for DRPs, including patients with multimorbidity and polypharmacy, patients taking high-risk drugs (such as warfarin), patients with frequent changes in treatment, and patients experiencing inadequate response to therapy [56–58]. Pharmacist-led MUR in this study identified unnecessary medications or medications which interact with warfarin, and these DRPs were addressed. The reduction in the number of unnecessary medications following pharmacist-led MUR in the present study has been similarly observed in previous studies [12, 65].

The pharmacist researcher's recommendations were directed for consideration by the physician, the community pharmacist dispensing the patient's chronic medications or the patient. Forty-nine percent of the recommendations were directed to the physician, which is similar to the 52% of DRPs referred for physician attention in a previous study undertaken in Jordan [7]. Most recommendations referred to the physician included the need to re-evaluate a drug or dose or need for monitoring. The high physician acceptance rate (84%) of the recommendations indicates that physicians acknowledged the pharmacist's input through MUR. The findings in this study are comparable to previous studies, where reported acceptance rates range from 54% to 92% [50, 66]. A positive collaboration between pharmacists, physicians and patients promotes improved pharmaceutical care [19].

Pharmacist intervention in the present study resulted in a significant increase in the percentage time spent within therapeutic range ($p < 0.05$). These results confirm that targeted MUR services focusing on anticoagulation management contribute to improving INR control by screening for

DRPs, monitoring treatment and identifying confounding factors causing fluctuations in INR. Maximising time spent within therapeutic range improves treatment outcomes, while lack of INR control may lead to an increased risk of treatment complications [67–69]. Roughead et al. [9] reported that an advanced pharmacist-led MUR service providing ongoing patient education and warfarin management strategies delays time for warfarin-related hospitalisation [7]. A study by Aidit et al. [70] carried out in 2017 concluded that a pharmacist-led warfarin medication therapy adherence clinic had a positive impact on anticoagulation control.

To-date, there is limited literature that supports community-based MUR clinics targeting patients on anticoagulation therapy [9, 17]. This was the first study carried out in Malta to evaluate the impact of a community pharmacist-led MUR for patients on warfarin. Evidence from this study indicates that the Profile developed and the adoption of the DOCUMENT system [34] to sustain the intervention by community pharmacists supports management of patients on warfarin. To ensure successful and sustainable service provision following implementation, appropriate standard operating procedures, methods for quality control and quality assurance of the service, standard pharmacist accreditation processes and continuous training should be outlined.

The authors acknowledge the limitations of this study. The patients were recruited by convenience sampling since contact with participants could only be established during pharmacy hours when patients collected their entitled chronic medications which may have introduced some selection bias. No control group was investigated which may have compromised the internal validity of the study. The absence of up-to-date official patient health records may have resulted in inappropriate and incomplete patient health documentation including medical and drug history since in some instances the researcher had to rely on the accuracy of self-reported information provided by patients. Patients were only followed-up once, hence it is recommended that further studies are carried out over an extended period to assess the long-term impact of pharmacist-led MUR and the accepted recommendations. Use of written reactive notifications using the 'Anticoagulation and Medication Profile' to communicate the recommendations with the physician may have resulted in a lower rate of implemented recommendations compared to multidisciplinary face-to-face discussion. INR control was assessed over a two-month period which may be considered short and the Rosendaal method used makes assumptions that may lead to over- or underestimation of INR control.

Conclusion

The high percentage of accepted recommendations and the improvement in INR control indicate that a pharmacist-led MUR service in community pharmacy can contribute to improve the anticoagulation therapy management in patients on warfarin. Evidence from this study advocates for the expansion of the clinical activities of community pharmacists such as through provision of MUR services. Further studies with the participation of a larger number of community pharmacists and patients to investigate the impact of pharmacist-led MUR and to evaluate long-term patient and economic outcomes are warranted.

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Conflicts of interest The authors declare that they have no conflict of interest to disclose.

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