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Prevalence and Associated Cost of Hospitalization Arising from Preventable Drug-Related Problems in Singapore: A Cross-Sectional Study

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Abstract **Original Research Article**

Background: Drug-related problems (DRPs) are risk factors for preventable hospital admissions/readmissions, especially in elderly. Studies have reported the prevalence and types of DRPs in Singapore/Asian elderly, but did not classify them based on preventability, which determines the possibility of avoiding these DRPs. Literature on ways policymakers can tackle DRPs, including collaborations with and interventions by community pharmacists, and local/Asian data on resulting cost savings, is also limited. Additionally, the scarcity of economic data supporting the role of these actions restricts evaluation of their cost-effectiveness. ***Objective:*** This study aims to identify, categorize and quantify preventable DRPs present among hospital admissions, estimating associated healthcare costs. ***Methods:*** This cross-sectional study was conducted among patients admitted into Alexandra Hospital from October to December 2017. DRPs were categorised using Pharmaceutical Care Network Europe DRP classification version 8.02, then further classified as preventable, non-preventable or potentially preventable based on pre-defined criteria. Hospitalization cost was estimated using published average bill sizes from Singapore's Ministry of Health. ***Results:*** Out of 379 hospitalizations, 145 (38.3%) had one or more DRPs with 90.3% (131/145) being preventable. Most DRPs were related to pharmacotherapy non-compliance, followed by unnecessary drug therapy and adverse drug reactions. Median cost per admission was higher in hospitalizations with non-preventable DRPs on admission than those with preventable DRPs on admission, though not statistically significant ($2,217.19 vs $1,424.00, p=0.192). The average cost of admissions with preventable DRPs was sizeable especially to most elderly who could no longer earn stable incomes. ***Conclusions:*** Many DRPs found in this study can be potentially addressed by the community pharmacy sector. Possible interventions include regular medication review/reconciliation services, and provision of easy-to-understand leaflets for medications/conditions. There is still much room for service expansion in this area.
Keywords: Aged, Hospital admission, Preventable drug-related problems, Community pharmacy services.

INTRODUCTION

Similar with many advanced economies around the world, Singapore is experiencing a "silver tsunami" with a rapid increase in the proportion of residents aged 65 years and older- from 9% of the total resident population in 2010 to 13% in 2017[1]. This percentage is expected to rise further to 25.3% in 2025 and 41.2% in 2050[2]. In tandem with this ageing population, acute hospitals are facing a large proportion of elderly admissions – patients 65 years and older comprised 60.8% of admissions to acute hospitals in 2017[3].

To manage this changing healthcare landscape, the Singapore Ministry of Health (MOH) has set three key shifts for our healthcare system. The first is to move beyond healthcare to health via more effective health promotion and disease prevention. The second is to shift the center of gravity of care from the acute hospital setting to the primary care, community and home settings, while maintaining care outcomes. The last focus is to shift beyond quality to value by ensuring provision of appropriate and cost-effective care[4].

In line with this MOH healthcare transformation roadmap, it is worthwhile to look into the reasons for this large percentage of elderly admissions, in order to facilitate reallocation of resources, and prioritize initiatives that help patients cope in the community and ultimately reduce preventable readmissions. Other countries including a number in the Organisation for Economic Co-operation and Development (OECD), have also been revamping their healthcare and healthcare financing models in order to reduce admissions/readmissions and associated costs[5]. Many modifiable risk factors for preventable hospital admissions and readmissions have been

identified in the literature, including a wide array of drug-related problems (DRPs) [6-9]. It is known that the elderly population are at greater risk of experiencing DRPs, hospital admissions and readmissions [10, 11]. With better understanding on the prevalence and types of DRPs, their underlying causes and associated healthcare expenditures arising from healthcare consumption among elderly, targeted interventions may be planned for[8, 12]. Several international studies have reported on the prevalence and types of DRPs faced by elderly populations [10, 13-16], including a few on advanced Asian healthcare systems such as Singapore. In a study conducted in Singapore on a majority elderly (89.7%) population, 525 DRP were identified from 1353 medications reviewed, in 107 patients. The most common DRP identified was "failure to receive drug" (31.0%) including non-compliance, followed by "untreated indication" (26.7%)[11]. In another study population with 58.2% elderly patients, 10.8% had DRPs which resulted in or were coincidental to admission. The DRPs were all avoidable and majority involved non-compliance (28.1%), followed by adverse drug reactions (ADRs) (25%), then requiring synergistic therapy (25%)[9]. However the studies did not classify these DRPs based on preventability.

Moreover, while it has been shown that collaborations between hospital and community pharmacies can increase detection and resolution of DRPs[17] and that community pharmacists are able to promote safe use of medications through interventions[18], such discussion in literature, along with other aspects that policymakers can focus on tackling DRPs, is limited. In addition, the scarcity of economic data supporting the role of these actions restricts evaluation of their cost-effectiveness. This is especially so in Singapore and other advanced Asian economies where the research field in this subject is still in its infancy[11, 19, 20]. Yet, due to the aging population that is commonly present in these countries[21], tackling such issues is set to become increasingly important, in order to decrease hospitalizations, resource utilization and their associated cost burdens to society.

Hence, the primary objective of this study is to identify, categorize and quantify the scale of preventable DRPs among elderly admissions to our tertiary healthcare institutions, where interventions and collaborations may be explored with community pharmacist counterparts. Additional cost estimates for elderly admissions with preventable DRPs would help to derive the potential economic benefits in tackling this problem.

METHODOLOGY

Study design and data collection

This is a cross-sectional study conducted over a period of 3 months (October - December 2017). Patients admitted into Alexandra Hospital (AH) during this period were screened for inclusion into the study. Alexandra Hospital is an acute care hospital in Singapore. It is equipped with 330 inpatient beds, 2 operating theatres, and a 24-hour acute care clinic. It also accepts non-trauma and stable transfers from the emergency departments of other acute care hospitals.

Patients were included in the study if they were adult patients aged 65 and above and with unplanned admission(s) to AH during the study period. Patients were excluded from the study if they had planned admissions, or if there was incomplete data in the electronic database for data collection.

Data of eligible patients was collected from Sunrise Clinical Manager (SCM), from the following sources: Clindocs (Admission notes, Pharmacy Medication Reconciliation Notes, Pharmacy Intervention Notes, Emergency Department Notes), Hospital Inpatient Discharge Summary (HIDS), Rx Manager and Patient information (Visit history).

The data collected included: patient demographics (age, gender, race, comorbidities, drug allergy), admission related information (date of admission, date of discharge, duration of stay, ward location/class), chief complaints for the admissions, causes of admissions, discharge plan (discharge location, involvement of patient navigator, presence of social/family support), estimated cost of hospitalization (Singapore's MOH Average Inpatient Bill Size table[22] was used for computation) and medication-related information: medication list, the number of medications taken per day on a regular basis, whether the patient is seeing more than one regular physician, presence of chronic kidney or liver disease and presence of DRPs (frequent/chronic use of "only when required (PRN)" medications, presence of any potential side effects, potentially unnecessary therapy, drug-drug interactions, discrepancies in medication use, any untreated/undertreated indications).

This study is approved by the SingHealth Centralized Institutional Review Board (CIRB Reference number: 2017/2689).

Preventable DRP classification

Classification of DRPs was done according to the Pharmaceutical Care Network Europe (PCNE) DRP classification version 8.02. DRPs were classified as preventable, non-preventable or potentially preventable based on criteria defined by Hallas *et al.*[23] and Koh *et al.*[9] (Appendix: Table 6)

Sample size calculation

To establish the prevalence of preventable DRPs on admission, sample size was calculated taking reference from published prevalence of 10.8% [9]. With a more conservative estimate at 10%, and a margin error of at 3%, we would require 385 complete cases.

Statistical analysis

The baseline characteristics of the study sample were reported as proportions for categorical variables, and as medians and interquartile ranges (IQR) for continuous variables. The median cost per admission of non-preventable DRPs was compared against that for preventable DRPs using the Mann Whitney U-test. All statistical analyses were performed using IBM SPSS Version 23 (Chicago: SPSS Inc.).

RESULTS

Baseline characteristics of elderly patients admitted to AH

There were 385 cases (profiles in Table 1) included in the study during the period of October to December 2017, after excluding 15 who had yet to be discharged by the end of the data collection period.

Table-1: Baseline characteristics of study sample

Characteristic	Number (n=385)
Median age (interquartile range)	78 (71-84)
Age group (%)	
65-69	65 (16.9%)
70-74	76 (19.7%)
75-79	72 (18.7%)
80-84	81 (21.0%)
85-89	60 (15.6%)
90-94	19 (4.9%)
95-99	11 (2.9%)
100 or more	1 (0.3%)
Gender (%)	
Male	183 (47.5%)
Female	202 (52.5%)
Race (%)	
Chinese	312 (81.0%)
Malay	37 (9.6%)
Indian	30 (7.8%)
Others	6 (1.6%)
Discharge location (%)	
Home	308 (80.0%)
Nursing home	62 (16.1%)
Hospice	1 (0.3%)
Community hospitals	4 (1.0%)
Other hospitals	7 (1.8%)
Others	3 (0.8%)
Presence of social† /family‡ support (%)	
Yes	359 (93.5%)
No	26 (6.8%)
Presence of CKD§/ liver disease¶ (%)	
Yes	126 (32.7%)
CKD Stage 3	71
CKD Stage 4	39
CKD Stage 5	13
Child Pugh A	3
No	259 (67.3%)
Is patient seeing> 1 regular physician (%)	
Yes	113 (29.4%)
No	272 (70.6%)
Median number of comorbidities (interquartile range)	5 (3-7)
Median Charlson comorbidity index (interquartile range)	1 (0-2)
Median number of DRPs (interquartile range)	0 (0-1)

Legend

† Social support: being cared for in a nursing/community home, or having volunteers pack their medications.

‡ Family support: having family involvement in patient care, e.g. accompanying them on discharge from the hospital, ensuring they take their medications, packing their pillboxes.

§ Moderate/severe kidney disease: CKD stage 3 or worse.

¶ Moderate/severe liver disease: Child Pugh Score of A, B or C, or liver cirrhosis.

DRPs detected are summarized in Table 2.

Table-2: Medication profile of admitted elderly patients

Presence of >5 medications/ >12 doses/day	Number of cases (n=385)	Proportion
Yes	284	73.8%
No	101	26.2%
Is the patient using only when required (PRN) medications frequently or chronically?		
Non-steroidal anti-inflammatory drug (NSAID)/ muscle relaxant		
Yes	5	1.3%
No	13	3.4%
No such medications in list	367	95.3%
Benzodiazepine		
Yes	1	0.3%
No	6	1.6%
No such medications in list	378	98.2%
Anticholinergic		
Yes	0	0.0%
No	11	2.9%
No such medications in list	374	97.1%
Others		
Yes	4	1.0%
No	22	5.7%
No such medications in list	359	93.2%
Any potential side effects from chronic/high risk medications?		
Drugs causing anorexia/weight loss		
Yes	55	14.5%
No	324	85.5%
Drugs causing anticholinergic side effects		
Yes	29	7.7%
No	350	92.3%
Drugs causing sedative side effects		
Yes	77	20.3%
No	302	79.7%
Others		
Yes	25	6.6%
No	354	93.4%
Is the patient on drugs with unclear/ transient indication/potentially unnecessary therapy?		
Yes	42	11.1%
No	337	88.9%
Are there any drug-drug interactions (category D and above†)?		
Yes	43	11.2%
No	342	88.8%
Are there any adverse effects from the interaction?		
Yes	1	0.3%
No	378	99.7%
Barriers to medication use		
Yes	11	2.9%
No	374	97.1%
Discrepancies in medication use		
Yes	101	26.6%
No	278	73.4%
Any untreated/undertreated indications?		
Yes	13	3.4%

No	372	96.6%
Other issues		
Yes	16	4.2%
No	363	95.8%
Hospitalizations with DRP present		
Yes	145	38.3%
No	234	61.7%
Hospitalizations with preventable/non-preventable DRP		
Preventable	131	34.6%
Non-preventable	14	3.7%
No DRP	234	61.7%

Legend
† Using Lexicomp Drug Interactions tool (Wolters Kluwer).

38.3% (145/379) of hospitalisations had a DRP present. Having previously defined "preventable" in the Methodology section above, 90.3% (131/145) of hospitalisations from this study were found to have preventable DRPs on admission.

Frequency of preventable and non-preventable DRPs according to PCNE classifications were further tabulated and reported in Tables 3 and 4 respectively.

Table-3: Frequency of preventable drug-related problems

	Primary domain	Code	Elaboration	Frequency
Problems	1. Treatment effectiveness	P1.1	No effect of drug treatment	1
		P1.2	Effect of drug treatment not optimal	6
	2. Treatment safety	P2.1	Adverse drug event [possibly] occurring	9
	3. Others	P3.2	Unnecessary drug treatment	1
Causes	1. Drug selection	C1.1	Inappropriate drug according to guidelines/ formulary	1
		C1.2	Inappropriate drug (within guidelines but otherwise contra-indicated)	1
		C1.3	No indication for drug	23
		C1.4	Inappropriate combination of drugs or drugs and herbal medication	1
		C1.6	No drug treatment in spite of existing indication	6
		C1.7	Too many drugs prescribed for indication	1
	2. Drug form	C2.1	Inappropriate drug form [for this patient]	1
	3. Dose selection	C3.2	Drug dose too high	1
	5. Dispensing	C5.2	Necessary information not provided during dispensing	1
		C5.3	Wrong drug, strength or dosage advised (OTC)	2
		C5.4	Wrong drug or strength dispensed	1
	6. Drug use process	C6.2	Drug under-administered by a health professional or carer, despite proper dosage instructions (on the label)	7
		C6.3	Drug over-administered by a health professional or carer, despite proper dosage instructions (on the label)	3
		C6.4	Drug not administered at all by a health professional or carer, despite proper dosage instructions (on the label)	5
		C6.5	Wrong drug administered by a health professional or carer, despite proper	1

			dosage instructions (on the label)	
		C6.6	Drug administered via wrong route by a health professional or carer, despite proper dosage instructions (on the label)	1
	7. Patient-related	C7.1	Patient uses/takes less drug than prescribed or does not take the drug at all	69
		C7.2	Patient uses/takes more drug than prescribed	17
		C7.4	Patient uses unnecessary drug	5
		C7.6	Patient stores drug inappropriately	2
		C7.7	Inappropriate timing or dosing intervals	17
		C7.8	Patient administered/uses drug in a wrong way	3
		C7.9	Patient unable to use drug/ form as directed	2
	8. Other	C8.2	Other cause	1
Total				189

Table-4: Frequency of non-preventable drug-related problems

	Primary domain	Code	Elaboration	Frequency
Problems	1. Treatment effectiveness	P1.2	Effect of drug treatment not optimal	1
		P1.3	Untreated symptoms or indications	1
	2. Treatment safety	P2.1	Adverse drug event [possibly] occurring	8
Causes	1. Drug selection	C1.6	No drug treatment in spite of existing indication	3
	3. Dose selection	C3.2	Drug dose too high	1
	6. Drug use process	C6.2	Drug under-administered by a health professional or carer, despite proper dosage instructions (on the label)	1
	7. Patient-related	C7.1	Patient uses/takes less drug than prescribed or does not take the drug at all	2
		C7.9	Patient unable to use drug/ form as directed	1
Total				18

Costs of preventable and non-preventable DRPs on admission among elderly patients

As shown in Table 5, the median cost per hospitalisation episode with non-preventable DRPs on admission was comparable to that of those with preventable DRPs on admission (p=0.192).

Table-5: Comparison of cost of non-preventable DRPs vs cost of preventable DRPs on admission

	Cost of hospitalization with non-preventable DRPs identified ($)	Cost of hospitalization with preventable DRPs identified ($)
No. of hospitalisations	14	131
Median cost of admission† (interquartile range†)	2,217.19 (1,224.66-5,165.63)	1,424.00 (1,068-2,678.13)

†Computed with cost estimates published by Ministry of Health Singapore[22]

DISCUSSION

Profiling of elderly patients admitted to AH - DRPs

DRPs are defined as an event or circumstance involving drug treatment that may potentially or actually interfere with the patient experiencing an optimum outcome of medical care[24]. These can stem from either the patient, the physician, or at the point of dispensing[25].

The most common preventable DRPs included those which were compliance-related, followed by drug use without indication, and then related to treatment safety – the possibility of ADRs occurring.

The most common non-preventable DRPs were, in descending order, the possibility of ADRs occurring, and subsequently a tie between those which were compliance-related and when there was no drug treatment in spite of existing indication.

Compliance issues being the most common preventable DRP was in line with what we had expected, as per Koh *et al*[9]. Many other studies[26] have also reflected poor compliance rate in patients. In our study, 26.6% of patients had discrepancies in medication use, due to reasons such as perception of medications being unnecessary and the lack of observable effects after taking them. Non-compliance can lead to deterioration of disease conditions[27] and increasing costs of care. It is hence imperative to address reasons for non-compliance, which will be further elaborated on. However, we also classified a number of non-compliance cases as not preventable, which resulted in non-compliance too becoming the second most common non-preventable DRP. This included a case in which the patient was taking a lower dose of antihyperglycemic medication due to dizziness, and one where the patient refused to take a drug due to an ADR.

While the possibility of ADRs occurring was the third most common preventable DRP, it also turned out to be the most common non-preventable DRP. ADRs classified as non-preventable were those that were unpredictable, for instance acute kidney injury and hyperkalemia/hypokalemia. ADRs were deemed as preventable if no measures were taken to counteract known ADRs (e.g. hypotension with a combination of blood pressure medications, constipation due to anticholinergic drugs but the patient not being on laxatives). ADRs being among the most common DRPs corresponds to what we had expected, as in this study, 14.5%, 7.7% and 20.3% of patients were prescribed with medications with the ability to cause anorexia/weight loss, anticholinergic side effects and sedative side effects respectively, increasing risk of possible ADRs. The presence of drug interactions may further increase the possibility of ADRs - 11.3% of patients were prescribed with drugs with category D drug interactions. The probability of ADRs in elderly was also higher in literature reports compared to younger populations[28].

The second most common preventable DRP discovered is the lack of indication for the drug. In our study, most patients were prescribed unnecessary vitamins. Although relatively harmless, it still contributes to polypharmacy. Additionally, some medications like ascorbic acid for wound healing were started with a specified indication, however after this indication resolved, they may have been overlooked.

Untreated indication is the second most common non-preventable DRP, tying with compliance related issues. Some examples of such indications were low vitamin D levels and iron deficiency anemia. While untreated indications are also present among the preventable DRPs, it is not surprising that they tend to be more prominent among the non-preventable DRPs as it would be difficult for clinicians to treat conditions that they had not screened for.

Costs of preventable and non-preventable DRPs present on admission

Koh *et al.* have reported that around 10% of admitted patients in Singapore have DRPs on hospitalisation, which resulted in admission, or were detected on admission[8, 9]. Many of these DRPs are preventable. Due to this significant proportion of DRPs, especially preventable DRPs, the cost stemming from these is certain to be substantial. In fact, this study shows that the cost of preventable DRPs could be even greater as an even larger proportion - 38.3% - of hospitalisations had a DRP present. An overwhelming majority (90.3%) of the DRPs found in this paper are preventable (Table 2) and there was no significant difference between the median costs of hospitalisations with preventable and non-preventable DRPs on admission.

Like most countries in the developed world, the main cost driver of healthcare in Singapore is inpatient care [29]. Moreover, according to 2016 statistics released by the Ministry of Manpower[30], the median gross monthly income from work (excluding employer's Central Provident Fund contribution) of full-time employed Singapore residents 60 years and above is $2000. One hospital admission would thus use up 71.2% of their monthly income. Hence, avoiding such admissions by preventing DRPs that could lead to these admissions has potential cost savings for patients, taxpayers and the government, on top of health and quality of life benefits for patients. This also fits in with

the Singapore MOH policy of shifting beyond quality to value by ensuring cost-effective healthcare for patients.

Preventing DRPs via interventions by/collaborations with community pharmacists

In line with another MOH key policy of transferring care from the acute hospital setting to the primary care, community and home settings, many of the DRPs detected in this study, in particular the 3 most common preventable DRPs can potentially be prevented via interventions by or collaborations with community pharmacists. Community pharmacists are in a prime position to provide patient care as there are significantly more touch points in the community across Singapore. Studies have shown that community pharmacists are able to identify and address DRPs such as adherence, ADRs, unnecessary drug therapy, effectiveness of drug therapy, inappropriate dose and inappropriate drug selection[19, 20, 31], for instance via the New Medicine Service in the UK, which aims to improve adherence to new medications for patients' long-term conditions. Local examples include Project Octopill[20] and initiatives by the Pharmaceutical Society of Singapore e.g. "Befriending Your Pharmacist" (the theme of Singapore Pharmacy Week 2017)[32]. In our study, 80% of patients were discharged to their own homes. Post-discharge management by community pharmacists could potentially reduce DRP-related readmissions in this group of patients. Similar logic would apply to DRP-related admissions.

Community pharmacists can play a pivotal role in management of compliance issues[33] due to patient related factors, such as misconceptions regarding medications, poor motivation and lack of patient knowledge. These can be addressed through regular medication reviews. Some community pharmacies overseas have software applications storing patient information which also store data on patient compliance, so that the pharmacist knows when patients should be coming in for refills/repeat prescriptions, and raises alerts when they do not[31]. Such software applications work by calculating measures of patient adherence like the medication possession ratio (MPR). Other ideas include provision of customized patient information leaflets (PILs) for medications/conditions that are easy to understand as PILs that come together with drugs may be hard to digest.

Regular medication reviews and reconciliations by community pharmacists are also possible ways to address the DRP of unnecessary drug therapy and ADRs. The Patient's Medication List (PML) can be provided to patient after the medication review/reconciliation session. PML provides an updated list of the patient's medications which can potentially reduce DRPs and duplications during transition of care between private medical practice and the public health sector, and within the public health sector (e.g. from hospital to polyclinic)[20]. This is especially important in the community setting where the patient may be seeing private doctors, and may be using other non-prescribed medications/supplements. Although 70.6% of patients in our study were seeing only 1 regular physician for their chronic conditions, they could be obtaining non-chronic medications from private doctors or without a prescription. These could have contributed to DRPs on admission as well. Furthermore, majority of our patients (73.8%) were using more than 5 medications or more than 12 doses in a day, strengthening the need for regular medication reconciliations and reviews as polypharmacy is a significant risk factor for DRPs[8].

Moreover, by providing patient education and advice on how to monitor for ADRs, community pharmacists can help patients avoid these ADRs altogether or at least empower them to address these as soon as possible. One example would be providing counselling on the signs, symptoms and management of hypoglycemia, which was experienced by one patient in our study due to additive effect of anti-diabetic medications.

Some factors limiting such interventions by community pharmacists include the lack of incentive for community pharmacists to carry out medication reviews, identifying and addressing DRPs. While community pharmacies in Singapore are starting to provide a wider range of patient care services including allergy consultations, diabetes management (view Appendix for details) and smoking cessation programmes, provision of medication review services is still rare. Guardian, one of the community pharmacy chains in Singapore, charges $2 for each medication review, which may be insufficient incentive for community pharmacists to actively promote such services. It is also unclear if other community pharmacies provide medication review services. However, if it is shown that potential cost savings from addressing related DRPs are significant, this may support the generation of a remuneration model to incentivize private pharmacies to provide such services. Many healthcare financing systems are moving from the traditional pay-for service model to pay-for-performance or bundled payment models, including the US, UK and Netherlands, as the latter models have been shown to generate cost savings[5]. Community pharmacists can play important roles in these models by reducing acute healthcare utilization and preventing unnecessary hospitalizations[34]. The resultant healthcare cost reductions can be used to fund the aforementioned remuneration model for community pharmacies.

Furthermore, there may be a lack of acceptability by prescribers with regard to interventions made by community pharmacists, or difficulty contacting prescribers as compared to interventions made by hospital pharmacists to prescribers in the same

hospital. Community pharmacists may also be dissuaded from making interventions due to concerns about potential lack of acceptance. Studies done so far in this area have been promising though, with primary care physicians implementing or attempting to implement 72.3% of the interventions put forth by community pharmacists in one Canadian study[35].

In addition, due to privacy policies, community pharmacists in Singapore are not granted access to the patients' complete medical information. Medication reviews are hence limited to medical issues in the medication summaries from hospitals or via patient interview. Thus for now, greater collaboration between hospitals/primary care physicians and community pharmacists e.g. through provision of a PML after each visit can be explored as a means to better facilitate interventions by community pharmacists. In future, authorities may consider granting community pharmacists access to the National Electronic Health Record, a Singaporean nation-wide patient database, if further evidence points to cost savings generated by community pharmacy interventions/collaborations, similar to what was done in one Minnesota study of a collaboration between community pharmacies and an accountable care organization[34].

In the UK, the Medication Use Review adopted by the National Health System in community pharmacies has shown conflicting results [18, 36], despite pharmacists being well equipped with the ability to identify DRPs[37]. This was attributed to situational constraints and poor integration of the programme into the usual workload of pharmacists involved [36]. However in Singapore, the healthcare structure varies greatly with that of the UK's and the area of medication reviews by community pharmacists is largely under-studied and underutilised. Hence while it is a promising resource to tap on, more research is indicated, especially in terms of incentivization, increasing intervention acceptability by prescribers and integration of these services into the current job scope of community pharmacists.

Using software applications which store patient information to obtain data on patient compliance may not be highly applicable in the Singapore context as it is unlikely for patients to solely fill their prescriptions at community pharmacies, and at the same community pharmacy chain. Provision of easy-to-understand PILs for certain medications/conditions is a sound idea which can potentially improve patient compliance and aid in customer retention. Further research into means to improve medication adherence and reduce preventable DRPs is warranted.

Limitations

There were some limitations in this study. Data collection was highly dependent on medication reconciliation documents completed by pharmacists. If DRPs were not identified during medication reconciliation, they would be under-represented.

Besides, classification of what may constitute as preventable DRPs was subjective. As data was collected by two data analysts, initial opinions may differ on the classification of preventable or non-preventable DRPs. However, there were efforts to reach a consensus on what is considered preventable through case discussion among the study team members.

CONCLUSION

Among the elderly population, DRPs are significant risk factors for admissions. DRPs were found to be prevalent upon conducting medication reconciliation during admission, and most of the preventable DRPs were related to poor compliance, followed by unnecessary drug therapy and ADRs. This presents unique opportunities for community pharmacists to play a pivotal role in reducing these DRPs, for example via provision of customized PILs for certain medications/conditions and regular medication reviews/reconciliations. This could lead to substantial cost savings as well as benefits with regard to health and quality of life.

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