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GP registrars' deprescribing in older patients: a non-randomised controlled study.

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Abstract

Purpose

To evaluate the effect of a multi-component educational program aimed at improving general practitioner (GP) trainees' (registrars') deprescribing in patients 65 years and over. The hypothesis was that an educational program would increase registrars' deprescribing of potentially inappropriate medicines (PIMs) in older patients, relative to a control group, six months post-education.

Design

This was a pragmatic, non-randomised, non-equivalent control group design nested within an ongoing cohort study of registrars' practice (the ReCEnT study). The program consisted of an online module, face-to-face sessions for registrars, webinars for their supervisors, and facilitation of the registrar–supervisor dyad, including case-based discussions of deprescribing in teaching meetings. The program was underpinned by the Behaviour Change Wheel framework and delivered to registrars of a single registrar educational/training organisation (other educational/training organisations served as controls). Primary outcome measures were deprescribing any medicines and deprescribing medicines categorised as PIMs. Secondary outcomes were deprescribing of medications taken for three months or more and dose reduction with a view to deprescribing (cessation).

Findings

Data from 779 education-receiving registrars and 438 control registrars were analysed. Intervention group registrars showed no significant increase in deprescribing of any medication compared to controls (interaction aOR 1.00 (95%CI 0.69, 1.46) or of PIMs (aOR 1.29 (95%CI 0.74, 2.24), or significant changes in secondary outcomes.

Research implications

Despite no differences in prescribing, in this analysis, six months post-intervention, aspects of the findings suggest extended observation and further evaluation may be indicated.

Practical implications

The continuation of education for registrars around deprescribing of PIMs is essential. Further investigation is required to assess the effectiveness and efficiency of the behaviour change approach adopted in this study.

Originality/value

The multi-component behaviour change theory-based approach is novel for this educational setting, and this is an initial step in evaluating the approach.

Limitations

The major limitation is that randomisation in the study design was not practicable.

Trial registration

Australian New Zealand Clinical Trials Registry, ACTRN12618000731291 (2/5/2018).

Keywords: deprescriptions; general practice; education, medical, graduate; practice patterns, physicians'; inappropriate prescribing; polypharmacy.

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INTRODUCTION

Medicines safety is a significant health issue for older patients who are particularly vulnerable to adverse medicine events due to age-related changes (Hilmer & Gnjidic 2017; Hilmer, McLachlan & Le Couteur 2007; Shi and Klotz 2011). At the same time, ageing is often associated with chronic health conditions and multiple morbidities requiring increased use of medicines (Barnett et al. 2012).

Polypharmacy, which is commonly defined as five or more medications taken daily (Masnoon et al. 2017), is highly prevalent in older people. Observational studies have found that community-based older patients took an average of two to nine prescription medications per day and that these medicines often lack a current indication or are ineffective (Hajjar, Cafiero & Hanlon 2007). In an Australian community sample, 66% of people over the age of 75 take five or more regular medications (Morgan, Williamson et al. 2012). Furthermore, one in five medicines prescribed in primary care in Australia and internationally are potentially inappropriate (Opondo et al. 2012; Roughead, Anderson & Gilbert 2007).

Polypharmacy is associated with medication nonadherence, inappropriate medication use, adverse drug reactions, cognitive impairment, urinary incontinence, falls, decreased activities of daily living, functional decline, hospitalisation and mortality (adjusted for co-morbidities) (Beer, Hyde et al. 2011; Hajjar, Cafiero & Hanlon 2007; Hilmer et al. 2009; Rawle et al. 2018; Reeve, Thompson & Farrell 2017) and, paradoxically, undertreatment with appropriate medications (Beer, Hyde et al. 2011). The risk of harm is proportional to the number of medicines prescribed (Scott et al. 2015).

Deprescribing has been defined as 'the process of withdrawal of an inappropriate medication, supervised by a health care professional with the goal of managing polypharmacy and improving outcomes' (Reeve, Thompson & Farrell 2017, Pg 4). Deprescribing is strongly recommended in guidance for health professionals, and GPs have central roles in deprescribing (Donaldson et al. 2017; Fick et al. 2008; Kouladjian O'Donnell et al. 2021; Reeve et al. 2015; Scott et al. 2014). However, this is a complex area with limitations on evidence of efficacy, safety and implementation. Withdrawal of specific classes of medications in older patients leads to a resolution of adverse effects of those medicines (for example, diuretics, antihypertensives and psychotropics) (Gnjidic, Couteur & Hilmer 2014; Iyer et al. 2008). There are concerns about adverse drug withdrawal reactions and return of the underlying condition (Gnjidic, Couteur & Hilmer 2014; Iyer et al. 2008; Reeve et al. 2014; Reeve, Thomson & Farrell 2017). Implementation is complex in a fragmented healthcare system (Kouladjian O'Donnell et al. 2021).

Studies of deprescribing educational interventions in community settings suggest Potentially Inappropriate Medications (PIMs) can be reduced, but with little or no reduction in adverse health outcomes (Bloomfield et al. 2020; Omuya et al. 2023). Education in deprescribing, however, is considered desirable and is feasible by GPs in the Australian community context (Beer, Loh et al. 2011; Potter et al. 2016). A particular target for education regarding deprescribing is GP registrars (specialist general practice vocational trainees). GP registrars are at a formative stage of their clinical careers where prescribing patterns are being established.

The aim was to develop and test the efficacy of an educational program informed by a behaviour change theoretical approach—an advocated method in deprescribing interventions (Bai et al. 2022; Isenor et al. 2021) and current evidence around interventions to influence clinician behaviour.

The hypothesis was that a multi-component educational innovation would increase general practice registrars' deprescribing of inappropriate medicines in patients aged 65 years and older.

METHODS

The study employed a pragmatic, non-equivalent control group design.

SETTING AND PARTICIPANTS

Participants were GP registrars from three of nine Australian Regional Training Organisations (RTOs). The RTOs were government-funded, not-for-profit, geographically-defined GP vocational training organisations.

The three participating RTOs were GP Synergy, General Practice Training Tasmania (GPTT) and Eastern Victoria General Practice Training (EVGPT). These RTOs' footprints cover New South Wales, the Australian Capital Territory, Tasmania, and the eastern half of Victoria. They train 44% of Australian GP registrars and are participants in the Registrar Clinical Encounters in Training (ReCEnT) project, in which the study was nested. The RTOs cover the full spectrum of Australian GP training settings, ranging from practices located in a major city to remote classifications (Australian Government Department of Health and Aged Care 2021).

Within each RTO, registrars train in accredited independent practices under the supervision of an experienced GP supervisor. This supervision includes a weekly face-to-face one-on-one teaching session for Term 1 and Term 2 registrars (the first two of three six-month full-time-equivalent compulsory general practice-based terms within registrars' three-year vocational training program). Registrars also receive structured away-from-practice teaching organised by their RTO in Term 1 and Term 2.

ELIGIBILITY CRITERIA

Participants were GP registrars consenting to research use of their data at the three ReCEnT-participating RTOs. Data from ReCEnT data collection rounds 2016.2 (that is, the second of two semesters in 2016) to 2018.1 (pre-education) and 2018.2 (post-education) were included in analyses.

DESIGN

The study's non-equivalent control group design was nested within an ongoing cohort study, the ReCEnT study. ReCEnT is a multisite cohort study of GP registrars' in-consultation clinical experience (Davey et al. 2022; Morgan, Magin et al. 2012). At approximately the mid-point of each of the three six-month GP training terms, each registrar contemporaneously records details of clinical and educational experiences and activities in 60 consecutive patient consultations.

For all RTOs, participation in ReCEnT is an integral part of their education and training program. Registrars may also choose to provide informed

written consent for the data collected to be used for research purposes (Magin et al. 2015).

Assignment to education or control group was not random. Assignment was at the level of RTO and was on the basis of the willingness and capacity of the RTO to include the deprescribing program within their routine educational program. Randomisation of teaching sessions within RTO educational programs was not possible as the individual RTOs sought to deliver standard and equivalent educational programs to all registrars training within their organisation. The non-random allocation was controlled in our analyses via multivariable analyses utilising the large number of potential confounding variables measured in ReCEnT.

EDUCATIONAL PROGRAM FOR THE 'EDUCATION' GROUP

The educational program for GP Synergy registrars (and their supervisors) was conducted as part of their routine training and comprised:

- access to an online introduction module
- a 60-minute face-to-face session conducted during routinely scheduled out-of-practice educational workshops for registrars
- a webinar for the supervisors of these registrars based on the content of the face-to-face presentation with pre-webinar access to the online introductory module
- optional joint GP registrar-supervisor education activities for each registrar-supervisor dyad to use in their regular weekly one-on-one in-practice teaching meetings.

The content of each component is presented in Table 1. This content was underpinned by Michie's 'Behaviour Change Wheel (BCW)' (Michie et al. 2011). See Supplementary Table 1 for a mapping of educational program elements to BCW elements. The objective of the educational program was to change registrars' clinical behaviour (deprescribing).

The introductory module, face-to-face session, and webinar were constructed and delivered by the authors. The content was based upon the relevant literature concerning polypharmacy and deprescribing and the authors' clinical and educational experience, and was informed by our previous findings of registrars' prescribing (Holliday et al. 2015; Holliday, Morgan et al. 2017; Magin et al. 2016; Magin, Tapley, Dunlop et al. 2018) and deprescribing (Magin, Quain et al. 2021) practice and behaviour change principles (Michie et al. 2011). Two presenters provided written responses to questions submitted by individual members of the audience.

The first three components of the educational program were delivered in June 2018. The fourth component was delivered at the discretion of supervisors and registrars during July–August 2018. In this report, the educational program will be referred to as the 'intervention'.

Table 1. Components of the educational program

Online introduction module	• background material for face-to-face registrar session/supervisor webinar • enabled concentration on practical approaches to deprescribing in face-to-face session/webinar • 30-40 minutes to complete • available to registrars/supervisors 2-3 weeks prior to face-to-face session/webinar • contents: – polypharmacy – inappropriate prescribing in older patients – evidence for deprescribing – tools for assessing potentially inappropriate prescribing, e.g. Beers criteria (American Geriatrics Society 2015) and Drug Burden Index (DBI) (Hilmer, McLachlan & Le Couteur 2007) – role of GPs in the implementation of deprescribing – links to supporting materials.
Educational face-to-face workshop session	• 60-minute educational presentation • scheduled as part of the standard training program for GP Synergy registrars • led by a geriatrician assisted by a GP • content constructed by a research team of GPs, GP vocational training educators, academic GPs, and geriatricians/researchers • process informed by current literature in the area and findings from previous work on the prevalence and associations of registrars' deprescribing in older patients (Potter et al. 2016) • session focused on: – practicalities of deprescribing within a general practice setting, including determining if a patient has polypharmacy – determining risks vs benefits of continuing or deprescribing a particular medicine

	– identifying opportunities for deprescribing – how to employ a model of deprescribing – barriers to deprescribing inherent within the general practice setting and the registrar's position within a host practice – promotion of collaborative models of registrars and supervisors working together to implement appropriate deprescribing.
Webinar for supervisors	• succinct version of a face-to-face workshop session provided to registrars • emphasised potential models of supervisor-registrar collaboration in deprescribing • managing the GP-specialist relationship for challenging situations when specialists prescribe medication (Farrell et al. 2015).
Joint registrar/ supervisor activities	• encouraged to include case-based discussion of evidence-based deprescribing (supplied as part of the deprescribing educational program) in regular weekly one-on-one teaching meetings • other options, e.g. random case analysis or audit of older patients' clinical notes • joint registrar/ supervisor activities were optional as the content of registrar-supervisor weekly meetings is at the discretion of supervisors.

'CONTROL' GROUP

The control group of registrars training with two other RTOs (GPTT and EVGPT) received 'usual education' during the study period. Usual education comprised teaching/education as scheduled by the control RTOs, including usual education regarding deprescribing.

OUTCOME FACTORS

The primary outcomes in analyses were:

- medicine/s deprescribed
- PIMs deprescribed. That is, medicines from the following, either individually or a combination of:
  - the Beers Criteria list of Potentially Inappropriate Medications (American Geriatrics Society 2015)
  - the Drug Burden Index (Hilmer et al. 2007)
  - the medicine groups most highly rated as suitable for deprescribing by a Canadian expert clinician using the Delphi process (Farrell et al. 2015).

The secondary outcomes were:

- medicine/s deprescribed, restricted to medicines that patients have taken for three months or more
- medicine/s with dose reduced with a view to later cessation.

The Beers Criteria for Potentially Inappropriate Medication (PIM) Use in Older Adults is 'an explicit list of PIMs best avoided in older adults in general and in those with certain diseases or syndromes, prescribed at reduced dosage or with caution or carefully monitored' (American Geriatrics Society 2015, pg 2227). The Drug Burden Index is composed of anticholinergic and sedative medicines, which have been associated with an increased risk of adverse drug events, falls, and confusion in older people (Hilmer, Mager et al. 2007).

INDEPENDENT VARIABLES

Independent variables relate to registrar, patient, practice and consultation factors. See Table 2 for independent variables included in the analysis.

Table 2: Independent variables from ReCEnT included in the analysis

Registrar factors	• age • gender • training term at the time of data collection (Term 1, 2, or 3) • place of basic medical qualification (Australia or international) • worked at the practice during a previous term • RTO with which the registrar enrolled • year of medical graduation • duration of pre-GP training time spent in hospital practice • full-time/part-time status.

Patient factors	• age • gender • Aboriginal or Torres Strait Islander status • non-English-speaking background • if a patient was new to the practice • if a patient was new to the registrar.
Practice factors	• level of rurality of the practice location* • practice size** • socioeconomic status of the practice location* • if the practice routinely bulk bills (that is, patients pay no fee for the consultation).
Consultation factors	• duration of consultation (minutes) • number of diagnoses/problems dealt with in the consultation • diagnosis/problem, new or existing • problem/diagnosis of a chronic disease (classified according to an existing classification system) • pathology test/s ordered • imaging test/s ordered • follow-up organised • specialist referral made • registrar sought clinical information during the consultation from a specialist or electronic or hard-copy resource • registrar generated a learning goal related to the problem/diagnosis.

*Practice postcode was used to define the Australian Standard Geographical Classification-Remoteness Area (ASGC-RA) classification (Australian Government Department of Health and Aged Care. 2021). The degree of rurality of the practice location was also used, along with the practice location's Socioeconomic Index for Area (SEIFA) Relative Index of Disadvantage (Australian Bureau of Statistics 2023).

**Number of full-time equivalent GPs dichotomised to 'large', i.e., greater than full-time equivalent five GPs or 'small'—less than six full-time equivalent GPs.

STATISTICAL METHODS

Analyses were conducted at the consultation level. The analyses were confined to consultations with patients 65 years or older.

Calculations were performed for the proportion of consultations in which:

- any medicines were deprescribed
- PIMs were deprescribed
- medications that had been taken for three months or longer, were deprescribed
- medicines were ceased or reduced with a view to later cessation.

Subsequent analyses were 'intention to treat (educate)': that is, all registrar consultations were analysed, whether the registrar participated in the educational activities or not. ReCEnT six-monthly data collection rounds 2016.2 to 2018.1 (second semester of 2016 to first semester of 2018, inclusive) were classified as 'pre-education', 2018.2 (second semester of 2018) as 'post-education'.

The difference in the number of medicines deprescribed per 100 consultations in the post-intervention phase compared to the pre-intervention phase was calculated for both the 'education' and 'control' groups.

Descriptive statistics included frequencies for categorical variables and mean with SD for continuous variables.

Further analyses employed univariable and multivariable logistic regression. The outcome factor was medicines deprescribed (dichotomous). Independent variables in the model included the 'treatment' group ('education' group/'control' group), time (before 'intervention'/after 'intervention') and an interaction term of the treatment group by time. The p-value of the interaction term was used to determine statistical significance, and the intervention odds ratio was used to reflect the intervention effect (difference in post vs pre odds of deprescribing between intervention and control registrars).

Due to the high participation and retention rates in ReCEnT (>95%), it was determined that imputation would not be required in the analyses.

Logistic regression models were fitted within the generalised estimating equations (GEE) framework to account for repeated measures within registrars. An exchangeable working correlation structure was assumed. Univariable analyses were conducted on each covariate, with the outcome. Covariates with a univariable p-value < 0.20 were considered for inclusion in the multiple regression model. Once the model, with all significant covariates, was fitted, model reduction was assessed. Covariates that were no longer significant (at $p<0.2$) in the multivariable model were tested for removal from the model. If the covariate's removal did not substantively change the resulting model, the covariate was removed from the final model. A substantive change to the model was defined as any covariate in the model having a change in the effect size (odds ratio) of greater than 10%. The regressions modelled the log odds that a medication was deprescribed.

Analyses were programmed using STATA 14.1 and SAS V9.4.

RESULTS

Data for the primary analyses included 2,391 registrar rounds of data collection (1,488 education group registrar rounds, 903 in the control group, 1,087 pre-education registrar rounds, 401 post-education), with a total of 1,217 registrars contributing. The response rate of registrars for participation in ReCEnT during the study period was 96.4%. The demographics of registrars and registrar rounds in the education RTO and the control RTOs are presented in Table 3.

Table 3: Demographic characteristics of Education and Control Registrar and practices

		Education	Control
Registrar variables		**n=779**	**n=438**
Registrar gender	Female	475 (61.0)	257 (58.7)
Qualified as a doctor overseas	Yes	164 (21.1)	57 (13.0)
College Enrolled in	RACGP*	741 (97.0)	427 (98.2)
	ACCRM#	18 (2.4)	8 (1.8)
	Both	5 (0.7)	0
Number of years worked in hospital prior to entering GP training	Mean ± SD	3.4 (3.4)	3.3 (2.5)
Registrar round/practice variable		**n=1,488**	**n=903**
Registrar age (years)	Mean ± SD	32.8 (6.6)	31.7 (5.3)
Registrar works Full-time	Yes	1,102 (79.3)	676 (75.9)
Registrar training term	Term 1	671 (45.1)	294 (32.6)
	Term 2	571 (38.4)	368 (40.8)
	Term 3	246 (16.6)	241 (26.7)
Practice rurality	Major city	954 (65.1)	546 (62.8)
	Inner regional	401 (27.4)	211 (24.3)
	Outer regional remote	111 (7.6)	112 (12.9)
Practice location SES status (SEIFA^ index)	Mean ± SD	5.12 (2.7)	6.31 (3.0)

		Education	Control
Registrar variables		**n=779**	**n=438**
Practice routinely bulk bills	Yes	646 (43.8)	205 (23.6)
Practice size	Small (1-5 GPs)	667 (47.9)	294 (33.1)
	Large (6+ GPs)	725 (52.1)	594 (66.9)

*The Royal Australian College of General practitioners

#Australian College of Rural and Remote Medicine

^SEIFA-IRSD = Socioeconomic Index for Areas Index of Socioeconomic Disadvantage

PRIMARY OUTCOMES

There were 26,003 consultations with patients aged 65 years or over in the primary outcomes analyses. Of these consultations, 1,572 (6%) involved a medication being deprescribed. PIMs were deprescribed in 670 consultations (2.6%) of consultations.

ALL MEDICATION DEPRESCRIBED

In unadjusted comparisons (for all medications) post-intervention, there was less deprescribing than pre-intervention. In the control group, a decrease of 0.9 medications deprescribed per 100 consultations was seen in the post-intervention phase compared to the pre-intervention phase. In the education group, a reduction of 1 medication deprescribed per 100 consultations was seen in the post-intervention phase compared to the pre-intervention phase.

The characteristics associated with any medicine being deprescribed are presented in Supplementary Table 2.

The results of univariable and multivariable logistic regression with the outcome 'any medication deprescribed' are presented in Table 4.

Table 4. Univariable and multivariable logistic regression for consultations where medication was deprescribed

			Univariate		Adjusted	
Factor group	**Variable**	**Class**	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
Intervention factors	Pre/post Control/int interaction	Post-education/ education			1.00 (0.69, 1.46)	0.99
	Pre/post-education	Post-education	0.88 (0.76, 1.02)	0.094	0.80 (0.58, 1.10)	0.17

			Univariate		Adjusted	
Factor group	**Variable**	**Class**	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
	Control/education group	Education	1.05 (0.91, 1.20)	0.52	1.12 (0.95, 1.32)	0.17
Patient factors	Patient age group	75-84	1.26 (1.12, 1.40)	<.001	1.20 (1.06, 1.36)	0.005
	Referent: 65-74	85+	1.02 (0.86, 1.22)	0.80	0.97 (0.80, 1.18)	0.77
	Aboriginal or Torres Strait Islander	Yes	1.69 (0.97, 2.92)	0.062	1.68 (0.95, 2.98)	0.075
	Patient/practice status	New to registrar	0.51 (0.46, 0.57)	<.001	0.57 (0.50, 0.65)	<0.001
	Referent: Existing patient	New to practice	0.28 (0.18, 0.44)	<.001	0.26 (0.14, 0.46)	<0.001
Registrar factors	Registrar Full-Time or Part-Time	Part-time	0.88 (0.75, 1.03)	0.12	0.88 (0.74, 1.04)	0.14
Practice factors	Practice routinely bulk bills	Yes	0.90 (0.78, 1.04)	0.15	0.81 (0.68, 0.95)	0.010
	SEIFA index		0.96 (0.94, 0.98)	<.001	0.97 (0.94, 0.99)	0.008
Consultation factors	Chronic problem	Yes	1.94 (1.74, 2.17)	<.001	1.63 (1.43, 1.85)	<0.001
	Sought in-consultation help	Other sources	1.70 (1.48, 1.96)	<.001	1.41 (1.19, 1.67)	<0.001
	Referent: None	Supervisor	1.72 (1.49, 1.98)	<.001	1.32 (1.11, 1.57)	0.002
	Learning goals generated	Yes	1.58 (1.41, 1.78)	<.001	1.14 (0.99, 1.31)	0.068
	Consultation duration		1.02 (1.02, 1.03)	<.001	1.02 (1.01, 1.02)	<0.001

Before the intervention, multivariable models adjusted for potentially confounding factors showed little difference in the odds of deprescribing between intervention vs control participants (OR=1.12; 95% CI: 0.95, 1.32; p=0.17).

In the control group, multivariable models showed a small but non-significant decrease in the odds of deprescribing from pre- to post-

intervention (OR=0.8; 95% CI: 0.58, 1.10; p=0.17). Compared to controls, registrars in the education group showed no difference in the change in deprescribing from pre- to post-intervention, based on the interaction odds ratio (OR=1.00; 95% CI: 0.69, 1.46; p=0.99).

PIMS DEPRESCRIBED

In the control group, a decrease of 1 PIM deprescribed per 100 consultations was seen in the post-intervention phase compared to the pre-intervention phase. In the education group, a reduction of 0.8 PIMs deprescribed per 100 consultations was seen in the post-intervention education phase compared to the pre-intervention phase.

The characteristics associated with PIMs being deprescribed are presented in Supplementary Table 3.

The results of univariable and multivariable logistic regression with the outcome 'medication deprescribed' are presented in Table 5.

Table 5: Univariable and multivariable logistic regression for consultations where PIMs were deprescribed

			Univariate		Adjusted	
Factor group	**Variable**	**Class**	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
Intervention factors	Pre/post Control/int interaction	Post-education/ Education		.	1.29 (0.74, 2.24)	0.36
	Pre/post-education	Post-education	0.91 (0.74, 1.13)	0.39	0.61 (0.38, 0.98)	0.041
	Control/education group	Education	1.03 (0.86, 1.25)	0.73	0.96 (0.77, 1.20)	0.73
Patient factors	Aboriginal or Torres Strait Islander	Yes	2.38 (1.22, 4.63)	0.011	2.27 (1.11, 4.67)	0.026
	Patient/practice status	New to registrar	0.60 (0.50, 0.71)	<.001	0.69 (0.57, 0.84)	<.001
	Referent: existing patient	New to practice	0.19 (0.09, 0.42)	<.001	0.16 (0.06, 0.42)	<.001
Practice factors	Rurality Referent: Major city	Inner regional	1.25 (1.02, 1.54)	0.033	1.19 (0.94, 1.49)	0.15
		Outer regional remote	1.31 (1.02, 1.69)	0.037	0.92 (0.67, 1.26)	0.58
	SEIFA index		0.96 (0.93, 0.98)	0.002	0.97 (0.94, 1.01)	0.14

			Univariate		Adjusted	
Factor group	**Variable**	**Class**	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
Consultation factors	Chronic problem	Yes	2.04 (1.73, 2.39)	<.001	1.76 (1.46, 2.13)	<0.001
	Learning goals generated	Yes	1.43 (1.19, 1.73)	<.001	1.08 (0.87, 1.32)	0.49
	Referral ordered	Yes	1.19 (0.98, 1.44)	0.073	0.83 (0.66, 1.04)	0.099
	Consultation duration		1.03 (1.02, 1.03)	<.001	1.03 (1.02, 1.03)	<0.001

Before the intervention, multivariable models adjusted for potentially confounding factors showed little difference in the odds of deprescribing PIMs between intervention vs control participants (OR=0.96; 95% CI: 0.77, 1.20; p=0.73).

In the control group, multivariable models showed a significant decrease in the odds of deprescribing from pre- to post-intervention (OR=0.61; 95% CI: 0.38, 0.98; p=0.041).

Compared to controls, registrars in the education group showed a non-significant difference in the change in deprescribing of PIMS from pre- to post-intervention, based on the interaction odds ratio (OR=1.29; 95% CI: 0.74, 2.24; p=0.36).

SECONDARY OUTCOMES

MEDICATIONS DEPRESCRIBED THAT HAD BEEN TAKEN BY PATIENTS FOR THREE MONTHS OR LONGER

Of 26,003 consultations, 563 (2%) involved a medication taken for more than three months being deprescribed.

The characteristics associated with one of these medicines being deprescribed are presented in Supplementary Table 4.

The results of univariable and multivariable logistic regression with the outcome 'medication taken by patients for three months or longer deprescribed' are presented in Supplementary Table 5. The interaction term for pre/post education and control/education showed no statistically significant change (p=0.27). The interaction odds ratio (OR) was 0.75 (95% CI: 0.45, 1.26).

MEDICATION CEASED OR REDUCED WITH A VIEW TO LATER CESSATION

Due to a later commencement of data collection for dose reduction, there were only 14,859 consultations available for analysis of this outcome. Of

these consultations, 1,088 (7%) involved a medication being deprescribed or reduced with a view to later deprescribing.

The characteristics associated with a medicine being deprescribed or dose-reduced are presented in Supplementary Table 6.

The results of univariable and multivariable logistic regression with the outcome 'medication deprescribed or dose reduced' are presented in Supplementary Table 7. The interaction term for pre/post education and control/education showed no statistically significant change (p=0.59). The interaction odds ratio (OR) was 1.11 (95% CI: 0.77, 1.59).

DISCUSSION

MAIN FINDINGS AND COMPARISON WITH PREVIOUS STUDIES

No significant effect of the educational program on registrars' total deprescribing or the deprescribing of PIMs was found. There was also no significant change in the secondary outcomes of deprescribing medications that the patient had been taking for three months or longer or when doses were reduced with the intent to deprescribe.

Most deprescribing interventions to date have focused on discontinuing one or more single medicines or classes of medicine (Johansson et al. 2016; Page et al. 2016). It has been established that interventions can reduce measures of patients' inappropriate medications (Bloomfield et al. 2020; Patterson et al. 2014). These interventions include educational interventions for clinicians, which aim to minimise polypharmacy rather than targeting specific medications (Bloomfield et al. 2020; Patterson et al. 2014).

There are few studies investigating deprescribing activities in general practice despite GPs playing a central role in caring for older people with multimorbidity and polypharmacy (Wallace et al. 2015). A systematic review has focused on deprescribing by GPs in primary care (Dills et al. 2018); however, the majority of these studies were set in long-term residential care. A recent scoping review found that the most frequently used activity was the identification of appropriate patients for deprescribing (Coe et al. 2021).

There are few studies of educational interventions targeting GPs. The OPTIMIZE trial (Bayliss et al. 2022) performed a large-scale deprescribing educational intervention for primary care clinicians and their older adult patients with cognitive impairment taking five or more long-term medications. It did not affect the number of long-term medications or the percentage of PIMs. Another Australia-based study of a GP-led intervention to reduce polypharmacy/PIMs in community-living older people found that the deprescribing intervention, which included five hours of training, use of co-designed software during an extended consultation and an optional referral for pharmacist review, appeared feasible, was modestly effective, and was not associated with any significant safety events (Anderson et al. 2020).

A recent meta-analysis found that educational interventions probably had little to no effect on all-cause mortality, hospitalisations, or health-

related quality of life, and the impact on falls was uncertain. However, all the trials that measured PIMs reported fewer in the intervention than in the control group (Bloomfield et al. 2020). There are no known previous studies of deprescribing educational interventions targeting GP registrars/trainees.

INTERPRETATION OF FINDINGS

An educational program on deprescribing was designed and implemented, based on behaviour change theory, targeting GP registrars, and failed to demonstrate a change in deprescribing. Several factors could have influenced the lack of efficacy in this study.

Not all the known barriers to GPs and GP registrars deprescribing may have been adequately addressed by the educational intervention despite its quite comprehensive content. There are considerable demonstrated barriers to deprescribing by GPs, such as concerns about adverse outcomes, a perceived imperative for adherence to single disease management guidelines, reluctance to deprescribe specialist-prescribed medications, therapeutic inertia, concerns regarding the patient-GP relationship, and a lack of specific knowledge (e.g. regarding a medication's anticholinergic potential) or how to conduct deprescribing (Ailabouni et al. 2016a; 2016b; Anderson et al. 2014; Anthierens et al. 2010; Magin, Goode & Pond 2015; Schuling et al. 2012)

Our previous research suggests that deprescribing by GP registrars for older patients is relatively uncommon (Magin, Quain et al. 2021). It is reasonable to believe that barriers to deprescribing may be especially problematic in the practice of GP registrars — given their junior status and that most of their older patients' long-term medicines (including inappropriate medicines) will have been initiated and maintained by their supervisors, other senior GPs, specialists or a combination of these medical officers. The risk-benefit balance of particular medicines (and thus, of deprescribing these medicines) is subject to multiple complexities, for example, the patient's age, their degree of frailty, co-morbidities and potential drug interactions. These factors must be considered in the complex context of engaging patients in a process of patient-centred shared decision-making, which is central to the deprescribing process (Reeve, Thompson & Farrell 2017; Scott et al. 2015). Deprescribing is also more likely to occur in the presence of a continuous therapeutic relationship between GP and patient (Anderson et al. 2017), something that can be difficult for a GP registrar to establish due to training location requirements. Thus, although algorithms to aid deprescribing have been developed (Poudel et al. 2016), deprescribing can be very challenging for inexperienced GPs.

There may have been factors in the lack of efficacy beyond the inherent difficulty in changing these clinical behaviours (noting that the educational program was designed to address these very factors). In keeping with the Behaviour Change Wheel model (Bai et al. 2022; Hansen et al. 2018; Michie et al. 2011) that informed our program, the registrars' 'education' is but one factor in changing their behaviour. Other factors addressed in our educational program, such as changes in the practice environment and procedures and structural changes in the functioning of the registrar-supervisor dyad within the practice, may take considerably longer to bed down than the duration of data collection for our analysis.

IMPLICATIONS FOR PRACTICE, EDUCATION, AND FUTURE RESEARCH

There is strong evidence for the role of deprescribing as part of good prescribing. Deprescribing education is being advocated and included in GP training programs without evidence of its efficacy increasing deprescribing. Despite the negative findings of this study, the educational program developed is worthy of further research, with a broader range of outcomes (e.g. knowledge and self-efficacy) and with prescribing outcomes collected over an extended period and in the context of other system-wide changes to facilitate deprescribing (Kouladjian O'Donnell et al. 2021), before being deemed not to be of value.

The current educational program could also be iterated in response to feedback received annually from registrars and consideration of further Behaviour Change Techniques (Michie et al. 2013) that are frequently integrated into the Behaviour Change Wheel Framework (Corker et al. 2022), and that may be applicable in the singular context of GP vocational training.

That there was no change in overall deprescribing was unsurprising — the program was closely focused on identifying PIMs in-patient medicines regimens, assessing their suitability for deprescribing, and practical deprescribing in the registrar's practice environment. The 29% increase in deprescribing of PIMs associated with the education program (though not statistically significant), together with the consideration above of the likely timeframe for practice-level changes to influence deprescribing, suggests further analyses over a longer time frame than possible in this time-limited grant-funded study are indicated. It also suggests the possibility of a Type II error, and a longer timeframe of data collection would increase the power to detect a clinically significant difference. The ReCEnT study would provide a framework for this, though the temporally uneven effects of the COVID-19 pandemic across education and control regions could restrict the interpretation of analyses beyond 2019 data collection.

STRENGTHS AND LIMITATIONS

A strength of this study was that this was a pragmatic educational program based on behaviour change principles and delivered within existing educational/training programs for registrars and supervisors. The use of online materials and relatively brief large-group training makes it an efficient and scalable means of delivering a complex educational program.

The high response rate, unusual for the studies of GPs (Bonevski et al. 2011), is a strength, as is the coverage of practice in classifications of rurality from major cities to remote practice. The analysis was conducted on an 'intention to educate' basis, providing a robust evaluation of a real-world training activity.

In terms of limitations, in our non-randomised study (necessary in the Australian GP training context), inferences of causality were less strong than for an RCT. However, an adjustment was made for the non-randomised design with multivariable analyses, including a large set of relevant independent variables. This methodology has been used previously with educational programs addressing other GP registrar clinical behaviours (Holliday, Hayes et al. 2017; Magin, Tapley, Morgan et al. 2018).

A further limitation was that it was impractical to collect data on the uptake of the various components of the intervention by registrars and supervisors. Attendance by registrars at the face-to-face session was compulsory (though strict compliance was not measurable). Compliance with the other intervention elements was not able to be measured, and assessment of implementation within the practice environment was not practicable. Thus, fidelity to intervention could not be measured.

Additionally, ReCEnT records only practice-based consultations, which affects the generalisability of our findings to residential care. As mentioned above, the short period of post-education follow-up was a limitation.

CONCLUSION

No significant increase in deprescribing in older patients with a multi-component educational program for GP registrars was found. The caveat to this finding is the short timeframe of intervention to measure the effect. Further evaluation of the educational program, therefore, may be appropriate.

DECLARATIONS

ETHICS APPROVAL

Ethical approval for the ReCEnT project has been granted by the Human Research Ethics Committee (HREC) from [blinded for peer review]. A variation regarding the analyses reported here was approved in April 2018.

CONSENT FOR PUBLICATION

Not applicable.

DATA AVAILABILITY STATEMENT/DATA DEPOSITION

The data is not available on Human Research Ethics Committee advice due to a lack of explicit participant consent for data sharing.

Findings from the study will be communicated to participants via routine communications from their RTO, for example, the GP Synergy Training Updates for registrars and supervisors.

There will be no restrictions on publication or presentation to disseminate study findings to healthcare professionals and the public.

Professional writers will not be used for publications reporting study findings.

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The funders had no role in the study design, collection, management, analysis, and interpretation of data. The writing of the report and the decision to submit the report for publication were independent of the funding bodies.

AUTHORS' CONTRIBUTIONS

PM conceived the study. SH, PM, and BB coordinated the design of the educational content. BB provided expertise in behaviour change. PM, SH, MVD, BB, EH, CE-B, AT, NS, AD, KF, CG, JF, and RT provided methodological and clinical input into quantitative study design, analysis, educational content, or a combination of these factors. SH delivered the educational sessions and webinars. AT was responsible for data management and contributed to the analyses. EH provided overall supervision of statistical analyses. JB conducted the main analyses, and AR contributed to the analyses. SB led the writing of the clinical content of the educational module. SB developed the online module. RT and PM wrote the first manuscript draft, and all authors contributed to and approved the final manuscript.

AUTHORS' CONFLICTS OF INTEREST

[Blinded for peer review] is a Director of Medcast Pty Ltd, a health professional education company that developed the learning modules for this project. He was not involved in the data analysis relating to the evaluation of the education.

[Blinded for peer review] has provided advice to Boehringer-Ingelheim regarding educational programs for general practitioners.

All other investigators declare no competing interests.

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