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Original Research

Community pharmacists' awareness, identification, and management of prescribing cascades: A cross-sectional survey

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ABSTRACT

Background: Prescribing cascades can lead to unnecessary medication use, healthcare costs, and patient harm. Pharmacists oversee prescriptions from multiple prescribers and are well positioned to identify such cascades, making pharmacists key stakeholders to address them.
Objectives: To evaluate community pharmacists' awareness, identification, and management of prescribing cascades and to assess behavioural determinants that may be targeted in future strategies to minimise inappropriate prescribing cascades.
Methods: An online survey was developed using the Theoretical Domains Framework (TDF) and emailed to all registered community pharmacists in Ireland (n = 3775) in November 2021. Quantitative data were analysed using descriptive and inferential statistics. Free-text sections were given to capture reasons for non-resolution of identified prescribing cascades and suggestions to aid prescribing cascade identification and management; this text underwent content analysis.
Results: Of the 220 respondents, 51% were aware of the term '*prescribing cascade*' before the survey, whilst 69% had identified a potentially inappropriate prescribing cascade in practice. Over one third were either slightly confident (26.4%) or not confident at all (10%) in their ability to identify potentially inappropriate prescribing cascades in patients' prescriptions before the survey, whilst 55.2% were concerned that patients were receiving prescribing cascades they had not identified. Most respondents wanted further information/training to help prescribing cascade identification (88.3%) and management (86.1%). Four predominant TDF domains identified were common to both i) influencing non-resolution of identified prescribing cascades and ii) in the suggestions to help identify and manage prescribing cascades: '*Environmental Context and Resources*', '*Social/Professional Role and Identity*', '*Social Influences*' and '*Memory, Attention and Decision Processes*'.
Conclusions: There is a clear need to provide additional resources to help community pharmacists identify and manage prescribing cascades. These findings will support the development of theory-informed behaviour change strategies to aid the minimisation of inappropriate prescribing cascades and decrease the risk of medication-related harm for patients.

1. Introduction

A prescribing cascade occurs when one drug is used to manage the side effect of another drug.[1,2] '*Appropriate*' prescribing cascades are typically initiated intentionally, e.g. when a side effect of one drug might be easily recognised or expected, and the side effect is then deliberately managed by starting another drug – such as a patient being prescribed a laxative to manage opioid-induced constipation.[3,4] '*Inappropriate*' prescribing cascades are usually initiated unintentionally, e.g. where a symptom has not been recognised as a drug side effect[4]; an example of this may be where a loop diuretic is prescribed to manage gabapentinoid-induced peripheral oedema – likely less well known than the '*calcium channel blocker → oedema → loop diuretic*' cascade. Savage et al. found that 3.8% of older patients who were prescribed amlodipine

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were prescribed a loop diuretic within one year.[5] While this percentage may seem low and there are limitations to interpreting prescription sequences in this manner as potential prescribing cascades,[6] it is still likely that there is a compelling number of unnecessary prescriptions for loop diuretics annually, increasing the risk of patient harm (e.g. acute kidney injury). However, the true prevalence of potentially inappropriate prescribing cascades is unknown, and this is just one example; therefore, prescribing cascades may be much more widespread given the large number of them that exist and their complex nature.[7]

Healthcare providers and patients struggle to identify prescribing cascades when they occur, partly due to lack of awareness and knowledge.[8,9] Recognising side effects and potentially inappropriate prescribing cascades is important as these cascades can cause adverse events, reduce patients' quality of life, and result in unnecessary medication costs and healthcare utilisation.[10–12] Older adults in particular are more likely to suffer from prescribing cascades owing to the increased risk of age-related physiological changes, multimorbidity, and polypharmacy, and are more likely attending multiple prescribers.[1,7,13] As medication experts and the healthcare professional typically in most frequent contact with patients,[14,15] community pharmacists are uniquely positioned to identify and prevent prescribing cascades in their everyday practice, especially as they oversee prescriptions from multiple prescribers. Whilst the term '*prescribing cascade*' was first coined over 25 years ago,[1,16] it remains unclear how aware pharmacists are of these phenomena, what they perceive to be the contributory factors, and the strategies they would suggest to minimise their occurrence. To date, there has been a paucity of qualitative research on prescribing cascades in general, especially focused on pharmacists' insights.[8,9,17–19]

Given the harms associated with prescribing cascades, it is vital that novel mechanisms are implemented to aid their identification, management, and prevention.[20] Stakeholder engagement is required to help ascertain ways in which behavioural change can be targeted to minimise these phenomena. Whilst the Theoretical Domains Framework (TDF) has been used to identify behavioural determinants of inappropriate prescribing that can be targeted for interventions across a variety of settings,[21–25] it appears that it has not yet been used in exploratory research work on prescribing cascades. Therefore, this study aimed to fill this important research gap by utilising a theory-informed survey based on the TDF to assess community pharmacists' awareness of prescribing cascades and to explore their views on their identification, management, and prevention – which, in turn, should help inform future behaviour change strategies to minimise the scourge of inappropriate prescribing cascades.

2. Methods

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement was used to guide reporting in this study.[26]

2.1. Study context

Community pharmacists in Ireland primarily obtain prescriptions in paper form from patients or directly from prescribers via a secure clinical email service called Healthmail. It has only been permissible to transfer prescriptions electronically to pharmacies without the need for a paper copy from the prescriber since April 2020.[27] In Ireland, prescriptions are not legally required to have therapeutic indications on them, community pharmacists do not have access to patients' health records, and there is no legislation recognising pharmacist prescribing.

2.2. Survey design

This survey was developed by the research team and its content informed by a review of prescribing cascades literature, the TDF,[28] and the study team's experience in this area. The TDF was used to aid in the identification of targets for behaviour change to guide future interventions in minimising prescribing cascades. The survey was piloted with pharmacist peers practising in community pharmacy settings, who reviewed it for face and content validity and provided minor feedback to aid survey refinement. The final survey (**Appendix 1**) covered topics such as prescribing cascade awareness, knowledge and skills in their identification and management, perceived enablers and barriers to their identification, management, resolution, and prevention, as well as suggestions for the future. The survey used a combination of yes/no questions, multiple choice questions, Likert-scale questions, and two questions with an open comment box – one assessing reasons for non-resolution of identified prescribing cascades and one final question asking to provide any suggestions that would help in identifying, managing, and preventing prescribing cascades.

2.3. Survey distribution

Ethics approval was granted by the School of Pharmacy Social Research Ethics Committee of University College Cork. An email list was obtained from Ireland's pharmacy regulator, the Pharmaceutical Society of Ireland (PSI), which contained email addresses of all PSI-registered pharmacists with community pharmacy as their area of practice (n = 3815). An email containing a link to the anonymised survey on Microsoft® Forms was sent on November 10th 2021 to these 3815 pharmacists inviting those who practised full or part time as a pharmacist in a community pharmacy setting to participate (n = 40 emails not successfully delivered). Participation was voluntary, and participants were entitled to withdraw from the study up until data submission. To enhance the response rate, a notice was posted on the Pharmabuddy® forum website on November 11th to encourage pharmacists to check their email regarding the survey. Pharmabuddy® is a pharmacist education and support network with a forum used regularly by pharmacists in Ireland. This post did not contain the survey link; it provided the research team's contact details to allow eligible pharmacists who had not received the email to request the survey link (which resulted in one request). One follow-up reminder email was sent to pharmacists on November 24th, and the survey was closed on December 1st.

2.4. Data analysis

The percentage survey response rate was calculated by dividing the number of responses by the number of pharmacists who successfully received an email containing the survey link (i.e., n = 3776), and then multiplying by 100. IBM® SPSS version 28 was employed to calculate descriptive and inferential statistics. Descriptive statistics were performed on all closed-ended questions (based on valid responses). Chi-squared tests were conducted to compare groups of categorical data to assess whether significant differences existed between respondents based on their demographics (as shown in **Appendix 2**). All statistically significant results from this analysis are reported for each analysed statement. Post-hoc analysis was undertaken using the z-test to compare column proportions, with adjustment for multiple testing using the Bonferroni method. There was 2.7% missing data in this survey (excluding open box comments). Where any data were missing, statistics were calculated based on the valid response for each question. Reported percentages are based on valid percentages. All statistically significant differences were reported for the post-hoc analysis using the Bonferroni method, i.e. where $p < 0.05$.

Responses from the two open comment questions were imported into NVivo® version 12 to facilitate content analysis by three authors (KD/RC/NOS); responses to both questions were analysed independently. Phase 1 analysis comprised reading and re-reading responses for familiarisation. Phase 2 comprised conventional content analysis, which involved open coding to create initial non-hierarchical codes. Phase 3 involved directed content analysis, where responses were deductively coded using the TDF domains as pre-determined codes to identify the

domains present. Each response could be coded with multiple conventional codes and TDF domains. Thereafter, the conventional codes were categorised under the TDF domains, and conventional themes were developed under each of the relevant TDF domains. Predominant domains were determined by the authors by considering the (i) frequency of beliefs per domain, (ii) existence of conflicting beliefs, and (iii) perceived strengths of the beliefs. Discussion amongst authors occurred at all stages, including for the final write-up of themes and TDF domains.

3. Results

In total, 220 valid responses were received (5.8% response rate), with the respondent characteristics displayed in Table 1.

Pharmacists with i) more years of experience, ii) higher confidence in side effects knowledge, and iii) non-locum roles indicated significantly more often ($p < 0.05$) that they and their pharmacy colleagues provided a thorough description for side effects of newly prescribed medication.

The quality of side effects counselling for newly prescribed medication provided by the respondent or their colleagues was significantly more likely ($p < 0.05$) in those i) with higher confidence in side effects knowledge and ii) more frequently providing a thorough description of side effects.

3.1. Awareness of prescribing cascades

Approximately half of participants (51%) reported awareness of the term '*prescribing cascade*' prior to the survey. The most commonly selected sources that made pharmacists aware of this were undergraduate training (51.8%), their own reading (39.1%), and through a training course/webinar (30.9%). Other sources included a healthcare colleague (16.4%), postgraduate course/degree (15.5%), and social media (1.8%), whilst 9.1% were unable to remember the source. Over half agreed that this survey informed them about prescribing cascades they were not previously aware of (58%).

- ➢ Those with 0–4 years' of post-qualification experience were significantly more likely ($p < 0.05$) to be aware of the term prior to the survey and to have become aware through their undergraduate training.

3.2. Identification of prescribing cascades

Whilst only half were aware of the term '*prescribing cascade*' prior to the survey, 69% had personally identified a potentially inappropriate prescribing cascade in clinical practice. Over one quarter were either 'slightly confident' (23.4%) or 'not at all confident' (2.7%) in their ability to identify potentially inappropriate prescribing cascades in patients' prescriptions prior to this survey, compared to the three quarters that were 'moderately confident' (45.9%), 'very confident' (23.4%), and 'extremely confident' (4.5%).

- ➢ Those with higher confidence in side effects knowledge were significantly more likely ($p < 0.05$) to be confident in in their ability to identify potentially inappropriate prescribing cascades and to have personally identified one previously.
- ➢ Higher confidence in ability to identify potentially inappropriate prescribing cascades was significantly more likely ($p < 0.05$) in men (versus women) and in those with higher awareness levels of the indications for the drugs they dispense. Notably from Table 1, 70.3% of pharmacists were aware of the indication for at least eight out of every ten drugs they dispense (excluding antibiotics).

Specific details pertaining to the frequencies for the statistically significant findings ($p < 0.05$) in the results section thus far are available in Appendix 3.

Table 2 shows the extent to which respondents agreed or disagreed

Table 1
Respondent characteristics.

Descriptor	Frequency
Gender:	
Man	39.3%
Woman	59.8%
Other	0%
Prefer not to answer	0.9%
Role: [a]	
Pharmacy owner	24.5%
Superintendent pharmacist[b]	20%
Supervising pharmacist[c]	35%
Support pharmacist[d]	33.6%
Locum pharmacist	15%
Other	2.7%
Years' experience post registration:	
0-4	9.1%
5-9	11.8%
10-19	28.6%
20-29	30%
≥30	20.5%
Number of items dispensed per day on average:	
0-99	8.7%
100-199	33.9%
200-299	33%
300-399	13.8%
≥400	10.6%
Number of pharmacists most commonly working with at one time: (i.e. overlapping with on a given day)	
0	49.3%
1	34.7%
2	13.7%
≥3	2.3%
Out of every 10 newly prescribed drugs dispensed (except antibiotics), how many would you know the indication for?	
0	0.9%
1	0%
2	0.9%
3	1.8%
4	0.9%
5	5%
6	4.5%
7	15.5%
8	25.6%
9	26%
10	18.7%
Level of confidence in knowledge of drug side effects:	
Extremely	1.8%
Very	21.4%
Moderately	65.9%
Slightly	8.6%
Not at all	2.3%
How often is a thorough description provided for side effects of newly prescribed medication:	
Always	7.7%
Very often	34.5%
Sometimes	43.6%
Rarely	14.1%
Never	0%
Quality rating in counselling of side effects provided by you and pharmacy colleagues to patients/caregivers:	
Poor	2.3%
Fair	24.1%
Good	38.6%
Very good	27.7%
Excellent	7.3%

[a] Respondents could have chosen more than one option.

[b] The superintendent pharmacist is in overall control of the management of a pharmacy, including its professional and clinical management and management of the administration of the sale and supply of medicines. They can act in respect of more than one pharmacy (i.e. all pharmacies within a company/chain), and must have a minimum of three years' post-registration experience.[29]

[c] The supervising pharmacist is the person responsible for the day-to-day management and operation of the pharmacy. A supervising pharmacist can only act in respect of one pharmacy premises and must have a minimum of three years' post-registration experience.[30]

[d] A support pharmacist works under the supervising pharmacist and may be responsible for the safe and effective running of the pharmacy in the supervising pharmacist's absence.

Table 2
Identification of prescribing cascades.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
It is the responsibility of a community pharmacist to identify potentially inappropriate prescribing cascades.	21.4%	51.8%	20.9%	5.5%	0.5%
➢ Pharmacists who rated themselves as '*not at all confident*' about their knowledge of drug side effects were significantly more likely ($p < 0.05$) to disagree that it is their responsibility (2/5; 40%), compared to those who rated themselves as being 'very confident' (0/47; 0%). ➢ Superintendent pharmacists were significantly more likely to select '*strongly agree*' that identification was a community pharmacist's responsibility (34.1% versus 18.2%; $p < 0.05$).					
I believe that identifying prescribing cascades is important for patient safety.	39.4%	56.7%	3.4%	0%	0.5%
I believe that failing to identify inappropriate prescribing cascades could be considered an indicator of poor professional performance.	9.5%	25.7%	34.3%	23.8%	6.7%
➢ Pharmacy owners were significantly more likely to agree compared to other roles (48% versus 31.3%; $p < 0.05$).					
For me, my other community pharmacist duties are higher priority compared to identifying prescribing cascades.	4.3%	25.8%	35.9%	28.7%	5.3%
It is my responsibility to make my pharmacy staff colleagues aware about potentially inappropriate prescribing cascades.	11.5%	54.3%	22.6%	10.1%	1.4%
➢ Pharmacy owners and superintendent pharmacists were significantly more likely ($p < 0.05$) to agree that it is their responsibility compared to other roles: 78% versus 62% and 79.1% versus 62.4% respectively. ➢ Locum pharmacists were much more likely to disagree that it is their responsibility compared to all other roles (28.1% versus 8.5%).					
It is the responsibility of other non-pharmacist staff in a pharmacy to identify potentially inappropriate prescribing cascades.	0.5%	5.7%	8.6%	55%	30.1%
It is the responsibility of the prescriber to identify potentially inappropriate prescribing cascades.	45.1%	47.5%	5.4%	2%	0%
➢ Most agreed with this (92.6%), which ranged from 93.2% to 100% across the years of experience levels, with the exception of those with ≥30 years' experience. Significantly fewer pharmacists with ≥30 years' experience agreed with this compared to those with 10–19 years' experience (79.5% versus 96.8%; $p < 0.05$).					

Table 3
Factors influencing the non-resolution of prescribing cascades.

TDF Domain	Factors influencing the non-resolution of prescribing cascades
Intentions	• Stability of prescriber intentions ➢ Prescriber resistance ➢ Prescriber inertia or reluctance to change ➢ Prescriber motivation (e.g. unwilling to engage) ➢ Patient resistance (e.g. inertia or unwilling to address) • Certainty of prescriber intentions ➢ e.g. "*Prescriber thought they knew better*" • Intentional continuation ➢ Deliberate use of two drugs (whether appropriate or not)
Social/Professional role and identity	• Professional boundaries ➢ "*Reluctance by one doctor to discontinue medication started by another*" • Prescriber identity and individual differences ➢ Some are "*open to suggestions*" and others are more ignorant
Memory, Attention, and Decision Processes	• Deciding on the need for medication ➢ Actively deciding it was necessary to initiate a prescribing cascade • Forgetting ➢ Prescribing cascade initiated short term, then forgetting that it continued • Prescriber as the '*decision-maker*' ➢ Prescriber with the final decision and disagreed with pharmacist
Environmental context and resources	• Busy working conditions ➢ Time pressures for review or discussion • Interprofessional communication and relationships ➢ Difficulty contacting or calls not returned – worse with hospitals ➢ Trusting relationship facilitates resolution
Social Influences	• Social norms and hierarchical influences ➢ e.g. prescribers not happy to overrule a hospital consultant • Prescriber influence on patient ➢ Patient will follow the decisions of a more trusted/familiar prescriber
Beliefs about consequences	• Benefit versus risk: medication effectiveness and side effect duration ➢ "*First drug was necessary/benefit outweighed side effect*" ➢ Temporary side effect duration facilitates cascade initiation/continuation
Goals	• Goal priority ➢ e.g. "*Doctor decided original medication was too important to stop/change*"
Beliefs about capabilities	• Difficulty contacting prescriber • Empowering patients ➢ Informing patients of drug side effects facilitates resolution
Knowledge	• Prescriber knowledge ➢ Lack of knowledge about prescribing cascades or alternative options • Pharmacist not having enough information (e.g. medication indication)
Reinforcement	• Alternative option available or not ➢ No alternative to the original medication (e.g. different drug class)

with statements regarding prescribing cascade identification. Notably from Table 2, the majority (92.6%) agreed that it was the prescriber's responsibility to identify potentially inappropriate prescribing cascades; however, only three quarters (73.2%) agreed it was the community pharmacist's responsibility.

3.3. Resolution/non-resolution of prescribing cascades

Whilst 69% of respondents had personally identified a potentially inappropriate prescribing cascade, one quarter selected that <20% of these cascades were resolved (24.5%). A similar proportion said that 20–39% or 40–59% were resolved (13.9% and 15.2% respectively). Almost one third said that 60–79% or 80–100% were resolved (14.6% and 16.6% respectively). Meanwhile, 23 respondents were '*not sure*' what proportion were resolved (15.2%). Superintendent pharmacists were more likely to have these resolved; no superintendent pharmacist said they were resolved <20% of the time versus 30% for others ($p < 0.05$). Locum pharmacists were significantly more likely to be unsure of the proportion that were resolved compared to others (30.8% versus 9.3%; $p<0.05$).

Participants were welcomed to share any reasons why prescribing cascades identified were or were not resolved, of which 74 (49%) respondents commented. Table 3 shows the factors influencing the non-resolution of identified prescribing cascades, categorised according to the TDF domains. The first five domains were determined to be the predominant TDF domains influencing non-resolution. The respondents' quotations that support these factors are provided in Appendix 4.

3.4. Barriers to identifying or managing prescribing cascades

Participants were asked to rate the extent to which they believed the factors in Table 4 are barriers to identifying or managing prescribing cascades. The factors most highly rated as a strong barrier to identifying or managing prescribing cascades were not having access to a patient's medical history (57.6%), busy working conditions of community pharmacy (51.9%), and prescriber reluctance to make medication changes to stop a prescribing cascade once identified (49%).

3.5. Future implications

Participants were asked to rate the extent to which they agreed or disagreed with the statements in Table 5. When asked about their opinion on electronic alerts in the dispensing software that notify pharmacy staff of potential prescribing cascades, 84.1% agreed that these alerts would be useful. Most respondents agreed that they would like further information/training to help them both identify and manage prescribing cascades going forward (88.3% and 86.1% respectively).

When asked about their ability to identify and manage prescribing cascades in patients' prescriptions in the future, over one quarter were either '*very confident*' (24.7%) or '*extremely confident*' (1.4%), over half (51.6%) were '*moderately confident*', whilst less than one quarter were either '*slightly confident*' (21%) or '*not at all confident*' (1.4%). When compared to the earlier results regarding the ability to identify potentially inappropriate prescribing cascades in patients' prescriptions *prior to* the survey, these results are very similar.

3.6. Suggestions to aid in identification and management of prescribing cascades

Participants were welcomed to provide suggestions to aid in identification, management, and prevention of prescribing cascades, of which 75 (34.1%) respondents commented, which are provided in Table 6 and categorised according to the TDF domains. The quotations from the respondents that support the suggestions are provided in Appendix 5. Five predominant TDF domains influencing the suggestions to aid in identification and management of prescribing cascades were identified: '*Knowledge*', '*Environmental Context and Resources*', '*Social/Professional Role and Identity*', '*Social Influences*' and '*Memory, Attention and Decision Processes*'.

Table 4
Potential barriers to identifying or managing prescribing cascades.

	Not a barrier	Weak barrier	Moderate barrier	Strong barrier
Not having access to a patient's medical history.	7.8%	8.8%	25.9%	57.6%
Busy working conditions of community pharmacy. ➢ Pharmacy owners were significantly less likely to rate this as a strong barrier compared to non-owners (30.6% versus 58.6%; $p < 0.05$). ➢ Those who worked with 2 pharmacists at one time in a community pharmacy were significantly less likely to think that this was a strong barrier compared to those who work with no/one other pharmacist (24.1% versus 56.6% and 55.6%; $p < 0.05$). ➢ Pharmacists that '*rarely*' provided thorough descriptions of side effects were significantly more likely to rate this as a strong barrier compared to those who always/very often/sometimes provide a thorough description (80.6% versus 40%/42%/51.6%; $p < 0.05$). ➢ Pharmacists who rated their quality of counselling as '*fair*' were more likely to rate this as a strong barrier compared to all other ratings of quality (72.5% versus 48.8% and lower), which was statistically significantly lower ($p < 0.05$) than those who rated their quality of counselling as *'very good'* (41.8%).	2.9%	11.2%	34%	51.9%
Prescriber reluctance to make medication changes to stop a prescribing cascade once identified.	3.8%	13.8%	33.3%	49%
Multiple concurrent prescriptions for individual patients (from one or more prescribers).	1%	15.3%	39.2%	44.5%
Insufficient knowledge to identify prescribing cascades. ➢ Those who were unaware of the term *'prescribing cascade'* were significantly more likely to rate this as a strong barrier (35.2% versus 19.3%; $p < 0.05$).	9.2%	25.3%	38.2%	27.2%
Insufficient knowledge on where to find information on prescribing cascades. ➢ Pharmacists with 0–4 years' experience were more likely to rate as a strong barrier compared to all other ratings (50% versus 33.3% and lower), which was significant ($p < 0.05$) compared to those with ≥30 years' experience (12.5%). ➢ Pharmacists that rated insufficient knowledge to identify prescribing cascades as not a barrier were significantly more likely to also rate this as not a barrier compared to others (57.9% versus 15.1% and lower; $p < 0.05$).	12.4%	24.9%	37.3%	25.4%
Insufficient knowledge of the indication for medications in a potential prescribing cascade.	18.7%	27.8%	28.2%	25.4%
Not knowing how to manage potentially inappropriate prescribing cascades once identified. ➢ Those with ≥30 years' experience were the least likely to rate this as a strong barrier compared to other experience levels (5% versus 15.4% and higher); this was significantly lower than those with 5–9 years' experience (33.3%; $p < 0.05$).	18.7%	32.1%	32.1%	17.2%

Table 5
Future implications.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
This survey has informed me about prescribing cascades that I was not previously aware of. ➢ Whilst 58% agreed, this ranged from 53% to 68% across the years of experience levels, with the exception of those with <5 years' experience. Significantly fewer pharmacists in this category agreed with this compared to those with 10–19 years' experience (30% versus 66.7%; $p < 0.05$). ➢ Pharmacists that self-rated as '*slightly confident*' or '*moderately confident*' in their knowledge of drug side effects were significantly more likely to agree with this compared to those who self-rated as '*very confident*' (73.7% and 64.6% versus 31.9%; $p < 0.05$).	19.2%	38.8%	18.3%	20.5%	3.2%
I am concerned that patients are receiving prescribing cascades that I did not identify. ➢ Those with an '*excellent*' quality of side effects counselling were more likely to disagree here (57.1% versus 24.6% and lower), which was statistically significant ($p < 0.05$) compared to those who rated their quality of counselling as '*good*' (16.7%) and '*fair*' (15.4%). ➢ Pharmacists who were aware of the term '*prescribing cascade*' prior to the survey were more likely to disagree, which was significant compared to pharmacists who were unaware of the term (27.6% vs 14%; $p < 0.05$). ➢ Those who rated insufficient knowledge to identify prescribing cascades as '*not a barrier*' were significantly less likely to agree with this versus those who perceived it as a strong/moderate/weak barrier (15% versus 72.4%/57.7%/50%; $p < 0.05$).	8%	47.2%	24.1%	19.8%	0.9%
After this survey, I intend to check my patients for prescribing cascades (e.g. by reviewing patient records in the dispensing software). ➢ Pharmacy owners were significantly less likely to agree versus non-owners (47.1% versus 67.3%; $p < 0.05$).	12.7%	49.8%	22.5%	13.1%	1.9%
It would be useful to have electronic alerts in the dispensing software that notify pharmacy staff on potential prescribing cascades (e.g. like drug interaction alerts). ➢ All pharmacists who were '*not at all confident*' in their side effects knowledge ($n = 5$) agreed, which was significantly more than those who were slightly/moderately/very confident (88.9%/83.2%/86.7%; $p < 0.05$). ➢ Those who perceived insufficient knowledge to identify prescribing cascades as '*not a barrier*' were less likely to agree with this compared to those who perceived it as a strong/moderate/weak barrier (65% versus 79.6% and higher); this was found to be significantly lower than those who selected '*moderate barrier*' (89.9%; $p < 0.05$).	34.3%	49.8%	11.3%	3.8%	0.9%
I would like further information/training to help me IDENTIFY prescribing cascades. ➢ Those who were '*very confident*' in their side effects knowledge were significantly less likely to agree compared to those who were moderately or slightly confident (77.8% versus 91.6% and 94.4%; $p < 0.05$). ➢ Those that were unaware of the term '*prescribing cascade*' were significantly more likely to agree compared to those that were aware of the term (93.5% versus 83%; $p < 0.05$). ➢ Those who perceived insufficient knowledge to identify prescribing cascades as '*not a barrier*' were significantly less likely to agree with this versus those who perceived it as a strong or moderate barrier (65% versus 94.8% and 91.1%; $p < 0.05$).	36.2%	52.1%	7.5%	3.8%	0.5%
I would like further information/training to help me MANAGE prescribing cascades.	33.7%	52.4%	10.6%	2.4%	1%

Table 6
Suggestions to aid community pharmacists in the identification, management, and prevention of prescribing cascades.

TDF Domain	Suggestion
Environmental Context and Resources	• Improve access for pharmacists to patients' healthcare information (e.g. diagnoses) • Provide indications for prescribed medication (e.g. making it a requirement) • Optimise interprofessional communication ➢ Enhance use of direct pharmacist-doctor communication (e.g. via email) ➢ Reduce the disconnect between primary care and hospitals • Improve working conditions: need to address staffing and administrative workload ➢ More time required to review prescriptions and talk to patients
Knowledge	• Education and training: as part of continuous professional development, and interprofessional if possible • More information on cascades and guidance on how to manage them • More information for the public on cascades/side effects (e.g. information leaflet) • Establish the drug indication by asking patients (and documenting it in the patient record so that others can know it in future)
Social influences	• Patient empowerment ➢ Informing patients of side effects and the possibility of cascades ➢ Encouraging patients to ensure that all healthcare professionals are aware of relevant prescriptions • Reduce employer influence ➢ e.g. evaluate employees based on interventions, with less focus on revenue • Increase interprofessional collaboration and relationships ➢ Encouraging good working relationships and multidisciplinary team working • Minimise interprofessional conflict and address hierarchical influences ➢ e.g. "*doctors being trained and realising pharmacist potential and not being dismissive of our profession*" so that doctors do not "*feel they are being undermined*" or that pharmacists are "*challenging their professional judgement*"
Memory, Attention, and Decision Processes	• Electronic alerts • Have one or more lists of cascades available (e.g. of common examples) • Provide an aide memoire on display in healthcare settings (e.g. pharmacies) • Focus attention on identification, especially when dispensing a new medication • Improve decision-making on prescribing cascade appropriateness ➢ e.g. taking a holistic approach in ensuring all factors considered when deciding if a prescription sequence is appropriate or inappropriate
Social/Professional role and identity	• Enhance emphasis on medication reviews • Review roles allocated to pharmacists ➢ e.g. minimising certain tasks being performed by pharmacists (such as sales and administrative tasks) to allow them to focus on medication appropriateness • Have increased pharmacist presence in general practices
Reinforcement	• Incentivise their identification and management ➢ Reimbursement for medication reviews (and identifying cascades)
Behavioural regulation	• Be welcoming of behaviour change interventions (e.g. software-based) • Once awareness is increased about one or more cascades, action planning is required ➢ Plan to research and update knowledge
Beliefs about capabilities	• Provide pharmacists with more health-related information to give them a greater ability to recognise and minimise prescribing cascades
Intentions	• Recognise intentional versus unintentional prescribing cascades ➢ Establish when cascades are intentional, e.g. where there are no alternatives
Beliefs about consequences	• Communicate side effects and risk-benefit to patients ➢ e.g. rather than patients unknowingly putting up with side effects

4. Discussion

This is the first study to explore community pharmacists' views on prescribing cascades, and also appears to be the first that has used the TDF to assess behavioural determinants that influence the prevention, identification, and management of prescribing cascades. Only 51% of pharmacists in this study were aware of the term *'prescribing cascade'* prior to the survey and a similar proportion were concerned that their patients were receiving prescribing cascades that were not identified (55.2%) – highlighting the need to increase awareness around these phenomena and for additional strategies to be utilised to aid in their minimisation.

This research discovered characteristics of both pharmacists (e.g. years of experience, role, side effects knowledge) and pharmacies (e.g. pharmacist staff numbers at one time, quality of staff counselling on side effects) that influence prescribing cascade identification and management. This study found opportunities for pharmacy teams to improve their thoroughness and quality of patient counselling regarding side effects. Patients who are less aware of side effects are less likely to recognise and report them when they occur. An interview study by Farrell et al. had '*varying awareness of medications and cascades*' as one of three interrelated themes on how cascades develop and persist.[8] In that study, patients seldomly recognised symptoms they experienced as potential medication side effects. Whilst acknowledging the busy working conditions in community pharmacy, this finding underscores the importance of efforts to empower patients to recognise and report possible side effects, thus facilitating cascade prevention. Our findings have shown that there is room to optimise pharmacists' knowledge of side effects, as this is fundamental for identifying prescribing cascades. Whilst pharmacists are medication experts, many respondents (65.9%) were only 'moderately confident' or lower in their side effects knowledge; therefore, greater emphasis must be placed on this knowledge during undergraduate training and its maintenance thereafter. Similarly, Farrell et al. highlighted that clinicians and patients also need to improve their knowledge of medication side effects, and emphasised the importance of asking '*can this be caused by a drug?*'.[9]

This survey has demonstrated that pharmacists want and need more information to help identify and manage prescribing cascades; better resources should help minimise prescribing cascades.[31] Even though the survey itself included only seven examples of prescribing cascades (**Appendix 1**), pharmacists said this included examples they were not previously aware of, and indicated that having a list of prescribing cascades or aide-memoire would be beneficial in identifying them. Since the survey was distributed, a list of nine clinically important prescribing cascades for older adults has been published.[2] This ThinkCascades tool should raise awareness about prescribing cascades in general and aid in recognising them, thus contributing to their prevention and management. Importantly though, whilst knowledge was identified as a predominant TDF domain from the open comments, it was ranked lower as a '*strong barrier*' in prescribing cascades' identification and management. This suggests that other domains may be more important as

behavioural targets for future interventions.

This study found that while most community pharmacists (92.6%) agreed it was the prescriber's responsibility to identify prescribing cascades, only 73.2% agreed it was a community pharmacist's responsibility. Given community pharmacists' oversight of patients' medication and their pharmacotherapy expertise, this may be somewhat surprising and warrants further exploration. Not having access to patients' medical history was perceived as the strongest barrier to identifying or managing a prescribing cascade; perhaps this was a contributing factor. Gernant et al. demonstrated that pharmacists identified more medication-related problems when they had access to medical records.[32] Therefore, having a centralised electronic health record accessible to all healthcare team members may facilitate prescribing cascade identification. Related to this, pharmacist respondents revealed that the indication is not known for 1 in 5 new medications on average (other than antibiotics), with some suggesting that providing indications on prescriptions should be a legal requirement. In a previous study by Whaley et al., pharmacists expressed they should be provided with indications, alongside other prescription information (medication name, dose, frequency etc.), to allow them assess medication safety more effectively and provide better care to patients.[33] Therefore, having medication indications as a prescription requirement in future, as suggested by respondents in this study, may make it more likely for community pharmacists to not only prevent inappropriate prescribing cascades, but also to have more informed decision-making in managing them.

Most pharmacists in this study (84.1%) agreed it would be useful to have electronic alerts in dispensing software to flag possible prescribing cascades, which would primarily align to three of the predominant TDF domains identified: '*Environmental Context and Resources*', '*Knowledge*', and '*Memory, Attention and, Decision Processes*'. However, any alerts created should probably not just aid in identifying potential cascades but should be linked with suggestions on how to manage them. As patients may attend multiple healthcare providers, it may be beneficial to have such alerts in both prescribing and dispensing software. Such alerts may be complex to develop due to many drugs being potentially involved in prescribing cascades. High specificity and sensitivity would be needed to ensure their relative effectiveness,[34] due to the risk of alert fatigue.[35] Furthermore, such technology would also require updating of current prescribing and dispensing software, as well as the development of guidance on how to manage prescribing cascades. While there are recommendations available for some prescribing cascades,[36] no comprehensive guidance has been compiled to date.

Considering 55.2% of pharmacists were concerned their patients had been exposed to prescribing cascades and 62.5% intended to check their patients for these after the survey not only shows that the survey itself has acted as an intervention, but more importantly emphasises the urgency with which we require strategies to minimise patient harm from prescribing cascades. However, simply identifying possible cascades does not automatically mean that they will be resolved. Some of the strongest barriers to non-resolution included having multiple prescribers, prescriber inertia, and busy working conditions – which have been identified previously as contributors to these phenomena and inappropriate prescribing in general.[37] As predominant TDF domains influencing non-resolution, '*Social/Professional Role and Identity*' and *'Social Influences'* represent important targets for future behaviour change interventions. A starting point would be in considering the suggestions from Table 6, such as re-allocating some tasks to other pharmacy staff to allow pharmacists to focus on reviewing medications and/or work more closely with primary care physicians.

This study identified four predominant TDF domains that were common to both the reasons for non-resolution of identified prescribing cascades and the suggestions to aid in the prevention, identification, and management of prescribing cascades. Therefore, it would be recommended to map all predominant TDF domains to the Behaviour Change Wheel[38] to help develop interventions to target the behaviours of healthcare professionals, patients, and caregivers. Through discussion and applying the APEASE criteria,[38] this would allow the identification of possible intervention types that may be feasible in clinical practice and hopefully successful ultimately in minimising prescribing cascades as much as possible.

4.1. Strengths and limitations

The use of the TDF in constructing and analysing the survey not only allows for comparison to other TDF-based studies, but importantly facilitated a comprehensive assessment of behavioural determinants and better informs the development of behaviour change interventions.[39] Whilst the response rate in this study may appear low (5.8%), it must be acknowledged that this survey was distributed during the COVID-19 pandemic, and a response rate of 5–15% may typically be expected when a survey is distributed via the email list used.[40,41] Furthermore, the response rate may also have been hindered by pharmacists simply not knowing what a '*prescribing cascade*' is, and therefore possible inertia with participation; this is supported by the fact that only half of respondents were aware of the term prior to the survey. Consequently, we must consider the issue of non-response bias affecting our study findings, and it may suggest that awareness of prescribing cascades in the wider pharmacist population is lower than that reflected in our sample, further emphasising the need to heighten awareness of these phenomena.

Although it cannot be said that the responses gathered are representative of the whole community pharmacist population in Ireland, the respondents were diverse in terms of their role, years of post-registration experience, and pharmacy characteristics. However, this survey only obtained community pharmacists' views; therefore, future research could assess the views of other pharmacists and doctors from other settings to generate additional nuanced strategies to aid in minimising prescribing cascades. Lastly, it is unclear how transferable these findings would be to other countries, particularly where electronic health records and different prescription rules are present or where pharmacists can also prescribe medications.

5. Conclusion

This research has provided a unique insight into community pharmacists' awareness, identification, and management of prescribing cascades. Notably, only half of pharmacist respondents were aware of the term *'prescribing cascade'* prior to the survey. The majority of pharmacists had identified a potentially inappropriate prescribing cascade in their practice and many were worried that their patients were receiving prescribing cascades that were not identified, and most would like further information and training to help identify and manage prescribing cascades. Additionally, this survey demonstrated deficiencies in pharmacists' knowledge of side effects and the quality and comprehensiveness of side effects counselling, which should be addressed to better empower patients and caregivers to recognise and report possible side effects, so as to minimise the initiation of medication cascades.

This study highlighted several important barriers to prescribing cascade identification and management, such as not having access to patients' medical history, busy working conditions, interprofessional conflict, and prescribing boundaries. To address many of these, this study has provided a plethora of useful suggestions that should aid in the minimisation of prescribing cascades – such as having electronic alerts, necessitating indications for prescription medications, and increasing education and guidance on the topic. Furthermore, this research has importantly identified four TDF domains that predominantly appear both in these suggestions and in the reasons for non-resolution of identified prescribing cascades: *'Environmental Context and Resources'*, *'Social/Professional Role and Identity'*, *'Social Influences'* and '*Memory, Attention and Decision Processes'*. Therefore, these novel survey findings provide targets to prioritise and will assist the development of theory-informed behaviour change interventions to enhance awareness of

prescribing cascades amongst healthcare professionals, patients, and caregivers alike, and ultimately help both minimise their occurrence and reduce medication-related harm for patients in future.

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CRediT authorship contribution statement

Kieran Dalton: Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Robert Callaghan:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Niamh O'Sullivan:** Writing – original draft, Visualization, Formal analysis. **Lisa McCarthy:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

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