

This is the peer reviewed version of the following article:

**Impact of the Collaborative Pharmaceutical Care at Tallaght Hospital (PACT) model on medication appropriateness of older patients,**

which has been published in final form at

<http://ejhp.bmj.com/content/early/2015/06/18/ejhpharm-2014-000511.short?rss=1>

*Eur J Hosp Pharm* doi:10.1136/ejhpharm-2014-000511

Copyright © 2016 European Association of Hospital Pharmacy

Article first published online: 18 June 2015

Title of the article.

Impact of the Collaborative Pharmaceutical Care at Tallaght Hospital (PACT)  
model on medication appropriateness of older patients

Corresponding author

Dr Tamasine C Grimes, Tallaght Hospital, Dublin 24, Ireland,

[tagrimes@tcd.ie](mailto:tagrimes@tcd.ie), telephone 00 353 87 6490714, fax 00 353 1 896 2810.

Authors

Maria Tallon

John Barragry

Ann Allen

Niall Breslin

Evelyn Deasy

Eddie Moloney

Tim Delaney

Catherine Wall

John O'Byrne

Tamasine Grimes

## **ABSTRACT**

### **Objectives**

A high prevalence of potentially inappropriate prescribing (PIP) has been identified in older patients in Ireland. The impact of the Collaborative Pharmaceutical Care at Tallaght Hospital (PACT) model on the medication appropriateness of acute hospitalised older patients during admission and at discharge is reported.

### **Methods**

Uncontrolled before-after study. The study population for this study was medical patients aged  $\geq 65$  years, using  $\geq 3$  regular medicines at admission, taken from a previous before-after study. Standard care involved clinical pharmacists being ward-based, contributing to medication history taking and prescription review, but not involved at discharge. The innovative PACT model involved clinical pharmacists being physician team-based, leading admission and discharge medication reconciliation and undertaking prescription review, with authority to change the prescription during admission or at discharge. The primary outcome was the Medication Appropriateness Index (MAI) score applied pre-admission, during admission and at discharge.

### **Results**

Some 108 patients were included (48 PACT, 60 standard). PACT significantly improved the MAI score from pre-admission to admission (mean difference 2.4, 95% confidence interval (95CI) 1.0-3.9,  $p < 0.005$ ), and from pre-admission to discharge (mean difference 4.0, 95CI 1.7-6.4,  $p < 0.005$ ). PACT resulted in significantly fewer drugs with one or more inappropriate rating at discharge (PACT 15.0%, standard 30.5%,  $p < 0.001$ ). The MAI criteria responsible for most inappropriate ratings was "correct directions" (4.8% PACT, 17.3% standard), expense (5.3%, 5.7%) and dosage (4.0%, 0.6%). PACT suggestions to optimize medication use were accepted more frequently, and earlier in the hospital episode, than standard care (96.7%, 69.3%,  $p < 0.05$ ).

### **Conclusion**

Collaborative pharmaceutical care between physicians and pharmacists from admission to discharge, with authority for pharmacists to amend the

prescription, improves medication appropriateness in older hospitalised Irish patients.

### **Key messages**

What is already known on this subject -

- Older patients are at greater risk of drug related problems, including adverse drug effects, than younger patients.
- Potentially inappropriate prescribing is common generally in older persons and care transitions add an additional level of risk.
- There is limited evidence in Ireland regarding the benefit of a collaborative model of pharmaceutical care, between physicians and pharmacists, on the quality of prescribing in older hospitalised patients.

What this study adds -

- Collaborative pharmaceutical care that integrates clinical pharmacy with medical care, for older hospitalised patients results in improved quality of prescribing.
- Collaborative pharmaceutical care should be delivered across the entire inpatient episode from admission to discharge.
- Medicines reconciliation and medicines review are both important aspects of collaborative pharmaceutical care.

## INTRODUCTION

The proportion of the world's population who are aged  $\geq 65$  years is increasing and expected to increase further in the upcoming decades (11% in 2010 to an estimated 22% in 2050) and the Irish projection is consistent with this trend.<sup>1</sup> Those aged  $\geq 65$  years also consume the greatest proportion of drugs and in Ireland account for approximately half of the prescription drugs dispensed within the Health Services Executive Primary Care Reimbursement service (HSE PCRS).<sup>2</sup> The Irish Longitudinal Study on Ageing identified that 26% of people aged  $\geq 50$  years use five or more regular medicines.<sup>3</sup>

It is widely reported that older people are more likely to have more comorbidities than younger people and, owing to age-related changes in pharmacokinetics and pharmacodynamics, are at greater risk of drug related problems and adverse drug reactions.<sup>4</sup> Furthermore older hospitalised patients are vulnerable to fragmentation of care and adverse events at transitions of care.<sup>5</sup> Safe, appropriate and effective prescribing remains one of the challenges in geriatric medicine. Potentially inappropriate prescribing (PIP) has been reported in the range of 35% to 60% of patients aged  $\geq 65$  years in acute hospitals<sup>6,7</sup> and has been associated with increased medical expenses and drug-related hospital admissions.<sup>8,9,10</sup> The estimated expenditure on PIP in those aged  $\geq 70$  years in Ireland was in excess of €45 million in 2007, which is 9% of the overall expenditure on pharmaceuticals in that cohort.<sup>11</sup>

To optimise an individual's pharmacotherapy, a systematic multidisciplinary approach is advised. Inclusion of clinical pharmacists in medicines management has been shown to optimise appropriate prescribing and contribute to positive clinical outcomes for patients.<sup>9,10,12,13,14,-15</sup> Pharmacists are ideally placed to perform medicines reconciliation and review and have the expertise and knowledge to deliver such services.<sup>16,17</sup> This type of integrated medicines management has been adopted in Sweden<sup>9,10,18-,19,20</sup> and Northern Ireland<sup>12,14,15</sup> to good effect. To date, many Irish studies have described the prevalence of PIP, adverse drug events or medication error in

hospitalised patients.<sup>11,21-22,23,24</sup> However, few have investigated the effect of a collaborative model of pharmaceutical care on the quality of prescribing in older patients.<sup>13</sup> This study examined the appropriateness of medicines use in hospitalised patients aged  $\geq 65$  years receiving care through the PACT (Collaborative Pharmaceutical Care in Tallaght Hospital) service, compared with those receiving standard pharmaceutical care.<sup>25</sup>

## **METHODS**

### **Study population and setting**

The results presented in this article are part of the aforementioned study, a prospective observational uncontrolled before-after study comparing patients who obtained standard clinical pharmacy care against those who received a collaborative multidisciplinary approach involving pharmacists and medical practitioners, (PACT).<sup>25</sup> The PACT study recruited adult medical patients (n=233) of any age. This study reports on the medication appropriateness in a sub-population of older patients only (those aged 65 years or more, n=108).

The PACT study was undertaken from July 2010 to May 2011 in Tallaght Hospital, Dublin, Ireland; a 600 bed acute teaching hospital.<sup>25</sup> Standard clinical pharmacy service involved ward based clinical pharmacists serving numerous consultants and contributing to prescription review and medicines reconciliation at admission, during the inpatient stay, but not at discharge. Clinical pharmacists in the PACT group were integrated into a designated consultant's team and served numerous wards. Responsibilities included medicines reconciliation at admission and discharge, prescription review with the authority to amend the prescription on the drug chart or discharge prescription, as deemed appropriate by discussion with physicians. Two clinical pharmacists contributed to PACT. Activities of both care models and outcome measures are described in the supplementary section and in the previously mentioned study.<sup>25</sup>

### **Recruitment process for Medication Appropriateness Index (MAI) assessment**

Adult medical patients were eligible for inclusion if:

- (i) aged  $\geq 65$  years

- (ii) using  $\geq 3$  regular medicines at admission
- (iii) were admitted to and discharged alive from hospital under the care of one of the study teams during the study period

Exclusion criteria:

- (i) staff members who were admitted as patients
- (ii) patients that were re-admitted during the study period and already included

The study protocol was submitted to and approval was obtained from the St James' Hospital /Tallaght Hospital Joint Research Ethics Committee (SJH/AMNCH REC ref 2010/03/11). The protocol detailed that the MAI would be employed to investigate the quality of prescribing amongst patients aged 65 years or older. It was considered an investigation of service delivery, all investigators were employed clinicians, contractually bound to maintain patient confidentiality. Patient consent was not required.

### **Description of MAI**

The Medication Appropriateness Index (MAI) is one method of assessing prescribing quality in older people (aged 65 years or more).<sup>26</sup> It is an implicit (judgement based) tool which is patient-tailored and gives an opportunity to completely assess an individual's pharmacotherapy. Tests of inter-rater agreements have found the MAI to be a valid, reliable tool for evaluation.<sup>27</sup> However, it is time consuming, dependent on clinical judgement and does not take into account under-prescribing. MAI measures the appropriateness of prescribing for elderly patients, using 10 weighted criteria for each medicine: (indication (3); population effectiveness (3); dosage correct (2); directions correct (2); directions practical (1); drug-drug interactions (2); drug-disease interactions (2); cost (1); unnecessary duplication (1) and duration (1). Each of these 10 criteria is related to the patient and medicine. Responses of "appropriate" or "marginally inappropriate" are not given a score but if a medicine was deemed "inappropriate" then the weighted score for that criterion are assigned. The higher the MAI score, the more inappropriate the prescribing (scores range from 0-18 per drug).

In this study, a score was calculated for each drug at pre-admission, during admission and discharge. The clinical pharmacist's medication history was regarded as the gold standard pre-admission medication list; a previously developed and appraised method employed in two Irish hospitals.<sup>21,23</sup> The investigator performed medication reconciliation and developed a best possible discharge medication list, against which the documented discharge prescription was assessed. Medication were categorised using the World Health Organisation's Anatomic Therapeutic Classification (ATC) system.

Two investigating pharmacists (not involved in delivering the PACT intervention) retrospectively used the explicit definitions and instructions that accompanied the MAI.<sup>26</sup> Local clarifications and rules were also introduced to ensure consistency, for example where a medication was unintentionally omitted or intentionally stopped/withheld without documentation on the discharge list, it was categorised as "directions correct - inappropriate" and a score of (2) was applied. A sample of 10% (n=11) of all cases were validated by a third investigating pharmacist to ensure reliability. The investigating pharmacists were not blinded to study allocation and had access to all sources of medication and clinical details in the healthcare record, as required to assess appropriateness. The summated score for each patient at each stage and the differences from pre-admission to admission and from pre-admission to discharge were calculated. Under-use of medication, (whether each of the patient's present medical conditions or risk factors was treated), was not assessed.

### **Outcome measurements**

- (i) The primary outcome was the appropriateness of prescribing in patients aged  $\geq 65$  years as measured by the MAI at pre-admission, during admission and discharge.
- (ii) The secondary outcome was the frequency of acceptance of clinical pharmacists' suggestions.

### **Statistical analysis**

SPSS, version 22 was used to support data analysis. Data distribution was analysed using the Kolmogorov-Smirnov test. Differences between groups



were identified using the chi squared test for categorical data, Mann Whitney U test (reporting median and inter-quartile range) for nonparametric continuous data, and the Student's t test (reporting mean and standard deviation (SD) for parametric continuous data. For all tests, p-values <0.05 were considered statistically significant.

## RESULTS

### Recruitment process for MAI assessment

Some 108 patients were eligible for inclusion. There were no differences in clinical or demographic characteristics between the groups (Table 1) and there was no difference in the baseline pre-admission MAI score (Table 2). The PACT intervention significantly improved the quality of prescribing both during admission and at discharge (Tables 2 and 3).

**Table 1 - Patients' demographic and clinical characteristics, intervention and standard care**

Characteristic	Standard (n=60)	PACT (n=48)	p value
Gender, n (%), male	28 (47.8)	25 (52.2)	0.164
General Medical Service* status, (%) in receipt	41 (69.0)	30 (63.8)	0.538
Smoking status, (%) current user	11 (18.4)	12 (25.6)	0.403
Alcohol use, (%) current user	30 (51.1)	27 (57.1)	0.615
Age, years, median (IQR)	75 (70-80)	78 (71-83)	0.077
Length of stay, days, median (IQR)	7.5 (5-12)	8.5 (5-13)	0.717
Charlson Co-morbidity index, median (IQR)	2 (1-3)	2 (1-3)	0.693
Number of medicines <sup>§</sup> , median (IQR)	11 (9-13)	10 (8-14)	0.975

IQR, Inter-quartile Range; NS, not statistically significant at 0.05.

\* General Medical Service refers to government support for healthcare including GP visits and prescribed medication, eligibility is largely based on income.

\$ Relates to the total number of medicines prescribed before admission and those added during admission that remained active at discharge, exclusive of medications commenced and stopped within the hospital episode.

**Table 2 - Medication appropriateness index - summated scores per patient at pre-admission, admission and discharge**

<b>Outcome</b>	<b>Standard</b>	<b>PACT</b>	<b>p value</b>
<b>Medication Appropriateness Index, median (IQR)</b>			
Summated MAI pre-admission	3 (1 to 6.8)	4 (1 to 7.5)	0.538
Summated MAI admission	4 (2 to 7)	2.5 (1 to 5)	0.013
Summated MAI discharge	6 (3 to 9)	2 (0 to 4)	0.000
Difference pre-admission to admission, summated MAI	0 (-2 to 4)	-0.5 (-3 to 0)	0.006
Difference pre-admission to discharge, summated MAI	1 (-1 to 6)	-1 (-3.8 to 0)	0.000

**Table 3 - Medication appropriateness index - scores per drug at pre-admission, admission and at discharge and proportion of drugs with at least one inappropriate rating**

	Standard	PACT	p value
<b>Proportion of drugs with at least one inappropriate rating (% , 95CI)</b>			
Pre-admission (n=523 in standard, 423 in PACT)	20.5 (17.2, 24.3)	21.5 (17.7, 25.6)	0.748
Admission (n=676 in standard, 540 in PACT)	21.4 (18.4, 24.7)	15.0 (12.2, 18.4)	0.005
Discharge (n=676 in standard, 540 in PACT)	30.5 (27.1, 34.2)	15.0 (12.2, 18.4)	<0.001
<b>MAI score per drug (mean, standard deviation SD)</b>			
Pre-admission	0.46, 1.08	0.52, 1.25	0.748
Admission	0.45, 0.99	0.30, 0.90	0.006
Discharge	0.64, 1.06	0.31, 0.89	<0.001
<b>Difference in mean MAI score per drug (mean, SD)</b>			<b>Mean difference, 95CI, p value</b>
Pre-admission to admission	0.05, 0.96	-0.19, 0.88	0.24, 0.12-0.36, <0.001
Pre-admission to discharge	0.24, 1.13	-0.21, 1.10	0.45, 0.31-0.59, <0.001

IQR, inter-quartile range; MAI Medication Appropriateness Index (increase in score represents reduction in quality of prescribing).

PACT reduced the proportion of drugs with one or more inappropriate ratings and reduced the overall MAI score compared to standard care (Table 3).

**Table 4 – Proportion of drugs rated as inappropriate for each MAI criterion**

MAI - Criterion	Standard			PACT		
	Pre-Admission n=523 (%)	Admission n=676 (%)	Discharge n=676 (%)	Pre-Admission n=423 (%)	Admission n=540 (%)	Discharge n=540 (%)
Indication	0.4	1.0	0.7	1.3	0.2	0.4
Effectiveness	2.2	1.9	1.9	2.6	2.6	2.4
Dosage	4.4	2.5	4.0	2.4	1.3	0.6
Correct Directions	0.0	6.7	17.3	0.2	0.7	4.8
Practical Directions	0.4	0.6	0.7	1.5	0.7	0.9
Drug-Drug Interaction	1.3	2.2	2.1	2.2	1.7	1.1
Drug-Disease Interaction	3.8	2.1	1.0	4.1	1.7	0.7
Duplication	0.7	1.0	0.6	1.7	1.1	0.9
Duration	2.4	2.5	0.3	3.0	4.6	0.2
Expense	4.9	5.3	5.3	5.2	6.1	5.7

The MAI criterion responsible for the largest proportion of inappropriate ratings on discharge was “correct directions” (4.8% in PACT versus 17.3% in the standard group) (Table 4). The frequency of drug-drug interactions almost doubled from admission to discharge in the standard group, and halved in the PACT group. The percentage of drugs that were classified as “effective” improved slightly in both groups however the PACT group had a higher baseline value. Similar trends were noted for both groups with respect to expense and duration.

**Table 5 - Medication class (ATC) identified most frequently with inappropriate use**

MAI - Criterion	Results for first level ATC (anatomical main group) reporting			
	ATC Chapter	Anatomical main group	As a percentage of PIP (%)	Percentage of drug class (%)
Indication	C	Cardiovascular	6/18 (33.3%)	6/347 (1.7%)
Effectiveness	N	Nervous	15/34 (44.1%)	15/152 (9.9%)
Dosage	C	Cardiovascular	33/72 (45.8%)	33/347 (9.5%)
Correct Directions	C	Cardiovascular	51/164 (31.1%)	51/347 (14.7%)
Practical Directions	R	Respiratory	8/18 (44.4%)	8/129 (6.2%)
Drug-Drug Interaction	R	Respiratory	9/32 (28.1%)	9/129 (28.1%)
Drug-Disease Interaction	C	Cardiovascular	27/52 (51.9%)	27/347 (7.8%)
Duplication	R	Respiratory	11/17 (64.7%)	11/129 (8.5%)
Duration	N	Nervous	30/47 (63.8%)	30/152 (19.7%)
Expense	A	Alimentary tract	66/87 (75.9%)	66/269 (24.5%)

The medication class identified with the most inappropriate ratings per MAI criterion is displayed in Table 5. Drugs used for obstructive airways disease (R03) had the most inappropriate ratings for practical directions, drug-drug interactions and duplication (8/1216 0.6%, 9/1216 0.7% and 11/1216 0.9% respectively). Nervous system medications involved mainly (N05) drugs, antipsychotics and benzodiazepines, while cardiovascular drugs involved (C09) drugs acting on the renin-angiotensin system and (C03) diuretics.

**Table 6 - Clinical pharmacists' documented suggestions and acceptance rates**

<b>Process measures</b>	<b>Standard</b>	<b>PACT</b>	<b>Chi<sup>2</sup>, df, p</b>
Clinical pharmacist suggestion made per patient, n (%)	43/60 (71.7%)	86/112 (83.3%)	2.040, 1, 0.153
Clinical pharmacist suggestion made per medication, n (%)	114/676 (16.9%)	121/540 (22.4%)	5.105, 1, 0.024
<b>Acceptance of clinical pharmacist suggestions</b>			
<b>(n (%) of suggestions)</b>	<b>Standard</b>	<b>PACT</b>	<b>Chi<sup>2</sup>,df, p</b>
Accepted during admission	65/114 (57%)	108/121(89.3%)	5.917, 5, 0.015
Accepted at discharge	14/114 (12.3%)	8/121 (6.6%)	
Not accepted	35/114 (30.7%)	4/121 (3.3%)	

**Clinical pharmacists' suggestions and acceptance rates**

Clinical pharmacists documented suggestions to optimize medication use significantly more frequently in PACT than standard care (Table 6). These suggestions were accepted more frequently and earlier in the hospital episode than standard care. The reasons for acceptance, or not, of the suggestions was not recorded.

## DISCUSSION

### Key findings

Medicines reconciliation and prescription review carried out according to the PACT model,<sup>25</sup> that is integrating the clinical pharmacy service with medical care, produced significant improvements in appropriateness of prescribing in hospitalised patients aged  $\geq 65$  years.

The main findings of this study were that the quality of prescribing improved for PACT patients and deteriorated in standard care, consistent with the literature regarding other collaborative pharmaceutical care models.<sup>9-13,14,15,18,28</sup> Like these studies,<sup>9,10,12,25,28,29</sup> our research confirms that the integration of a pharmacist into the health-care team facilitates comprehensive admission and discharge medication review. The deterioration in the MAI score of standard care patients could be related to a focus on medicines reconciliation on admission only, a result also noted by Swedish studies.<sup>10,18</sup> The latter reported that drug-related problems may be introduced during the inpatient stay and at discharge which may not be reviewed by a pharmacist due to time constraints. Similarly, two recent Dutch studies reported that drug errors can occur at points of transitions in care, especially at discharge<sup>30</sup> and often persist post-discharge through to primary care.<sup>31</sup> Evidence from the PACT study supports the involvement of the clinical pharmacist in medication management across the entire inpatient episode, inclusive of discharge.

This study is not without its limitations. It was an uncontrolled before-after study undertaken at a single site, which limits the external generalizability. An uncontrolled before-after study is regarded as inferior to a controlled or a randomised study design: changes that occur over time make it difficult to attribute any observed change to the intervention; there is evidence that the results of such studies may overestimate the effects of quality improvement-like interventions<sup>32</sup>. It was not feasible to undertake a randomised controlled study at a single centre due to potential for contamination across the care of

patients receiving standard or intervention care by either the pharmacists or the doctors. However every effort was taken to minimise bias due to non-randomisation and no difference was identified in baseline demographic or clinical characteristics between the study groups. As with any prospective observational study, the Hawthorne effect may have been present, i.e. doctors and pharmacists may have acted or performed differently than they would normally because they were aware they were being observed.<sup>33</sup> The MAI assessment was prone to performance bias because the assessing pharmacists were not blinded to study allocation. It is acknowledged that using the clinical pharmacist's medication history as the gold standard pre-admission medication list may not always be accurate, as with any list however, it is highly likely that it is the best possible list.<sup>23</sup>

The elements of multidisciplinary working, and cost-effectiveness of therapy, are echoed across international hospital pharmacy standards, including the European Association of Hospital Pharmacists Statements,<sup>34</sup> Joint International Pharmaceutical Federation/World Health Organisation (FIP/WHO) guidelines on good pharmacy practice (GPP),<sup>35</sup> FIP's Basel statements on the future of hospital pharmacy,<sup>36</sup> and the Society of Hospital Pharmacists of Australia (SHPA) standards of Practice for Clinical Pharmacy Services.<sup>37</sup> The PACT model of pharmaceutical care conforms to this standard. To date, there are no nationally agreed hospital pharmacy standards in Ireland; however the Health Service Executive's Acute Medicine Programme advocates clinical pharmacy involvement at admission for the delivery of safe and quality driven care in the acute setting.<sup>38</sup> The findings of this study, however, support the clinical pharmacist's integration and involvement with the medical care of the patient through to the point of discharge.

Similar studies to PACT were carried out in Northern Ireland<sup>12,14,15</sup> and Sweden<sup>9,10,18-19,20</sup> where a systematic approach to individualise and optimise drug treatments was adopted. Both the IMM (Integrated Medicines Management)<sup>12</sup> and the L IMM (Lund Integrated Medicines Management)<sup>19</sup> models of care proved that this collaborative approach identified, resolved and



prevented drug-related problems. These models have acted as a service template from which PACT has evolved. All three approaches involve an increased input by a clinical pharmacist at each stage of the patients' hospital journey, from admission through to discharge, with a resulting significant improvement in medication appropriateness (discharge vs. reference admission). Typical steps in the process common to these models include medication history taking, medication reconciliation, medication review and collaboration with the medical team. Higher acceptance rates of clinical pharmacists' recommendations were noted in all cases.<sup>15,20</sup> The IMM model also included a dispensing service on discharge with an average of 4.5 items (out of a typical 8.4 items per prescription) being dispensed per patient, owing to use of patients own medicines.<sup>14</sup> The latter service was not provided by L IMM or PACT.

Failure to provide the correct directions for a medication was the MAI criterion accounting for the largest proportion of inappropriateness. This relates to medication omissions, for example undocumented/inadvertent omission of at least one scheduled medicine. Similar findings have previously been reported internationally.<sup>39,40</sup> Schmader reported a prevalence of 32.4% of drugs with inappropriate use for this MAI criterion.<sup>40</sup> Omissions of medication from the inpatient medication chart, if not rectified, are likely to be perpetuated on discharge leading to inaccurate transfer of information into primary care.<sup>29</sup>

The criterion "expense" relates to the use of a medicine where an alternative, less expensive agent of equal safety and effectiveness, is available. The ATC class most commonly implicated was A02; drugs used to treat acid related disorders, such as proton pump inhibitors (PPIs). This is consistent with previous Irish research reporting a PIP prevalence rate of 17% for PPIs.<sup>11</sup> The ATC class most commonly identified with "inappropriate duration" was psycholeptic drugs, largely benzodiazepines, again reflecting national trends.<sup>11</sup> The prevalence of this remained relatively constant across all stages of care for patients in both study groups. This likely reflects the complexity and duration of benzodiazepine withdrawal programmes, and patients' reluctance to embark on such programmes, as previously reported in this

hospital.<sup>41</sup> Nonetheless, it is an important point to highlight because the use of these medicines for longer than two to four weeks is well established as being associated with development of dependency issues and the risk of falls and cognitive decline in older patients.<sup>42</sup>

PACT patients benefitted from more clinical pharmacists' suggestions that were accepted more frequently and earlier in the hospital episode than standard care, coupled with a reduction in error and an improvement in the quality of prescribing.<sup>25</sup> The high acceptance rate could be attributed to enhanced communication between physicians and pharmacists in the PACT model, pharmacists' enablement to make changes to the prescription, the benefits of collaboration or a combination of all three. A previous study concluded that high acceptance rates are associated with clinical pharmacists working closely with the medical team, attending ward rounds or multi-disciplinary team meetings.<sup>43</sup> These findings are consistent with the results of this study.

The lower frequency of, and delayed acceptance of, standard care pharmacists' suggestions demonstrates an inefficiency in standard care. Importantly, the identified standard care acceptance rate is similar to other Irish studies where a ward-based clinical pharmacy service was also employed.<sup>21, 22</sup> Reasons for this may include an absence of doctor recognition of the pharmacist's contribution, as previously described in a London hospital, or inferior collaboration and teamwork in ward-based standard care.<sup>44</sup> The model of clinical pharmacy service currently provided in the majority of Irish teaching hospitals involves medicines reconciliation at admission.<sup>45</sup> However, clinical pharmacy is not universal in every Irish hospital, the prevailing reason being that resources are not sufficient to permit pharmacists to have patient facing roles.<sup>45</sup> The collective evidence<sup>9,10,12-,13,14,15,18,19,18,25</sup> creates a compelling argument for the integration of clinical pharmacists into the multidisciplinary healthcare team in a manner that facilitates optimal collaboration and team working. This study adds to the body of evidence demonstrating the benefits of collaborative pharmaceutical care on medication and patient safety of acutely hospitalised older patients.

## **Overall Conclusion**

There is a need for interventions to improve the appropriateness of prescribing in hospitalised older patients. This study identifies improved medication appropriateness, as evaluated by the MAI tool, when a collaborative pharmaceutical care model, PACT, is adopted. This innovative model of care is currently being implemented across medical and surgical specialties in the study hospital.

## **COMPETING INTERESTS**

None

## **FUNDING**

This study was supported by a Research Grant from The Meath Foundation.

## **REFERENCE LIST**

---

<sup>1</sup> Central Statistic Office (CSO). Population and Labour Force Projections 2016-2046. Dublin: Government of Ireland 2013.

<sup>2</sup> Health Service Executive (HSE). Primary Care Reimbursement Service, Statistical Analysis of Claims and Payments 2012. Dublin: HSE 2012. Available from <http://www.hse.ie/eng/staff/PCRS/PCRSPublications/> Accessed 24<sup>th</sup> August 2014.

<sup>3</sup> Murphy C, Moore P, McHugh S, et al. Health and Social Care Utilisation. Report from The Irish Longitudinal Study on Aging (TILDA); 2012. Available from <http://tilda.tcd.ie/assets/pdf/w2-key-findings-report/Chapter%205.pdf> Accessed 22nd August 2014.

<sup>4</sup> Shi S, Morike K, Klotz K. The clinical implications of aging for rational drug therapy. *Eur J Clin Pharmacol* 2008;64:183-199. Doi 10.1007/s00228-007-0422-1.

<sup>5</sup> Hill-Taylor B, Sketris I, Hayden J, Byrne S, O'Sullivan D. and Christie R. Application of the STOPP/START criteria: a systematic review of the prevalence of potentially inappropriate prescribing in older adults, and evidence of clinical, humanistic and economic impact. *J Clin Phar Ther* 2013;38:360–372.

- 
- <sup>6</sup> Gallagher P, O'Mahony D. STOPP (Screening tool of older persons' potentially inappropriate prescriptions): application to acutely ill elderly patients and comparison with Beers' criteria. *Age Ageing* 2008;37(6):673-9.
- <sup>7</sup> Wahab M, Nyfort-Hansen K, Kowalski S. Inappropriate prescribing in hospitalised Australian elderly as determined by the STOPP criteria. *Int J Clin Pharm* 2012;34(6):855-62.
- <sup>8</sup> Bradley M, Fahey T, Cahir C, et al. Potentially inappropriate prescribing and cost outcomes for older people: a cross sectional study using the Northern Ireland enhanced prescribing database. *Eur J Clin Pharmacol* 2012;68(10):1425-33.
- <sup>9</sup> Gillespie U, Alassaad A, Henrohn D, et al. A comprehensive pharmacist intervention to reduce morbidity in patients 80 years or older: a randomized controlled trial. *Arch Intern Med* 2009;169(9):894-900.
- <sup>10</sup> Hellstrom LM, Bondesson A, Hoglund P, et al. Impact of the Lund Integrated Medicines Management (LIMM) model on medication appropriateness and drug-related hospital revisits. *Eur J Clin Pharmacol* 2011;67(7):741-52.
- <sup>11</sup> Cahir C, Fahey T, Teeling M, et al. Potentially inappropriate prescribing and cost outcomes for older people: a national population study. *Br J Clin Pharmacol* 2010;69(5):543-552.
- <sup>12</sup> Burnett KM, Scott MG, Fleming GF, et al. Effects of an integrated medicines management (IMM) program on medication appropriateness in hospitalised patients. *Am J Health-Syst Pharm* 2009;66(9):854-9.
- <sup>13</sup> Spinewine A, Swine C, Dhillon S, et al. Effect of a collaborative approach on the quality of prescribing for geriatric inpatients: a randomized, controlled trial. *J Am Geriatr Soc* 2007;55(5):658-65.
- <sup>14</sup> Scullin C, Scott MG, Hogg A, et al. An innovative approach to integrated medicines management. *J Eval Clin Pract* 2007;13(5):781-8.
- <sup>15</sup> Scullin C, Hogg A, Luo R, Scott MG, et al. Integrated medicines management-can routine implementation improve quality? *J Eval Clin Pract* 2012;18; 807-815.
- <sup>16</sup> Grimes T, Duggan C, Delaney T, et al. Medication details documented on hospital discharge: cross sectional observational study of factors associated with medication non-reconciliation. *Br J Clin Pharmacol* 2011;71(3):449-57.
- <sup>17</sup> Villanyi D, Fok M, Wong RY. Medication reconciliation: identifying medication discrepancies in acutely ill hospitalised older adults. *Am J Geriatr Pharmacother* 2011;9(5):339-44.
- <sup>18</sup> Gillespie U, Alassaad A, Hammarlund-Udenaes M, et al. Effects of pharmacists' interventions on appropriateness of prescribing and evaluation of the instruments'

---

(MAI, STOPP and STARTs') ability to predict hospitalization - analyses from a randomized controlled trial. *PLoS One* 2013;8(5):e62401.

<sup>19</sup> Eriksson T. Results from a project to develop systematic patient focused clinical pharmacy services. The Lund Integrated Medicines Management (LIMM)-model. *Eur J Hosp Pharm* 2014;21:121-4. doi:10.1136/ejhpharm-2013-000332.

<sup>20</sup> Bondesson Å, Holmdahl L, Midlöv P, et al. Acceptance and importance of clinical pharmacists' LIMM-based recommendations. *Int J Clin Pharm* 2012;34:272-6.

<sup>21</sup> Galvin M, Jago-Byrne MC, Fitzsimons M, et al. Clinical pharmacist's contribution to medication reconciliation on admission to hospital in Ireland. *Int J Clin Pharm*.2013;35(1):14-21.

<sup>22</sup> O'Sullivan D, O'Mahony D, O'Connor M, et al. The impact of a structured pharmacist intervention on the appropriateness of prescribing in older hospitalised patients. *Drugs Aging* 2014 Jun;31(6):471-8.

<sup>23</sup> Fitzsimons M, Grimes T, Galvin M. Sources of pre-admission medication information: observational study of accuracy and availability. *Int J Pharm Pract* 2011;19(6):408-16.

<sup>24</sup> Cullinan S, O'Mahony D, Fleming A, et al. A meta-synthesis of potentially inappropriate prescribing in older patients. *Drugs Aging* 2014 Aug;31(8):631-8.

<sup>25</sup> Grimes T, Deasy E, Allen A, et al. Collaborative pharmaceutical care in an Irish hospital: uncontrolled before-after study. *BMJ Qual Saf* 2014;23:574-583.

<sup>26</sup> Hanlon J, Schmader K, Samsa G, et al. A method for assessing drug therapy appropriateness. *J Clin Epi* 1992;45(10):1045-51.

<sup>27</sup> Shelton P, Fritsch M, Scott M. Assessing medication appropriateness in the elderly: a review of available measures. *Drugs Aging*. 2000; 16:437-50.

<sup>28</sup> Hellstrom LM, Bondesson A, Hoglund P, et al. Errors in medication history at hospital admission: prevalence and predicting factors. *BMC Clin Pharm*. 2012;12:9,doi: 10.1111/jcpt.12001.

<sup>29</sup> Hale AR, Coombes IC, Stokes J, et al. Perioperative medication management: expanding the role of the preadmission clinic pharmacist in a single centre, randomised controlled trial of collaborative prescribing. *BMJ Open*. 2013;3:e003027.

<sup>30</sup> Karapinar-Carkit F, Borgsteede SD, Zoer J, et al. The effect of the COACH program (Continuity Of Appropriate pharmacotherapy, patient Counselling and information transfer in Healthcare) on readmission rates in a multicultural population of internal medicine patients. *BMC Health Serv Res*. 2010;10(39).

- 
- <sup>31</sup> Farley M, Shelsky C, Powell S, et al. Effect of clinical pharmacist intervention on medication discrepancies following hospital discharge. *Int J Clin Pharm* DOI 10.1007/s11096-014-9917.
- <sup>32</sup> Eccles M, Grimshaw J, Campbell M, et al. Research designs for studies evaluating the effectiveness of change and improvement strategies. *Qual Saf Health Care*. 2003;12(1):47-52.
- <sup>33</sup> Bowling A. *Research methods in health: investigating health and health services*. 3<sup>rd</sup> edition. New York: McGraw Hill Publishing; 2009.
- <sup>34</sup> European Statements of Hospital Pharmacy. Brussels: 2014. Available from <http://www.eahp.eu/events/european-summit/summit-documents>. Accessed 28<sup>th</sup> September 2014.
- <sup>35</sup> International Pharmaceutical Federation (FIP). Reference Paper Collaborative Practice. The Hague, The Netherlands: 2009. Available from [https://www.fip.org/www/uploads/database\\_file.php?id=319&table\\_id](https://www.fip.org/www/uploads/database_file.php?id=319&table_id) Accessed 28<sup>th</sup> July 2014.
- <sup>36</sup> The Basel Statements on the future of hospital pharmacy. *Am J Health-Syst Pharm*. 2009; 66(Suppl 3):S61-6. Available from <http://www.fip.org/files/fip/HPS/Basel2008/FinalBaselStatements.pdf> Accessed 25<sup>th</sup> August 2014.
- <sup>37</sup> The Society of Hospital Pharmacists of Australia (SHPA). Standards of Practice for Clinical Pharmacy Services. *J Pharm Pract and Res*. 2013;43(2):91-93.
- <sup>38</sup> Health Service Executive (HSE). National Clinical Programme for Acute Medicine 2012. Dublin HSE 2012. Available from <http://www.hse.ie/acutemedicineprogramme/>. Accessed 28<sup>th</sup> August 2014.
- <sup>39</sup> Lessard S, DeYoung J, Vazzana N. Medication discrepancies affecting senior patients at hospital admission. *Am J Health Syst Pharm*. 2006 Apr 15;63(8):740-3.
- <sup>40</sup> Schmader KE, Hanlon JT, Weinberger M et al. Appropriateness of medication prescribing in ambulatory elderly patients. *J Am Geriatr Soc*. 1994; 42:1241-7.
- <sup>41</sup> Jennings S, Murphy N, Collins R et al. Reluctance of older people to discontinue long-term benzodiazepines and related hypnotics. *JAGS*. 2010; 58: 1205-1206.
- <sup>42</sup> Tinetti M, Speechley M, Ginter S. Risk factors for falls among elderly persons living in the community. *N. Engl. J. Med*. 1988. 319, 1701-1707.
- <sup>43</sup> Spinewine A, Schmader KE, Barber N, et al. Appropriate prescribing in elderly people: how well can it be measured and optimised? *Lancet*. 2007 Jul 14;370(9582):173-84.

---

<sup>44</sup> Pullinger W, Franklin BD. Pharmacists' documentation in patients' hospital health records: issues and educational implications. *Int J Pharm Pract.* 2010;18(2):108-15.

<sup>45</sup> The Pharmaceutical Society of Ireland Baseline Study of Hospital Pharmacy in Ireland. Dublin: 2012. Available from [http://www.thepsi.ie/Libraries/Publications/PSI\\_Hospital\\_Baseline\\_Study\\_Report\\_2012.sflb.ashx](http://www.thepsi.ie/Libraries/Publications/PSI_Hospital_Baseline_Study_Report_2012.sflb.ashx). Accessed 1st August 2014.