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

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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 ≥ 65 years, using ≥ 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% CI 1.0 to 3.9, $p < 0.005$), and from pre-admission to discharge (mean difference 4.0, 95% CI 1.7 to 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 were 'correct directions' (4.8% PACT, 17.3% standard), expense (5.3% PACT, 5.7% standard) and dosage (0.6% PACT, 4.0% standard). PACT suggestions to optimise medication use were accepted more frequently, and earlier in the hospital episode, than standard care (96.7% PACT, 69.3% standard, $p < 0.05$).

Conclusions 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.

proportion of drugs and in Ireland account for approximately half of the prescription drugs dispensed within the Health Services Executive Primary Care Reimbursement service.² The Irish Longitudinal Study on Ageing identified that 26% of people aged ≥ 50 years use five or more regular medicines.³

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.⁴ Furthermore, older hospitalised patients are vulnerable to fragmentation of care and adverse events at transitions of care.⁵ Safe, appropriate and effective prescribing remains one of the challenges in geriatric medicine. Potentially inappropriate prescribing (PIP) has been reported in the range of 35–60% of patients aged ≥ 65 years in acute hospitals^{6–7} and has been associated with increased medical expenses and drug-related hospital admissions.^{8–10} The estimated expenditure on PIP in those aged ≥ 70 years in Ireland was in excess of €45 million in 2007, which is 9% of the overall expenditure on pharmaceuticals in that cohort.¹¹

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.^{9–10, 12–15} Pharmacists are ideally placed to perform medicines reconciliation and review and have the expertise and knowledge to deliver such services.^{16–17} This type of integrated medicines management has been adopted in Sweden,^{9–10, 18–20} and Northern Ireland^{12–14, 15} to good effect. To date, many Irish studies have described the prevalence of PIP, adverse drug events or medication error in hospitalised patients.^{11, 21–24} However, few have investigated the effect of a collaborative model of pharmaceutical care on the quality of prescribing in older patients.¹³ This study examined the appropriateness of medicines use in hospitalised patients aged ≥ 65 years receiving care through the Collaborative Pharmaceutical Care at Tallaght Hospital (PACT) service compared with those receiving standard pharmaceutical care.²⁵

METHODS

Study population and setting

The results presented in this article are part of the aforementioned study, a prospective observational

INTRODUCTION

The proportion of the world's population who are aged ≥ 65 years is increasing and is 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.¹ Those aged ≥ 65 years also consume the greatest

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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).²⁵ The PACT study recruited adult medical patients (n=233) of any age. This study reports on the medication appropriateness in a subpopulation of older patients only (those aged ≥ 65 years, n=108).

The PACT study was undertaken from July 2010 to May 2011 in Tallaght Hospital, Dublin, Ireland; a 600-bed acute teaching hospital.²⁵ 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 online supplementary material and in the previously mentioned study.²⁵

Recruitment process for Medication Appropriateness Index assessment

Adult medical patients were eligible for inclusion if

1. aged ≥ 65 years
2. using ≥ 3 regular medicines at admission
3. were admitted to and discharged alive from hospital under the care of one of the study teams during the study period.

Exclusion criteria:

1. staff members who were admitted as patients
2. patients that were readmitted during the study period and already included.

The study protocol detailed that the Medication Appropriateness Index (MAI) would be employed to investigate the quality of prescribing among patients aged ≥ 65 years. It was considered an investigation of service delivery, and all investigators were employed clinicians, contractually bound to maintain patient confidentiality. Patient consent was not required.

Description of MAI

The MAI is one method of assessing prescribing quality in older people (aged ≥ 65 years).²⁶ It is an implicit (judgement based) tool that 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.²⁷ 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 to 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.^{21 23} 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 WHO'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.²⁶ 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 was 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. Underuse of medication (whether each of the patient's present medical conditions or risk factors was treated) was not assessed.

Outcome measurements

1. The primary outcome was the appropriateness of prescribing in patients aged ≥ 65 years as measured by the MAI at pre-admission, during admission and discharge.
2. The secondary outcome was the frequency of acceptance of clinical pharmacists' suggestions.

Statistical analysis

SPSS, V.22, was used to support data analysis. Data distribution was analysed using the Kolmogorov-Smirnov test. Differences between groups were identified using the χ^2 test for categorical data, Mann-Whitney U test (reporting median and interquartile range) for non-parametric continuous data and the Student's t test (reporting mean and SD for parametric continuous data).

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 comorbidity index, median (IQR)	2 (1–3)	2 (1–3)	0.693
Number of medicines†, median (IQR)	11 (9–13)	10 (8–14)	0.975

*General Medical Service refers to government support for healthcare including general practitioner 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.

PACT, Collaborative Pharmaceutical Care in Tallaght Hospital; NS, not statistically significant at 0.05.

Table 2 Medication appropriateness index (MAI)—summed scores per patient at pre-admission, admission and discharge

Outcome	Standard	PACT	p Value
MAI, median (IQR)			
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

PACT, Collaborative Pharmaceutical Care at Tallaght Hospital.

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).

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

The MAI criterion responsible for the largest proportion of inappropriate ratings on discharge was 'correct directions' (4.8% in PACT vs 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.

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.

Clinical pharmacists' suggestions and acceptance rates

Clinical pharmacists documented suggestions to optimise 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 were not recorded.

DISCUSSION

Key findings

Medicines reconciliation and prescription review carried out according to the PACT model,²⁵ that is, integrating the clinical pharmacy service with medical care, produced significant improvements in appropriateness of prescribing in hospitalised patients aged ≥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.^{9–15 18 28} Like these studies,^{9 10 12 25 28 29} our research confirms that the integration of a pharmacist into the healthcare 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.^{10 18} 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 discharge³⁰ and often persist post-discharge through to primary care.³¹ 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 generalisability. 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

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

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

MAI (increase in score represents reduction in quality of prescribing).

PACT, Collaborative Pharmaceutical Care at Tallaght Hospital.

Table 4 Proportion of drugs rated as inappropriate for each Medication Appropriateness Index (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

PACT, Collaborative Pharmaceutical Care at Tallaght Hospital.

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.³² 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, that is, doctors and pharmacists may have acted or performed differently than they would normally because they were aware they were being observed.³³ 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.²³

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,³⁴ Joint International Pharmaceutical Federation/WHO (FIP/WHO) guidelines on

good pharmacy practice,³⁵ FIP's Basel statements on the future of hospital pharmacy³⁶ and the Society of Hospital Pharmacists of Australia standards of Practice for Clinical Pharmacy Services.³⁷ 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.³⁸ 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^{12 14 15} and Sweden,^{9 10 18–20} where a systematic approach to individualise and optimise drug treatments was adopted. Both the Integrated Medicines Management (IMM)¹² and the Lund Integrated Medicines Management (LIMM)¹⁹ 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

Table 5 Medication class (Anatomic Therapeutic Classification (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%)

MAI, Medication Appropriateness Index; PIP, potentially inappropriate prescribing.

Table 6 Clinical pharmacists' documented suggestions and acceptance rates

	Standard	PACT	χ^2 , df, p Value
Process measures			
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
Acceptance of clinical pharmacist suggestions (n (%) of suggestions)			
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%)	

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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.^{15–20} 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.¹⁴ The latter service was not provided by LIMM 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.^{39–40} Schmader reported a prevalence of 32.4% of drugs with inappropriate use for this MAI criterion.⁴⁰ 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.²⁹

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.¹¹ The ATC class most commonly identified with 'inappropriate duration' was psycholeptic drugs, largely benzodiazepines, again reflecting national trends.¹¹ 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.⁴¹ Nonetheless, it is an important point to highlight because the use of these medicines for longer than 2–4 weeks is well established as being associated with the development of dependency issues and the risk of falls and cognitive decline in older patients.⁴²

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.²⁵ 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 multidisciplinary team meetings.⁴³ 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.^{21–22} 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.⁴⁴ The model of clinical pharmacy service currently provided in the majority of Irish teaching hospitals involves medicines reconciliation at admission.⁴⁵ 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.⁴⁵ The collective evidence^{9–10, 12–15, 18–19, 25} 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.

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.

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.

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