Original Article

Pharmacy-intern-led transition of care services impact on health-related outcomes at King Abdullah bin Abdulaziz University Hospital

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ABSTRACT

Transition of care (TOC) service reflects a systemic approach to the quality and safety of the healthcare system. Globally, several studies have evaluated the impact of TOC programs. Incorporating pharmacists in such programs improved the patients' outcomes post-TOC services. Therefore, this study aims to evaluate the effect of pharmacy-intern-led TOC services on patients' health-related outcomes at King Abdullah bin Abdulaziz University Hospital (KAAUH) in Saudi Arabia. This study is a retrospective secondary data analysis, extracted from August 2020 to July 2022, that compares patients who received TOC services and those who only received standard care services. Eligible patients were those of higher risk due to diseases of high readmission rates and on multiple medications. Of 457 included patients, 247 received pharmacy-intern-led TOC services. Compared to patients not receiving pharmacy-intern-led TOC services, E.D. visits within 30 days were lower in the intervention group (44.8% vs. 55%, $p = 0.030$). Similarly, the 30-day hospitalization rates were significantly lower following pharmacy-intern-led TOC services (37% vs. 62.9%, $p = 0.004$). Moreover, there was a significant difference between patients who received pharmacy-intern-led TOC and those who did not in the mean length of stay in the hospital. This study was the first to evaluate the impact of pharmacy-intern-led TOC services on healthcare utilization at KAAUH in Saudi Arabia. Pharmacy-intern-led TOC services were associated with lower risk in most measured outcomes. The study findings demonstrated the significance of implementing pharmacy-intern-led TOC programs and how such programs can optimize patients' therapy plans.

Keywords: Transition of care, TOC, Medication reconciliation, Healthcare utilization, Pharmacy intern, Saudi Arabia

Introduction

Transition of care (TOC) service reflects a systemic approach to quality and safety. The World Health Organization defines TOC as the numerous points at which a patient moves to or returns from a specific physical place or contacts a healthcare worker to receive healthcare [1]. This definition covers different levels of transitions through the hospital, home, and long-term care settings, as well as consultations with various healthcare experts in outpatient institutions. Optimizing TOC became a universal healthcare concern under the Affordable Care Act in 2012 [2]. At that time, the Joint Commission (TJC) launched a three-year program to increase the effectiveness of care transitions [2].

In a separate attempt to improve TOC, the Centers for Medicare and Medicaid Services (CMS) launched the hospital readmission reduction program to develop a communication channel and coordinate the patient's care during discharge [3]. In addition, these discharge plans encourage the patient's participation, improve their knowledge, and decrease unnecessary

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readmissions. Although these measures to reduce readmission rates began more than five years ago, providing efficient TOC services continues to be challenging in healthcare settings [3]. Furthermore, the Joint Commission National Patient Safety Goals proposed that medication reconciliation be undertaken at all levels of TOC to prevent poor patient outcomes connected with drug discrepancies [4].

The main target of TOC programs was to care for the population with chronic diseases to avoid undesirable patient outcomes. Chronic diseases are defined by the Centers for Disease Control and Prevention (CDC) as conditions that last one year or more and require ongoing medical attention or limit activities of daily living or both [5]. Disease-targeted transitional care programs have shown a successful reduction in readmission rates for individuals with chronic diseases such as heart failure (H.F.), chronic obstructive pulmonary disease (COPD), and asthma [6]. One in five patients discharged from the hospital experienced drug-related side effects and health complications weeks post-hospitalization [7]. Readmissions and readmissions to the emergency department (E.D.) are still challenging, particularly for patients with anticoagulation problems, diabetes, dyslipidemia, heart failure, COPD, and hypertension. Therefore, follow-up care is crucial for those with these chronic diseases.

Incorporating pharmacists within the healthcare team improves the quality of TOC services because of their medication knowledge and expertise [8]. Pharmacists can efficiently and effectively manage patients' chronic conditions, medications, and follow-up care through collaboration with other healthcare professionals [6]. Pharmacists' participation in inpatient and outpatient teams has been found to minimize hospital readmission rates and enhance patient care and treatment [9]. Medication reconciliation, patient education, medication dosage modifications, patient monitoring, disease management pathway building, medication adherence promotion, and post-discharge follow-up are services provided by pharmacists in the TOC healthcare team.

Globally, several studies have evaluated the impact of Pharmacist-managing TOC programs. For example, a systematic review of randomized trials demonstrated that patients who received pharmacist-directed TOC had reduced rates of all-cause hospitalization (odds ratio [OR] = 0.71; 95% CI: 0.54-0.94) and HF-related hospitalization (OR = 0.69; 95% CI: 0.51-0.94) [10]. Moreover, a single-center pre-post quasi-experimental study evaluating the impact of pharmacy-led discharge counseling and medication reconciliation on the H.F. readmission rate resulted in a higher average length of stay in the control group (5.6 ± 3.8 vs. 4.9 ± 3.3 days, $p = 0.008$) [4]. In addition, a prospective, randomized, single-period longitudinal study assessed the impact of pharmacist involvement in the transition of care [11]. The study found that 55 patients (39%) in the control arm experienced inpatient readmission or E.D. visits within 30 days post-discharge compared to 34 patients (24.8%) in the study arm ($p = 0.01$). Furthermore, a systematic review and meta-analysis, including 13 randomized trials, demonstrated a beneficial effect in reducing E.D. visits in patients who received the pharmacist-led TOC intervention compared to the control group with an odds ratio (95% CI) of 0.42 (0.22-0.78), and a number needed to treat (95% CI) of 6.2 (3.4-1.4) [12].

Despite the positive outcomes of implementing TOC programs, many obstacles are holding back the implementation, such as staff, support, training programs, and standardizations of the discharge plan [13]. As an alternative option, incorporating other pharmacy providers, such as residents, interns, students, and technicians, has been used to overcome these challenges. The impact of a pharmacy post-graduate year (PGY)-2 resident who provided TOC pilot service was assessed by targeting patients with COPD and heart failure [14]. The study used a retrospective comparative design to evaluate the 30-day hospital readmissions and 30-day E.D. visits of the targeted population at the University of Louisville Hospital (ULH). This study revealed that none of the twenty-three enrolled patients were readmitted within 30 days, compared to 12.3% of all eligible patients. Similarly, no patients presented to the E.D. within 30 days of discharge, as opposed to 18.6% in the comparator group. While numerous studies have been conducted to examine pharmacists' and pharmacy residents' input in TOC programs, the engagement of pharmacy interns has received less scrutiny. Only a few studies have evaluated the impact of pharmacy interns on TOC activities, though those studies found interns could effectively provide this service while increasing their confidence and clinical expertise [15-17].

During the advanced pharmacy practice experience (APPE) program that is part of the internship year, pharmacy interns could contribute while applying the knowledge and skills they learned during the pharmacy courses. Only two studies evaluated pharmacy-intern-led TOC services' impact in Saudi Arabia [18, 19]. The first randomized controlled study was conducted at King Saud Khalid University Hospital (KKUH) to determine the effect of pharmacy-intern-led TOC programs for patients discharged with high-risk medications, including insulin and/or warfarin, on the 30-day readmission rate. Although the rate of 30-day hospital readmission rate was lower in the study group, the difference in the time-to-first unplanned healthcare use or the time-to-first clinic visit post-discharge was insignificant between the two groups [19]. Additionally, only a small number (98) of patients were included in the study and final analysis. The other recent prospective interventional pilot study at King Abdullah bin Abdulaziz University Hospital (KAAUH) assessed the implementation of pharmacy-intern-led TOC service [18]. It also illustrated the pharmacy-intern-led TOC service's impact on patient care quality and determined the type and frequency of medication discrepancies and interventions. Results showed that 102 discrepancies were detected, with an average of 0.7 discrepancies per patient. However, the focus of the study was to report and evaluate the medication discrepancies without assessing the healthcare utilization outcomes. Furthermore, the study considered a one-year service. As observed, no studies showed the impact of pharmacy-intern-led TOC services on patients' healthcare utilization in Saudi Arabia. Therefore, this study aimed to demonstrate the effect of pharmacy-intern-led TOC services on patients' outcomes related to several healthcare

utilization measures at King Abdullah bin Abdulaziz University Hospital in Saudi Arabia.

Materials and Methods

This study is a non-randomized, non-controlled, retrospective design that compared patients who received pharmacy-intern-led TOC services and patients who only received standard care services at King Abdullah bin Abdulaziz University Hospital (KAAUH). Data from August 2020 to July 2022 was obtained to examine the study objectives. In addition, this study extracted patients' data, including demographics, history, comorbidities, medications, and provided services, from the patient's medical records.

Eligible patients with five or more chronic medications, including anticoagulants, oral hypoglycemic, antimicrobials, antipsychotics, narcotics, antiarrhythmics, digoxin, chemotherapeutics, antidepressants, and inhalers, or patients with diseases of high readmission rates, such as diabetes, asthma, chronic obstructive pulmonary disease, heart failure, or mental illness, were included to receive pharmacy-intern-led TOC services and considered the intervention group. In contrast, eligible patients who did not receive TOC services during periods of no APPE pharmacy interns' rotations are in the control group since the KAAUH TOC program is intern-led. The presence of chronic disease diagnosis and the use of the medications were recognized based on the patient's medical history. A retrospective design was used to conduct this study and compare the two groups.

Princess Nourah bint Abdulrahman University Institutional Review Board (PNU IRB) approved and exempted this study because it is a secondary data analysis. The PNU IRB protocol number was 22-0409. Patient information was confidential and de-identified before analysis; therefore, using the data is not considered human-subject research.

The transition of care in the KAAUH team consisted of two to three APPE pharmacy interns supervised by the TOC pharmacist-in-charge as part of their last professional internship year. In the morning, the admission office emailed the pharmacist-in-charge a daily list of patients who had just been admitted from the E.D. Using the inclusion criteria, the pharmacy team then screened the patients to identify who was eligible for the TOC. Then, they conducted a patient interview to document the medication history and compared the patient's discharge medications to those reported on the admission medication lists. Afterward, they provided organized, individualized, written discharge counseling and assessed adherence. After discharge, pharmacy interns conducted follow-up phone calls 72 hours post-discharge to determine compliance and identify any side effects, adverse drug reactions, or changes in patient health.

In contrast, patients in the control group were provided with the standard of care according to KAAUH policies. Medication reconciliation was to be provided by the assigned nurse or physician upon admission, transfer (to another setting, physician, or level of care), post-operatively, and at discharge time. Furthermore, discharge medication counseling was to be provided to all patients by pharmacists unless that was not achievable. If the assigned pharmacist is unavailable, such as on nights or weekends, the primary physician in charge of the patient's care will take this responsibility. The pharmaceutical care department, medical and nursing affairs, and other healthcare providers were responsible for implementing these policies and procedures.

This study assesses the impact of TOC services on patients' health-related outcomes. Variables related to healthcare utilization were selected because they capture various aspects of chronic disease-related outcomes. Post-TOC services 30-day E.D. visits are defined as any E.D. visits within 30 days of receiving TOC services. Furthermore, post-TOC services 3-month E.D. visits are defined as any E.D. visits within three months of receiving TOC services. In addition, post-TOC services hospitalization is defined as any overnight admission after receiving TOC services in the past 30 days and the past three months. The length of stay is the number of days of overnight hospitalization, 30 days, and three months post-TOC services.

Descriptive analysis was performed and summarized as means and 95% confidential intervals or frequency and percentages for continuous or categorical variables to describe the essential characteristics of the study sample and the study groups. The two groups were compared to evaluate the significant differences using chi-square and independent t-tests for categorical and continuous variables, respectively. Linear and logistic regression models evaluated the association between TOC recipients and study-dependent variables (E.R. visits: Yes/No, within 30 days and three months; hospitalization: Yes/No, within 30 days and three months; and length of stay) among study patients. In the regression models, the receiving of TOC was assigned as the independent variable, and the healthcare utilization variables were selected as dependent variables. Using a univariate regression model, the study evaluated the relationship between receiving a TOC and all study-dependent factors. Multivariate regression models, which account for covariates such as age, smoking, marital status, diabetes, cardiovascular illnesses, and antiarrhythmics, evaluated the relationship between receiving TOC and all study-dependent variables. The data analysis was conducted using version 26 of the Statistical Package for the Social Sciences (SPSS). In addition, a p-value of 0.05 with a two-tailed significance level was used to estimate the significance level.

Results and Discussion

Of 457 eligible patients who were identified and included in the study, 247 received the TOC services, while 210 received standard care, as shown in **Figure 1**. The count and the percentage of adult patients diagnosed with chronic diseases who used five or more chronic medications and their essential characteristics from August 2020 to July 2022 are presented in **Table 1**.

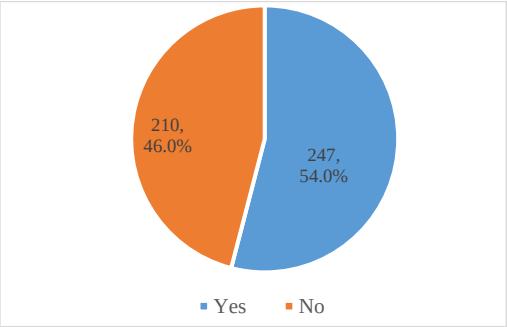

Figure 1. The percentage of patients receiving TOC services

Table 1. Essential characteristics of the study population (N= 457)

Parameter	Total, n (%)
Age, mean (S.D. [η])	55.9 (22.5)
Sex	
Males	185 (40.5%)
Females	272 (59.5%)
Marital status[π], married	143 (31.3%)
Smoker[π], yes	36 (7.9%)
Comorbidities	
Diabetes, yes	304 (66.5%)
Asthma, yes	64 (14.0%)
COPD, yes	17 (3.7%)
CVD, yes	290 (63.5%)
Mental illnesses, yes	37 (8.1%)
Others*, yes	281 (61.5%)
Medications	
Anticoagulants, yes	188 (41.1%)
Oral hypoglycemic, yes	198 (43.3%)
Antimicrobials, yes	13 (2.8%)
Antipsychotics, yes	21 (4.6%)
Antiarrhythmics, yes	124 (27.1%)
Chemotherapeutics, yes	17 (3.6%)
Inhalers, yes	76 (16.6%)
Insulin, yes	153 (33.5%)
Digoxin, yes	5 (1.1%)
Antidepressants, yes	47 (10.3%)
Narcotics, yes	3 (0.7%)
Others[#], yes	352 (77.0%)

Data are presented as numbers with percentages unless otherwise indicated.

S.D. [η]: standard deviation. COPD: chronic obstructive pulmonary disease. CVD: cardiovascular disease.

Others* include Dyslipidemia, Alzheimer, Epilepsy, Seizure, Dementia, Hypo/Hyperthyroidism, Arthritis, Osteoporosis, Chronic Kidney Disease, Anemia, Gastritis, Chronic sinusitis, Benign prostatic hyperplasia, Hypertriglyceridemia, Global Development Delay, Gout, Pituitary Micro-Adenoma, Vertigo, Disorder of Lipoprotein Metabolism, Urinary Tract Infections, Pneumonia, Urine Incontinence, Gastroesophageal Reflux Disease, Obstructive Sleep Apnea, Polycythemia, Multiple Sclerosis, Hyperprolactinemia, Chronic Hyponatremia, Eye Glaucoma, Spastic Quadriplegia, Systemic Lupus Erythematous, Bechet's Disease, Sickle Cell Disease, Cancer (lung, colon, breast), Thalassemia.

Others[#] include proton pump inhibitors, diuretics, statins, anti-hypertensives, hormone replacement, bisphosphonates, monoclonal antibodies, immunosuppressants, antifibrinolytics, injectable hypoglycemics, alpha-1 blockers, 5-alpha reductase inhibitors, antimuscarinics, anti-emetics, lipid-lowering agents (fibrates), anticonvulsants, antispasmodics, xanthine oxidase inhibitors (anti-uric acid), antivertigo, leukotriene receptor antagonists (LTRAs), carbonic anhydrase inhibitors, benzodiazepines, anti-anginal, skeletal muscle relaxants, corticosteroids, antifungals, antimalarials, laxative, antihistamines, beta-3-adrenergic-receptor agonist (bladder relaxants), dopamine agonists, decarboxylase inhibitors, NMDA receptor antagonists, pain killers (paracetamol, cox-2 inhibitors, NSAIDs), phosphodiesterase inhibitors, aldosterone receptor antagonists.

Denominators from marital status and smoker variables were 211 and 228, respectively[π].

Most of the study sample patients were females (59.5%). The mean age of all the sample patients was 55.9. Additionally, a percentage of 31.3% were married, and 7.9% were smokers. Furthermore, diabetes (66.5%), cardiovascular diseases (63.5%), and asthma (14%) were the predominant comorbidities among the study sample. Most patients used anticoagulants (41%) or oral hypoglycemics (43%).

Among the study sample, 54% of adult patients received TOC services. **Table 2** presents the essential characteristics of the study groups. There were significant differences in age, marital status, and smoking status between patients who received TOC services and those who did not receive TOC services. When comparing essential characteristics between the two groups, patients were older in the TOC recipients' group, with an average age of 58 years (p = 0.010) and a higher number of smokers (66.7%, p = 0.015). Additionally, no statistically significant differences were found in comorbidities between study groups except for diabetes (58% vs. 42.8%, p = 0.054) and cardiovascular diseases (60% vs. 40%, p = 0.001); both were highly prevalent in the patients who received TOC services. Notably, a higher percentage of patients who received TOC services used antiarrhythmics (66.9% vs. 33.1%, p = 0.001), while no statistically significant differences were observed with other medications, as presented in **Table 2**.

Table 2. General characteristics of study groups

Parameter	TOC intervention		p value[±]
	Yes	No	
Age, mean (S.D. [η])	58.4 (20.3)	53 (24.6)	**0.010**
Sex			
Males	104 (56.2%)	81 (43.8%)	0.443
Females	143 (52.6%)	129 (47.4%)	
[π]Marital status			
Single	29 (42.6%)	39 (57.4%)	**0.001**
Married	95 (66.4%)	48 (33.6%)	
[π]Smoker			
Yes	24 (66.7%)	12 (33.3%)	**0.015**
No	114 (59.4%)	78 (40.6%)	
Comorbidities			
Diabetes			
Yes	174 (58.2%)	130 (42.8%)	**0.054**
No	73 (47.7%)	80 (52.3%)	
Asthma			
Yes	28 (43.7%)	36 (56.3%)	0.075
No	219 (55.7%)	174 (44.3%)	
COPD			
Yes	13 (76.5%)	4 (23.5%)	0.059
No	234 (53.2%)	206 (46.8%)	
CVD			
Yes	174 (60.0%)	116 (40.0%)	**0.001**
No	94 (56.3%)	73 (43.7%)	
Mental illnesses			
Yes	16 (43.2%)	21 (56.8%)	0.169
No	189 (45.0%)	231 (55.0%)	
Other*			
Yes	127 (45.2%)	154 (54.8%)	0.682
No	83 (47.2%)	93 (52.8%)	
Medications			

Anticoagulants			
Yes	111 (59.0%)	77 (41.0%)	0.073
No	136 (50.6%)	133 (49.4%)	
Oral hypoglycemic			
Yes	116 (58.6%)	82 (41.4%)	0.086
No	131 (50.6%)	128 (49.4%)	
Antimicrobials			
Yes	8 (61.5%)	5 (38.5%)	0.852
No	239 (53.8%)	205 (46.2%)	
Antipsychotics			
Yes	8 (38.1%)	13 (61.9%)	0.133
No	239 (54.8%)	197 (45.2%)	
Antiarrhythmic			
Yes	83 (66.9%)	41 (33.1%)	**0.001**
No	164 (49.2%)	169 (50.8%)	
Chemotherapeutics			
Yes	9 (52.9%)	8 (47.1%)	0.926
No	238 (54.1%)	202 (45.9%)	
Inhalers			
Yes	37 (48.7%)	39 (51.3%)	0.304
No	210 (55.1%)	171 (44.9%)	
Insulin			
Yes	91 (59.5%)	62 (40.5%)	0.099
No	156 (51.3%)	148 (48.7%)	
Digoxin			
Yes	2 (40.0%)	3 (60.0%)	0.526
No	245 (54.2%)	207 (45.8%)	
Antidepressants			
Yes	26 (55.3%)	21 (44.7%)	0.854
No	221 (53.9%)	189 (46.1%)	
Narcotics			
Yes	3 (100%)	0 (0.0%)	0.109
No	244 (53.7%)	210 (46.3%)	
Other[#]			
Yes	208 (59.1%)	144 (40.9%)	**0.001**
No	39 (37.1%)	66 (62.9%)	

Data are presented as numbers with percentages unless otherwise indicated.
p value[±]: less than 0.05 shows a significant difference between the two groups
S.D. [η]: standard deviation. COPD: chronic obstructive pulmonary disease. CVD: cardiovascular disease.
Other* includes diseases mentioned in **Table 1**
Other[#] includes medications mentioned in **Table 1**
Denominators from marital status and smoker variables were 211 and 228, respectively[π].

Of the total patients, about one-quarter visited the E.D. within 30 days, and about one-quarter visited the E.D. within three months. On the other hand, a lower percentage of the patients were hospitalized within 30 days (13.6%). However, the percentage of patients hospitalized within three months increased to 16%. Moreover, the mean length of the study patient's stay in the hospital was 2.3 days, as shown in **Table 3**.

Table 3. Healthcare utilization of study population.

Parameter	Total, n (%)
ED[ω] visit within 30 days, yes	105 (23.0%)
E.D. visits within three months, yes	112 (24.5%)
Hospitalization within 30 days, yes	62 (13.6%)
Hospitalization within three months, yes	73 (16.0%)
Length of stay, mean (S.D. [η])	2.3 (8.6)

Data are presented as numbers with percentages unless otherwise indicated.
S.D. [η]: standard deviation, E.D. [ω]: Emergency Department.

Compared to patients not receiving TOC services, E.D. visits within 30 days were lower in the patients who received TOC services (44.8% vs. 55%, $p = 0.030$). Similarly, the 30-day hospitalization rates were significantly lower following TOC services (37% vs. 62.9% $p = 0.004$). Moreover, there was a significant difference between the patients who received TOC services and those who did not receive TOC services in the mean length of the study patient's stay in the hospital; the mean length of the study patient's stay in the hospital was lower in patients who received TOC services ($\mu_1 = 1.57$ vs. $\mu_2 = 3.20$; $p = 0.043$) **(Table 4)**. However, no significant differences between the study groups were noticed for E.D. visits and hospitalizations within three months.

Table 4. Healthcare utilization of study groups.

Parameter	TOC intervention		*p* value[±]
	Yes	No	
ED[ω] visit within 30 days			
Yes	47 (44.8%)	58 (55.2%)	**0.030**
No	200 (56.8%)	152 (43.2%)	
E.D. visits within three months			
Yes	65 (58.0%)	47 (42.0%)	0.330
No	182 (52.8%)	163 (47.2%)	
Hospitalization within 30 days			
Yes	23 (37.1%)	39 (62.9%)	**0.004**
No	224 (56.7%)	171 (43.3%)	
Hospitalization within three months			
Yes	38 (52.1%)	35 (47.9%)	0.709
No	209 (54.4%)	175 (45.6%)	
Length of stay, mean (S.D. [η])	1.57 (3.95)	3.20 (11.89)	**0.043**

Data are presented as numbers with percentages unless otherwise indicated.
p value[±]: less than 0.05 shows a significant difference between the two groups.
S.D. [η]: standard deviation. ED[ω]: Emergency Department

The unadjusted regression analysis revealed that TOC services were significantly associated with E.D. visits within three months ($p = 0.053$) **(Table 5)**. Compared with the non-TOC group, those who received TOC services had lower estimated odds of visiting the E.D. within three months (OR = 0.59, 95% CI: 0.346-1.007). Additionally, TOC services were associated significantly with the mean length of the study patient's stay in the hospital ($p = 0.01$) **(Table 5)**; TOC recipients had a lower risk of staying longer in the hospital than those who did not receive TOC (risk = 0.121, 95% CI: 0.103-0.612). Furthermore, evidence showed no significant association between TOC services and E.D. visits within 30 days, hospitalization within 30 days, or hospitalization within three months.

Table 5 also illustrates the results of the adjusted regression models for the association of healthcare utilization and receiving TOC services. The association between TOC services and either E.D. visits within 30 days or hospitalization within three months continued to lack significance after adjusting for selected covariates, including age, smoking, marital status, diabetes,

cardiovascular diseases, and antiarrhythmics. However, after adjusting for selected covariates, E.D. visits and length of stay within three months lost statistical significance.

The association between TOC services and hospitalization within 30 days was significant ($p = 0.019$) **(Table 5)**. TOC recipients were estimated to have higher odds of being admitted to the hospital within 30 days than the non-TOC recipients after adjusting for selected covariates (OR= 2.377, 95% CI: 1.155-4.888) **(Table 5)**.

Table 5. Association of TOC intervention with the healthcare utilization.

Variable	Unadjusted model			Adjusted model			*p* value±
	OR$^{\Omega}$	95% CI$^{\sigma}$		OR$^{\Omega}$	95% CI$^{\sigma}$		
		Lower	Upper		Lower	Upper	
ED$^{\omega}$ visits within 30 days							
No	1			1			0.409/0.210
Yes	1.259	0.729	2.173	1.447	0.812	2.580	
ED visits within three months							
No	1			1			**0.053**/0.066
Yes	0.590	0.346	1.007	0.588	0.334	1.035	
Hospitalization within 30 days							
No	1			1			0.083/**0.019**
Yes	1.848	0.924	3.697	2.377	1.155	4.888	
Hospitalization within three months							
No	1			1			0.790/0.877
Yes	1.089	0.583	2.032	1.053	0.550	2.014	
Length of stay	0.121	0.103	0.612	0.005	0.003	0.009	**0.01**/0.940

p-value ± (unadjusted/adjusted): less than 0.05 indicates a significant association between TOC intervention and independent variables.

CI$^{\sigma}$: Confidence Intervention, E.D. $^{\omega}$: Emergency Department, OR$^{\Omega}$: Odd Ratios.

This study assessed the impact of pharmacy-intern-led TOC services on patients' health-related outcomes for patients with comorbidities and polypharmacy. These risk factors put patients at a higher risk of complications; therefore, proper management is needed for them. This study is the first to investigate TOC services' association with healthcare utilization in Saudi Arabia. Thus, this study's findings could influence future TOC program development and modification. The findings of this study showed significant differences between TOC recipients and non-TOC recipients regarding E.D. visits, hospitalizations, and length of stay within 30 days. In addition, the study showed a significant association between receiving TOC services and E.R. visits within three months and hospitalizations and length of stay within 30 days. These results can be attributed to the study design and the data collection methods. Furthermore, we found a significant association between receiving TOC services and hospitalizations within 30 days after adjusting for the essential covariates. However, the odds of hospitalizations within 30 days were higher in the intervention group than in the usual care group; these results could be because of other potential covariates that were not considered in the adjusted regression analysis.

Although one previous local study showed conflicting results regarding the impact of pharmacist interventions on readmissions and hospitalization, lower numbers of patients visiting the E.D. or being hospitalized within 30 days in our total population were demonstrated [19]. In comparison, E.D. visits and hospitalization rates increased within three months. We can use this preliminary non-statistically significant increase to identify the cause to enhance TOC services. These results reflect that the population has unique characteristics that can also be used to tailor TOC programs to improve their health outcomes.

E.D. visits within 30 days and 30-day hospitalization rates were significantly lower in the intervention group compared with the control group. Similarly, in other studies, composite E.D. visits and inpatient readmissions were lower in the intervention group compared with the control group [11], H.F. 30-readmission rates were lower in the intervention group. The length of stay was longer in the control group [4], both all-cause and H.F. hospitalization rates were reduced in the intervention group compared with the control group [10], 30-day readmission rates and 30-day E.D. visits were reduced in the intervention group compared with the control group [14], and E.D. visits were reduced in the intervention group compared with the control group [12].

Enhancing the awareness of those patients with comorbidities and chronic medications is critical to their management plan and would greatly influence the criteria to be considered in providing TOC services. In our study, significant associations were found regarding receiving TOC services and E.D. visits within three months and length of stay; they were both lower in the TOC group. TOC recipients were estimated to have higher odds of being admitted to the hospital within 30 days than non-TOC recipients after adjusting for age, smoking, marital status, diabetes, cardiovascular diseases, and antiarrhythmics. There could be other overlooked causes causing these outcomes. A multivariate logistic regression adjusting for duration of stay, payer type, the total number of drugs prescribed at discharge, and the Charlson comorbidity index showed a decreased risk for combined E.D. visits and readmission rates in other research [11]. In another systemic review, a random effect model was used. The pooled odd ratio for all-cause and H.F. hospitalization risk demonstrated a risk reduction and a benefit from pharmacist care [10]. Moreover, multivariate regression controlling for age showed a lower risk of H.F. readmission rates in the study group 4. Additionally, a meta-analysis used a random effect model, and the overall effect of four studies evaluating pharmacist intervention on E.D. visits favored the intervention group [12].

Moreover, we did not assess the practicality of utilizing APPE pharmacy students in operating TOC services since most of the TOC programs are pharmacy-intern/student-led in Saudi Arabia. Bawazeer *et al.* (2021) demonstrated that formal training programs improved APPE students' knowledge and preparedness to perform TOC activities, enhancing and supporting pharmacy patient care services [19]. Improving APPE interns' qualifications and enhancing their knowledge and preparedness with intensive courses should be provided in advance. These courses will deliver a higher quality TOC program, particularly the clinical aspects, including interactions

with patients, medication-related education, counseling, and reconciliation,

The inclusion criteria for the TOC services at KAAUH targeted patients with polypharmacy and chronic diseases, which was our focus on population. Similarly, other studies included a similar population [10-12, 14, 19]. In our intervention group, more patients with CVD and diabetes were reported. These results were similar to those of another study, which found higher incidents of cerebrovascular diseases, diabetes, and COPD [4]. These results reflect that this high-risk population requires the development of tailored programs to improve TOC services. In addition, these findings encourage re-emphasizing patients' awareness of their chronic diseases and compliance with their medications and the critical role of involving family members in improving pharmacological and non-pharmacological therapies.

Regardless of the strength of this study, there were several limitations. First, the study period was from August 2020 to July 2022, which could limit the generalizability of the study beyond this period. This period was chosen because it started with the initiation of the TOC program at KAAUH and lasted until the end of the study period. Second, this study is a secondary data analysis. This type of analysis has limitations such as incomplete and outdated information due to changing patient factors, including their health status, smoking status, new diseases diagnosed, or medication prescriptions. Third, the KAAUH database does not provide information about the exact reasons for admission. Results might have differed if this variable had been considered. Fourth, the TOC program was intern-led and only performed during APPE rotations, leading to other issues. Fifth, there was no documentation of some patients due to the busy schedule of the TOC program preceptors; hence, those patients were excluded. Additionally, this study had a small sample size, which could also limit the generalizability of the results. Lastly, our findings might have differed since many unconsidered variables might have led to a residual confounding effect.

Conclusion

This study was the first to evaluate specific variables of healthcare utilization at KAAUH in Saudi Arabia. This study considered many factors contributing to patients' risks, including polypharmacy and comorbidities. TOC services were associated with lower risk in overall outcomes. Although some variables were non-significant, this may be due to the heterogenicity of comorbid diseases and other unconsidered variables. The study findings demonstrated the significance of implementing TOC programs and training interns and showed how this could improve patient outcomes and optimize therapy plans. This study has increased the knowledge and provided evidence to help tailor new or modify current services to address this population's unique characteristics and needs. This study can be a base for future research and clinical trials to explore other contributing risk factors and expand the TOC program nationally. A multicenter randomized trial is required to evaluate the impact of the improved version of TOC services and clinical, economic, and humanistic outcomes.

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