

## Original Article

# Descriptive Analysis of Patient Readmissions Within 60 Days Due to Medication-Related Events

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### Abstract

**Background:** Hospital readmissions have become a marker for quality health care. Readmissions secondary to failures of the medication use process are poorly documented and underrecognized.

**Objective:** To identify the incidence of readmissions related to the medication use process and identify associated patient- and therapy-related risk factors.

**Methods:** A prospective observational cohort study including patients discharged from an acute care medicine unit and readmitted within 60 days. The primary outcome was percentage of readmissions related to drug-related problems (DRPs) as defined by Pharmaceutical Care Network Europe (PCNE). Secondary outcomes included classification of problems using PCNE criteria, type and extent of pharmacist involvement in patient care, and identification of variables associated with a readmission related to a DRP.

**Results:** One hundred patients provided informed consent and were included for analysis. A DRP associated with readmission was identified in 64 patients. Sixty-one percent were classified as a potential problem with effect or lack of effect of pharmacotherapy. Patients who had a pharmacy consult were less likely to have a DRP (27% vs 47%;  $P = .04$ ), and patients who missed follow-up appointments were more than 3 times as likely to have a DRP (20% vs 4%;  $P = .03$ ). Presence of a pharmacy consult (odds ratio [OR], 0.38; 95% CI, 0.15-0.99;  $P = .05$ ) and missed follow-up appointments (OR, 5.63; 95% CI, 1.52-20.86;  $P = .01$ ) remained significant in a multivariate regression model.

**Conclusion:** DRPs were frequent in patients who were readmitted within 60 days. Clinical pharmacist involvement in care and support for appropriate patient follow-up may reduce unnecessary admissions.

**Key Words**—discharge, medications, pharmacist, readmissions

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Hospital readmissions have become a marker for quality health care. Excess readmissions can indicate poor clinical care and poor coordination of services during hospitalization or after discharge. The Hospital Readmissions Reduction Program (HRRP), a section of the Affordable Care Act, requires the Centers for Medicare and Medicaid Services to reduce payments to acute inpatient prospective payment system hospitals with excess

readmissions. HRRP became effective in October 2012, and the maximum penalty increased to 3% in 2014. Currently, the HRRP tracks readmissions for acute myocardial infarction, heart failure, and pneumonia. The expansion in 2015 resulted in the inclusion of chronic obstructive pulmonary disease (COPD), total hip arthroplasty, and total knee arthroplasty.<sup>1</sup> Patients admitted for these conditions are commonly discharged from an acute medical unit.

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The drug or medication use process has been identified as an important component contributing to excess readmissions, although it is poorly documented.<sup>2-5</sup> Many studies focus on readmissions due to adverse drug reactions (ADRs). Currently, there is no consistent definition for an ADR in the available literature. The World Health Organization (WHO) defines an ADR as a response to a drug that is noxious and unintended and occurs at doses normally used in humans for the prophylaxis, diagnosis, or therapy of disease or for modification of physiological function. In contrast, a side effect is an unintended effect occurring at normal doses related to the drug's pharmacological properties.<sup>6</sup>

Davies et al<sup>2</sup> reported that 40% of patients admitted to the hospital were readmitted within 1 year, of whom 18% had an ADR contributing to readmission. An ADR was defined in this study as "an appreciably harmful or unpleasant reaction, resulting from an intervention related to the use of a medicinal product, which predicts hazard from future administration and warrants prevention or specific treatment, alteration of the dosage regimen, or withdrawal of the product."<sup>7(p1255)</sup> Increased age and an index admission in a medical unit were associated with an increased incidence of readmissions related to an ADR.<sup>2</sup> Forster et al<sup>4</sup> reported that 11% of discharged patients experienced an adverse drug event (ADE), which was defined as any adverse outcome or patient injury that was caused by medication use. Patients had an increased risk for an ADE if they were prescribed greater than or equal to 12 medications and were less likely to experience an ADE if they were able to recall medication counseling. This study did not evaluate whether the ADE was a cause of hospital readmission.<sup>4</sup> Garrison, Mansukhani, and Bohn<sup>5</sup> evaluated hospitalized family medicine patients who were readmitted within 30 days. Patients who were readmitted within 30 days were less likely to be married; averaged more hospitalizations over the past 12 months; and had increased length of stay, increased number of discharge medications, and increased number of comorbidities.<sup>5</sup>

These definitions do not include other medication-related events that may be encountered during the medication use process. For the purposes of this study, medication or drug-related problems (DRPs) were categorized using the Pharmaceutical Care Network Europe (PCNE) Classification of Drug Related Problems version 6.2. This defines a DRP as an event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes. The problem domains include treatment

effectiveness, adverse reactions, treatment costs, and others. PCNE further classifies the problem into 8 different causes, including drug selection, drug form, dose selection, treatment duration, drug use process, logistics, and patient factors.<sup>8</sup>

Pharmacists' roles in the hospital setting have expanded to include more clinical activities such as participation on rounds with an interdisciplinary team, admission and discharge medication reconciliation, and management of specific medication therapy. Studies have documented that pharmacist interventions through these types of activities have helped reduce the rate of ADRs.<sup>9-11</sup> During this study, 46 clinical pharmacists and 17 pharmacy residents were employed at Houston Methodist Hospital (HMH). Patient care activities of the clinical staff include pharmacy consults; medication education; discharge counseling; medication history retrieval; medication reconciliation review; rounds with physicians; and review of admission, transfer, and discharge medications. A pharmacy consult is a request by the prescriber for the pharmacist to manage a specific pharmacotherapy regimen. Examples include renal dose adjustments, clinical pharmacokinetic monitoring, and anticoagulation management. This study aims to determine the incidence of 60-day readmissions related to various DRPs and identify risk factors for readmission.

### METHODS

This study was a prospective observational cohort study of adult patients discharged from an acute medical unit at HMH, a tertiary care academic referral center with 824 operating beds. A daily electronic report identified newly admitted patients who had been discharged within the previous 60 days. Patients were excluded if they did not speak English, had been readmitted for a planned procedure, had been admitted to the skilled nursing facility, refused to provide or were unable to provide consent, were previously enrolled in the study, or were discharged before consent was obtained. Patients who were discharged from either the transplant or heart failure units were also excluded; these units had established initiatives aimed at decreasing readmissions and would generate data that were not representative of the general patient population in the acute medical units. A convenience sample of patients was used; thus, patients admitted and discharged over the weekend were also excluded. Informed consent for a structured interview was obtained from patients who met inclusion criteria. A 10-question interview was conducted with the patients at bedside (**Appendix 1**).

Information was collected from the interview, bedside chart, electronic medical record, and medical records from previous admissions.

The primary outcome was the proportion of patients identified as having a DRP related to readmission as categorized by the PCNE classification. For the purposes of this study, patients were categorized as having a DRP if it was related to the chief complaint or diagnosis on readmission. Medication problems not related to the chief complaint or diagnosis on readmission were not classified as a DRP for the primary endpoint. Secondary outcomes included classification of the DRP using the PCNE criteria, characterization of pharmacist involvement, and identification of variables associated with increased likelihood of experiencing a readmission with a DRP. Factors evaluated for clinical pharmacist involvement during the index admission included presence of a pharmacy consult; documentation in the medical record of new medication counseling, discharge counseling, or completion of patient medication history by a pharmacist; and presence of a pharmacist on the primary team. All secondary variables, such as pharmacist involvement in care, were collected after a patient was determined to have had a DRP to minimize the risk for bias. Definitions for adverse effects and side effects were based on WHO definitions for this study.<sup>6</sup>

The primary outcome was determined by dividing the number of patients who were classified as having a DRP by the total number of patients included in the study. Sample size calculation was not performed, because there were no previous data on which to base risk estimates using the PCNE criteria. The Anderson-Darling test was used to determine the distribution of

variables. Continuous variables that were normally distributed were then analyzed using the Student *t* test, and nonparametric data were analyzed using the Mann-Whitney *U* test. Dichotomous outcomes were analyzed by the chi-square goodness-of-fit test. Variables compared between the 2 groups were considered significantly different if the *P* value was less than .05. Factors showing a univariate association of a *P* value of .2 or less and previously identified in the literature as potentially increasing the risk for readmission were included in a multivariate regression analysis.

## RESULTS

Between October 7, 2013, and January 17, 2014, 1,611 patients who were readmitted within 60 days met inclusion criteria. Of these, a convenience sample of 100 patients was interviewed after informed consent had been obtained. The mean patient age was  $56.1 \pm 17.9$  years, and there was an equal distribution between males and females. Seventy percent of patients included in the study were unemployed; however, 96% were insured. The median time to readmission was 20 days. The majority of patients had multiple comorbidities including hypertension (64%), diabetes (32%), hyperlipidemia (28%), chronic kidney disease (25%), coronary artery disease (24%), and cirrhosis (21%).

For the primary outcome, 64 patients were classified as having a readmission related to a DRP. Nine of 64 patients had more than 1 problem identified. Causes of the identified DRPs, including treatment effectiveness, adverse reactions, and treatment costs, are presented in **Table 1**. Sixty-two percent ( $n = 45$ ) of the problems classified using the PCNE criteria were

**Table 1.** Pharmaceutical Care Network Europe classification of problems and causes<sup>a</sup>

Causes	Treatment effectiveness ( <i>n</i> = 60)	Adverse reactions ( <i>n</i> = 32)	Treatment costs ( <i>n</i> = 4)	Others ( <i>n</i> = 1)
Drug use/administration process	15 (25)	4 (13)	1 (20)	0
Drug selection	13 (22)	8 (25)	3 (60)	0
Dose selection	12 (20)	9 (28)	0	1 (100)
Patient	8 (13)	4 (13)	0	0
Logistics	5 (8)	1 (3)	0	0
Treatment duration	2 (3)	0	1 (20)	0
Drug form	1 (2)	0	0	0
Other	4 (7)	6 (19)	0	0

Note: Values given as *n* (%).

<sup>a</sup>Patients had more than 1 problem and cause identified.

## Patient Readmissions Due to Medication-Related Events

related to treatment effectiveness. Drug use or administration process (25%), drug selection (22%), and dose selection (20%) were the most frequently identified problems with treatment effectiveness. Thirty-two percent ( $n = 23$ ) of the problems were a DRP related to an adverse reaction; dose selection (27%) and drug selection (25%) were the 2 most common causes. Five percent ( $n = 4$ ) of the problems had a DRP related to treatment costs, 3 of which were due to drug selection.

There were no significant differences between the 2 groups with regard to patient baseline characteristics, factors from index admission, type of pharmacist involvement, or factors from readmission (Table 2). The mean age was  $58.1 \pm 16.8$  years in the DRP group compared with  $52.6 \pm 19.5$  years in the non-DRP group ( $P = .16$ ). Fifty-two percent of the patients in the DRP group and 44% in the non-DRP group ( $P = .64$ ) were married. The median number of comorbidities documented (5; interquartile range

**Table 2.** Patient characteristics: DRP versus non-DRP

Baseline characteristics	DRP ( $n = 64$ )	Non-DRP ( $n = 36$ )	<i>P</i>
Mean age $\pm$ SD, years	58.1 $\pm$ 16.8	52.6 $\pm$ 19.5	.16
Male	35 (55)	16 (46)	.44
White	35 (55)	20 (56)	.93
Insured	61 (95)	35 (97)	.63
Married	33 (52)	16 (44)	.64
Employed	19 (30)	11 (31)	.93
Comorbidities, median [Q1-Q3]	5 [3-6]	5 [3-6.75]	.87
1-3 comorbidities	17 (27)	12 (33)	.63
4-7 comorbidities	41 (64)	22 (61)	.94
$\geq 8$ comorbidities	6 (9)	2 (6)	.77
<i>Factors regarding index admission, median [Q1-Q3]</i>			
Length of stay, days	6 [4-9]	6 [4-11]	.67
Days to readmission	17 [7-34]	23 [14-43]	.11
No. of medications at admission	9.5 [6-14]	10 [6-15]	.48
No. of medications at discharge	12.5 [8-15]	12.5 [9-20]	.48
No. of new medications at discharge	2 [0-4]	2.5 [1-4]	.63
No. of total medication changes at discharge	4 [2-7]	4 [2-7]	.72
<i>Type of pharmacist involvement at index admission</i>			
Medication history by RPh	31 (48)	23 (64)	.20
Pharmacy consults	17 (27)	17 (47)	.06
New medications counseling	14 (22)	9 (25)	.91
RPh on primary team	8 (13)	7 (19)	.52
Discharge counseling	5 (8)	3 (8)	.93
<i>Factors regarding readmission</i>			
Medication history by RPh	41 (64)	20 (55)	.53
Readmissions before scheduled outpatient follow-up	24 (38)	8 (22)	.27
Days to readmission, median [Q1-Q3]	17 [7-34]	23 [14-43]	.11
No. of total admissions during study period, median [Q1-Q3]	3 [1-4]	3 [2-4]	.42

Note: Values given as  $n$  (%) unless otherwise indicated. DRP = drug-related problem; RPh = registered pharmacist.

[IQR], 3-6 vs 5; IQR, 3-6.75), median number of admissions to HMH during the study period (3; IQR, 1-4 vs 3; IQR, 2-4), median number of medications at discharge (12.5; IQR, 8-15 vs 12.5; IQR, 9-20), and length of stay at the index admission (6 days; IQR, 4-9 vs 6 days; IQR, 4-11) were similar across both groups ( $P = .87, .42, .48, \text{ and } .67$ , respectively). The median time to readmission was 17 days (IQR, 7-34) in the DRP group compared with 23 days (IQR, 14-43) in the non-DRP group ( $P = .11$ ).

Thirty-four patients received a pharmacy consult during the index admission, which was more frequent in the group without a DRP than in the group with a DRP (47% vs 27%;  $P = .06$ ). Twenty-three patients received new medication counseling (25% vs 22%;  $P = .91$ ), and 8 received discharge counseling (8% vs 8%;  $P = .93$ ). Medication histories were completed by a pharmacist for 54 patients on the index admission (64% vs 48%;  $P = .20$ ) and for 61 patients on readmission (55% vs 64%;  $P = .53$ ). Fifteen of the patients had a pharmacist on the primary team on index admission (19% vs 13%;  $P = .52$ ).

Table 3 shows the number of patients whose primary diagnoses were captured for the purpose of the study. Six patients were admitted because of heart failure in the index admission, and 34 patients were hospitalized for the treatment of an infection, 10 of which were treated for pneumonia. Only 2 patients were admitted for treatment of COPD in this study. Other diagnoses such as sickle cell crisis ( $n = 7$ ) and complications of cirrhosis ( $n = 8$ ) were also documented in the study population.

In patient interviews, 81 patients remembered receiving discharge counseling from a nurse, pharmacist, or physician. Seventy-seven patients stated they received new prescriptions, of which 64 (83%) stated they filled their prescriptions within 1 week and any antibiotics within 2 days after discharge. Thirty-three patients intentionally or unintentionally took less of their medication than what was prescribed because they experienced adverse effects ( $n = 7$ ) or intolerable side effects ( $n = 15$ ) or because they did not understand the directions ( $n = 1$ ). Twenty patients intentionally or unintentionally took more medication than instructed because they believed the dose or frequency was not adequately effective. Seventy-five patients stated they only used 1 pharmacy, and 61 patients stated they receive counseling from a community pharmacist when they fill new prescriptions. Twenty-four of the patients stated they missed their follow-up appointment, including patients who were readmitted before the scheduled appointment.

**Table 3.** Primary diagnosis

Diagnosis	Index admission ( $n = 100$ )	DRP ( $n = 64$ )	No DRP ( $n = 36$ )	$P$
Any infection	34 (34)	21 (33)	13 (36)	.94
Pneumonia	10 (10)	5 (8)	6 (17)	.74
Complications of cirrhosis	8 (8)	7 (11)	1 (3)	.67
Sickle cell crisis	7 (7)	4 (6)	3 (8)	1.00
Heart failure	6 (6)	4 (6)	2 (6)	.54
COPD	2 (2)	2 (3)	0	1.00
Postoperative infections	—	3 (5)	2 (6)	—

Note: Values given as  $n$  (%). COPD = chronic obstructive pulmonary disease; DRP = drug-related problem.

Results from patient interviews are shown in Table 4. Through the patient interviews, it was identified that significantly more patients who experienced a DRP also missed follow-up appointments (17% vs 83%;  $P = .04$ ).

Variables included in the univariate and multivariate analyses included age, days to readmission, presence of a pharmacy consult, medication history taken by a pharmacist on the index admission, and the highest education level stated by the patient (associate degree or higher) (Table 5). Patients who had a pharmacy consult were less likely to have a DRP (27% vs 47%; odds ratio [OR], 0.04; 95% confidence interval [CI], 0.17-0.95), and patients who missed follow-up appointments based on the interview were more likely to have a DRP (20% vs 4%; OR, 3.64; 95% CI, 1.13-11.67). Presence of a pharmacy consult (OR, 0.38; 95% CI, 0.15-0.99) and missed follow-up appointments (OR, 5.63; 95% CI, 1.52-20.86) remained significant when analyzed in a multivariate regression. Increased age was also identified as an independent risk factor for readmission with a DRP (OR, 1.03; 95% CI, 1.00-1.06).

## DISCUSSION

This study suggests that a majority of patient readmissions within 60 days are associated with a DRP. Patients who had a clinical pharmacist involved in their care through a pharmacy consult were less likely to have a readmission related to a DRP; pharmacist involvement in patient care through medication counseling, discharge counseling, or taking medication histories did not have the same impact on

## Patient Readmissions Due to Medication-Related Events

**Table 4.** Patient interviews

Interview questions	DRP ( <i>n</i> = 64)	No DRP ( <i>n</i> = 36)	<i>P</i>
Received discharge counseling	50 (78)	31 (86)	.48
Received instructions for self-monitoring	45 (70)	29 (81)	.38
New prescriptions, median [Q1-Q3]	1 [0-2]	1 [0-2]	.68
Filled all prescriptions within 1 week	41 (82)	23 (85)	.99
Use of only 1 pharmacy	46 (72)	29 (81)	.47
Received counseling from outpatient pharmacy	38 (61)	23 (64)	.82
Took less medication than instructed	24 (38)	9 (25)	.29
Took more medication than instructed	13 (20)	7 (19)	.91
Missed follow-up appointments	20 (31)	4 (11)	.04
Received outside care	5 (8)	2 (5)	.99
Education			
Less than high school	8 (13)	7 (19)	.52
GED/high school graduate	30 (47)	20 (56)	.53
Associate degree or higher	26 (41)	9 (25)	.18

Note: Values given as *n* (%) unless otherwise indicated. DRP = drug-related problem.

**Table 5.** Factors affecting readmission related to a drug-related problem

Factors	Univariate analysis	Multivariate analysis
Missed follow-up appointment (based on interview)	3.64 (1.13–11.67)	5.63 (1.52–20.86)
Education, associate degree or higher	2.05 (0.83–5.07)	2.15 (0.80–5.82)
Age, years	1.02 (0.99–1.04)	1.03 (1.00–1.06)
Days to readmission	0.98 (0.96–1.01)	0.98 (0.96–1.01)
Medication history taken by pharmacist on index admission	0.53 (0.23–1.23)	0.56 (0.21–1.45)
Pharmacy consult present	0.04 (0.17–0.95)	0.38 (0.15–0.99)

Note: Values given as odds ratio (95% confidence interval).

DRP-related readmission as the presence of a pharmacy consult. This is supported by the finding that the majority of identified DRPs were due to a potential problem with the effect or lack of effect of pharmacotherapy, which may be mitigated by consultation with a pharmacist to assist in pharmacotherapy management. Patient medication education or discharge counseling at HMH does not routinely include medication reconciliation, which was shown in a previous study to decrease the number of preventable ADEs.<sup>11</sup> Also, only 14 of the patients included in this study had a pharmacist who rounded with the primary

team; a larger study would need to be conducted to evaluate the impact of clinical pharmacists on readmission as an integrated part of the medicine team.

Patients who missed follow-up appointments for any reason were more than 3 times as likely to have a readmission associated with a DRP. Patients who were readmitted before their follow-up appointments were also included in this analysis, although days to readmission were similar between the 2 groups. Other factors identified in prior studies related to ADRs such as being married, having an increased number of medications, increased number of

comorbidities, and increased length of stay did not have an impact in this study.<sup>2-5</sup>

There are limitations to this study. This study included only 6% of the patients who met inclusion criteria; a convenience sample was used for consent, potentially introducing a sampling bias. The study was conducted at a single academic hospital, which may limit the generalizability to other institutions. Also, the number of patients included with a primary diagnosis currently being tracked by the HRRP program was small, making it difficult to assess the true incidence of DRPs in this specific population.

The pharmacy department at HMH implemented changes that were supported by the findings of this study before the final analysis. Medication histories are now performed by pharmacy technicians, allowing clinical pharmacists to be more involved with clinical patient care activities. New clinical pharmacist positions focusing exclusively on the discharge process have also been implemented. Discharge pharmacists do not complete medication reconciliation but ensure that the reconciliation process has been completed accurately and that patients are being discharged with appropriate pharmacotherapy to which they have access. The impact of these changes is not seen in this study, because these initiatives started shortly after the study was concluded.

## CONCLUSION

Age, presence of a pharmacy consult, and missed follow-up appointments are significant factors associated with a DRP in this study. Treatment effectiveness is the major problem seen in patients readmitted within 60 days after discharge from an acute medical unit. Common causes of DRPs include drug selection and issues with drug use and/or the administration process. Patients who had a clinical pharmacist involved in their care through a pharmacy consult were also less likely to have a readmission related to a DRP.

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**APPENDIX 1**

**Patient Questionnaire**

1. Do you remember receiving medication counseling the last time you were admitted?
  - a. Yes
  - b. No
2. Were you given any instructions for self-monitoring your condition/disease at home? (eg, blood pressure, weight)
  - a. Yes
  - b. No
3. How many new prescriptions did you receive during your last discharge?
4. Were you able to fill all prescribed medications within 1 week (2 days for antibiotics)?
  - a. Yes
  - b. No

-If no, due to

  - i. Pharmacy/prescriber/access
  - ii. By choice
5. Do you fill all your medications at 1 pharmacy?
  - a. Yes
  - b. No
6. Did you receive counseling on the new medications from any of your local pharmacists?
  - a. Yes
  - b. No
7. How many times a week did you intentionally or unintentionally take the medication more or less than what was prescribed?

More x \_\_\_\_\_

Less x \_\_\_\_\_

Why?

  - a. Adverse reaction
  - b. Not effective enough at the prescribed dose
  - c. Felt bad on it/intolerable side effects
  - d. Did not understand directions
8. Did you miss any follow-ups with any health care provider after your last discharge?
  - a. Yes
  - b. No
9. Did you visit any outside clinic or emergency center after your previous discharge?
  - a. Yes
  - b. No
10. What is your highest level of education?
  - a. Less than high school
  - b. GED/high school graduate
  - c. Associate degree, bachelor's degree, or higher
  - d. Prefer to not answer