



Acute care model that reduces oncology-related unplanned hospitalizations to promote quality of care and reduce cost



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ABSTRACT

Background: Advances in cancer treatment has resulted in more oncology patients receiving outpatient therapy; however, this can promote a greater use of costly hospital-based acute care.

Methods: The Oncology Evaluation and Treatment Center (OETC) was established in March 2012 at Baylor University Medical Center (BUMC), a large urban hospital, as a quality improvement intervention to reduce oncology patient acute care and cost. The OETC provides after-hours acute care for oncology patients receiving outpatient care at BUMC. OETC care included optimal use of evidence-based cancer supportive care.

The intervention group included oncology patients who accessed the OETC and potentially BUMC emergency department (ED) during the study period. The control group included oncology patients who only accessed BUMC ED during this time.

March 1, 2012 through June 30, 2018, a total of 8335 unique oncology patients utilized the BUMC inpatient and outpatient settings (OETC and ED) for acute care.

Results: Oncology-related unplanned hospitalizations per 100 outpatient visits were lower in the intervention versus control group (27.3 versus 32.7, $P < 0.0001$). Furthermore, there was no difference in the average annual cost for outpatient acute care (OETC and ED) between the two groups (\$6368 versus \$6,593, $P = 0.35$), but the cost was lower for oncology-related unplanned hospitalizations in the intervention group (\$62,260 versus \$81,911, $P < 0.0001$). This translated to \$19,651 annual savings for unplanned hospitalizations for the intervention group.

Conclusions: Providing optimal use of evidence-based cancer supportive care to oncology patients in a dedicated acute care setting decreased oncology-related unplanned hospitalizations and related costs.

1. Introduction

Cancer care has become increasingly specialized at the same time advances in treatment have resulted in a larger proportion of oncology patients receiving outpatient therapy [1]. However, cancer treatment can result in a greater use of hospital-based acute care identified as a marker of higher cost and potentially a lower quality of care [2–4]. This usually arises due to the treating physician in the hospital-based setting not having the experience to effectively manage cancer treatment side effects, coupled with the potential for poor communication between these physicians and the oncology patient's oncologist [5]. Therefore, the US Centers for Medicare and Medicaid Service (CMS) recently

proposed a new rule to assess the quality of care for oncology patients being treated with chemotherapy and encourage performance improvement to reduce preventable acute care utilization. The goal of OP-35 is to reduce preventable emergency department (ED) visits and hospitalizations among oncology patients (excluding patients with leukemia) receiving outpatient chemotherapy for ten conditions (anemia, nausea, emesis, dehydration, neutropenia, diarrhea, pain, pneumonia, fever, and sepsis) [6].

Therefore, we tested the effectiveness of a dedicated acute care setting for oncology patients that provided the optimal use of evidenced-based cancer supportive care to lower their acute cancer care utilization and the related cost. We defined inpatient acute cancer care

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as oncology-related unplanned hospitalizations. As such, unplanned hospitalizations are not considered to be part of the patient's program of care and are potentially preventable. Moreover, unplanned hospitalizations have been proposed as a quality assessment outcome in cancer patients due to the assumption that they represent adverse outcomes of care, particularly when they occur as the result of treatment received in the outpatient setting [7]. In addition, acute cancer care, which includes oncology-related unplanned hospitalizations, may delay scheduled cancer treatment and, as a result, adversely impact disease outcomes and quality of life.

2. Methods

2.1. Study design

The Oncology Evaluation and Treatment Center (OETC) was established in March 2012 at Baylor University Medical Center (BUMC), a large urban hospital, as a quality improvement intervention to reduce oncology-related acute care utilization [8]. BUMC is a tertiary hospital in an urban setting. The OETC operates in a dedicated acute care clinic separate from the BUMC ED to provide oncology patients receiving cancer care from a physician on the BUMC medical staff with after-hours infusions and acute care which promotes the optimal use of evidence-based cancer supportive care derived from the National Comprehensive Cancer Network guidelines [9]. The most frequently used evidenced-based care in the OETC was related to anti-emesis (22%), cancer pain (19%), and neutropenic fever (17%); followed by anemia, and pneumonia (5%), the frequencies of which are similar to what is reported in the literature related to oncology patient acute care [10]. Strategies employed to optimize adherence to this evidenced-based care included education presented by the OETC medical director at an orientation session for new providers, and making them aware that their adherence would be measured regularly and incorporated into the hospital's quality improvement program with the goal for adherence to this evidenced-based care being 90% or greater.

Briefly, if patient transfer from the OETC to the Baylor Dallas ED is needed, it is accessible by an indoor connector. BUMC operates the OETC and employs oncology nursing staff. The medical director employed by BUMC, who is also a Texas Oncology medical oncologist, manages OETC medical care. OETC providers can access BUMC and Texas Oncology patient electronic health records. All physicians on the medical staff at BUMC may refer their oncology patients to the OETC for acute care [8].

The purpose of the study was to test the effectiveness of the OETC for decreasing oncology-related unplanned hospitalizations and the related cost. The intervention group included oncology patients who accessed the OETC and potentially the BUMC emergency department (ED) anytime during the study period. The control group included oncology patients who did not access the OETC but did access the BUMC ED during the study period. This study was approved by the BUMC Institutional Review Board.

2.2. Patient characteristics and cost data

We obtained oncology patient characteristics and health care utilization and cost data from the BUMC administrative electronic data warehouse (EDW) for all relevant hospitalizations and OETC visits from March 1, 2012 through June 30, 2018. Study outcomes were BUMC unplanned hospitalization number and the cost for BUMC unplanned oncology-related hospitalizations and outpatient acute care visits (OETC and ED). Therefore, we excluded BUMC hospitalizations for planned chemotherapy or surgery, and blood and marrow transplantation in our outcome measures of interest. We also excluded uninsured patients to whom the OETC does not provide care since lack of reimbursement affects utilization; and leukemia hospitalizations based on the US CMS proposed rule, OP-35. OP-35 excludes patients with

leukemia because hospital and ED visits among this population often do not reflect poorly managed outpatient care [6].

The Dallas-Fort Worth Hospital Council database indicated that health care utilization data derived from the EDW was $\geq 90\%$ complete [11]. Patient cancer type and stage were obtained from the BUMC North Texas Cancer Registry, which reports data to the Texas Cancer Registry.

2.3. Statistical analysis

The intervention group included oncology patients who accessed the OETC and potentially the BUMC emergency department (ED) anytime during the study period. The control group included oncology patients who did not access the OETC but did access the BUMC ED during the study period.

We measured utilization for the intervention and control groups, by calculating the rate as the number of BUMC unplanned oncology-related hospitalizations per 100 acute care hospital visits during the study period. Cost was calculated using direct costs of oncology patient care related to BUMC oncology-related unplanned hospitalizations and acute care provided in the OETC and BUMC ED settings during the study period.

Patient characteristics were summarized by mean and standard deviation for continuous variables, and percent or proportion for categorical variables. We compared the characteristics between the two study groups using the independent sample *t*-test and Chi-square test for continuous and categorical variables, respectively.

For measures of health care utilization, we obtained the total number of BUMC unplanned oncology-related hospital visits (hospitalizations, OETC, and ED visits) for each oncology patient during the study period. To evaluate the impact of the intervention on oncology-related unplanned hospitalizations, we modeled the rate of these unplanned hospitalizations per 100 acute care hospital visits as a dependent variable using negative binomial regression [12]. The independent variables were the study group [intervention (OETC) versus control group (non-OETC)], and we risk adjusted the analysis by including other covariates in the model to improve both the internal validity and accuracy of estimates from the study. This meant controlling for potential confounders such as sex, race, ethnicity, payer type, All Patient Refined-Diagnostic Related Group (APR DRG) case mix index, Charlson's Comorbidity index, anatomic system impacted, cancer stage, and duration of follow-up [13,14]. The covariates are listed in Table 1. To determine the trend in the unplanned hospitalization rate over time, a model to the above was fitted with the inclusion of the hospitalization year as an independent variable.

We obtained the total direct costs of BUMC oncology-related unplanned hospitalizations, and OETC and BUMC ED visits during the same period of time for each study patient. The total direct costs for each study patient were annualized by dividing the total number of years that they were in the study [15]. To assess the impact of the study intervention on cost, we modeled the annualized cost using a two-part model. In the first part, we predicted the probability of any oncology-related unplanned hospitalization using the logistic regression model, and in the second part we predicted the direct cost for each study patient by fitting a log-gamma regression model, conditional upon the occurrence of an unplanned hospitalization. Standard errors of cost estimates were computed by use of bootstrapping results from the two-part model and are included in Table 2 [16,17]. Again, to improve both the internal validity and accuracy of estimates from the study, as we did related to the outcome, oncology-related unplanned hospitalizations, the independent variables included study group (intervention versus control group), and we risk adjusted the analysis by including other covariates in the model, such as sex, race, ethnicity, payer type, APR DRG case mix index, Charlson's Comorbidity index, anatomic system impacted, cancer stage, and admission year (Table 1) [13,14].

Statistical analyses were conducted using SAS 9.4 (SAS Institute,

Table 1
Patient Characteristics in the Intervention and Control Groups.

Patient Characteristics	Intervention	Control	P-value
Total number of patients	804	7531	
Age (years), mean ± SD	60.5 ± 14.4	64.0 ± 14.5	< 0.0001*
Sex (female), n (%)	424 (52.7)	4078 (54.1)	0.44 [†]
Ethnicity, n (%)			
Hispanic	49 (6.1)	443 (5.9)	0.14 [†]
Non-Hispanic	518 (64.4)	4609 (61.2)	
Not reported	237 (29.5)	2479 (32.9)	
Race, n (%)			
White	437 (54.4)	3682 (48.9)	0.006 [†]
Black	103 (12.8)	1176 (15.6)	
Other	27 (3.4)	194 (2.6)	
Not reported	237 (29.5)	2479 (32.9)	
Payer type, n (%)			
Managed care/commercial	426 (53.0)	3047 (40.5)	< 0.0001 [†]
Medicaid	30 (3.7)	469 (6.2)	
Medicare	348 (43.3)	4015 (53.3)	
APR DRG case mix index, mean ± SD	1.0 ± 1.5	1.2 ± 1.7	< 0.0001*
Charlson's comorbidity score, mean ± SD	4.3 ± 3.0	4.3 ± 3.3	0.69 [†]
Anatomic system, n (%)			
Brain and central nervous system	6 (0.7)	214 (2.8)	< 0.0001 [†]
Breast	67 (8.3)	691 (9.2)	
Digestive system	199 (24.8)	1350 (17.9)	
Endocrine system	6 (0.7)	67 (0.9)	
Female genital system	17 (2.1)	301 (4.0)	
Head and neck	11 (1.4)	180 (2.4)	
Male genital system	16 (2.0)	175 (2.3)	
Musculoskeletal system	41 (5.1)	207 (2.7)	
Respiratory tract and thorax	62 (7.7)	763 (10.1)	
Urinary system	34 (4.2)	305 (4.0)	
Other sites/not-specified	345 (42.9)	3278 (43.5)	
Cancer stage, n (%)			
I	56 (7.0)	762 (10.1)	< 0.0001 [†]
II	46 (5.7)	510 (6.8)	
III	43 (5.3)	404 (5.4)	
IV	175 (21.8)	1148 (15.2)	
Not applicable	79 (9.8)	599 (8.0)	
Unknown	405 (50.4)	4108 (54.5)	

Abbreviations: APR DRG, All patient refined-diagnostic related group [14]; SD, standard deviation. P-values based on: *t-test; [†]Chi-square test.

Cary, NC) software. P-values of < 0.05 were considered statistically significant.

3. Results

Between March 1, 2012 and June 30, 2018, there were 6222 unplanned oncology-related hospitalizations and 12,342 acute care hospital visits (OETC and ED) made by a total of 8335 unique patients at BUMC. Of these patients, 804 made at least one visit to the OETC, while 7531 made at least one visit to the ED (Table 1).

Results of bivariate analysis showed that the patients in the intervention group were of younger age (60.5 ± 14.4 years vs 64.0 ± 14.5

Table 2
Comparison of Oncology-Related Unplanned Hospitalization Rate and Cost in the Intervention and Control Groups.

	Intervention	Control	Difference (95% CI)	P-value
Total number of patients	804	7,531		
Total number of outpatient acute care (OETC and ED) visits	3,109	15,455		
Total number of oncology-related unplanned hospitalizations	878	5,344		
Oncology-related unplanned hospitalization rate per 100 hospital visits (SE) ^a	26.8 (1.2)	32.6 (0.5)	- 5.8 (-8.1 to -3.2)	< 0.0001
Average annual cost for oncology-related unplanned hospitalizations (SE) ^{a,b}	\$62,260 (\$4382)	\$81,911 (\$2636)	\$-19,651 (-\$27,231 to -\$11,152)	< 0.0001

Abbreviation: Oncology Evaluation and Treatment Center (OETC), emergency department (ED), confidence interval, CI; standard error, SE.

*P-value test for significance difference between intervention and control groups for the same study period.

^a The analysis was adjusted for age, sex, race, ethnicity, payer type, All Patient Refined-Diagnostic Related Group (APR DRG) case mix index, Charlson's Comorbidity index, anatomic system impacted, and cancer stage. [13,14].

^b Whereas, the average annual cost for OETC and ED care in the intervention and control groups was not significantly different (\$6368 versus \$6,593, P = 0.35).

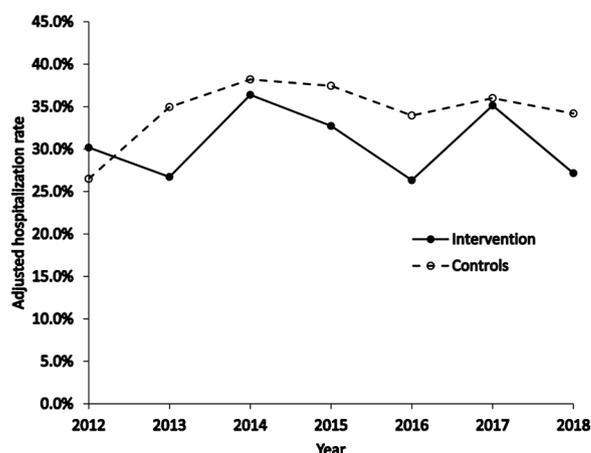


Fig. 1. Annual Oncology-Related Unplanned Hospitalization Rate for the Intervention and the Control Groups.

years, p < 0.0001), more likely to have a commercial payer (53.0% versus 40.5%, P < 0.0001), and have stage IV cancer (21.8% versus 15.2%, P < 0.0001), compared with patients in the control group (Table 1).

Risk adjusted analysis showed that the oncology-related unplanned hospitalization rate was lower in the intervention group as compared to the control group (27.3 versus 32.7, P < 0.0001; Table 2). Fig. 1 shows the oncology-related unplanned hospitalization rate annually in the intervention and control groups during the study period. In addition, there was no significant difference in the adjusted average annual cost for outpatient acute care between the intervention group and control group (\$6368 versus \$6,593, P = 0.35), but the cost was lower for oncology-related unplanned hospitalizations (\$62,260 versus \$81,911, P < 0.0001), translating to \$19,651 annual savings for the oncology-related unplanned hospitalizations in the intervention group (Table 2).

4. Discussion

The purpose of the study was to determine the effectiveness and cost savings of a dedicated acute care setting for oncology patients that provided the optimal use of evidenced-based cancer supportive care (OETC) to lower oncology-related unplanned hospitalizations at a large urban hospital. Our findings were that there was no significant difference in the average annual cost for outpatient acute care (OETC and ED) between the intervention and the control groups (\$6368 versus \$6,593, P = 0.35), but the oncology-related unplanned hospitalization rate, i.e., hospitalizations per 100 acute care hospital visits, was significantly lower in the intervention group compared to the control group (27.3 versus 32.7 P < 0.0001) as noted in Table 1 and Fig. 1. Furthermore, the cost was also lower for the oncology-related unplanned hospitalizations in the intervention as compared to the control group (\$62,260 versus \$81,911, P < 0.0001), translating to \$19,651

annual savings for the unplanned hospitalizations in the intervention group.

One of the major strengths of our study was that we conducted it in an applied, “real world” setting, and as a result, this allowed us to examine the effectiveness of the study’s intervention rather than its efficacy, increasing the generalizability of its results [18]. Realizing that the process of care and the infrastructure of care are both important for improving patient outcomes [19], we designed our intervention to provide processes of care in a healthcare setting that was dedicated to and unique for the acute care of cancer patients to best improve their clinical outcomes [19]. For the process of care, we incorporated evidence-based cancer supportive care into the acute care setting [9]. For the infrastructure of care, we established a clinical practice site that included providers educated on the implementation of evidenced-based cancer supportive care in a less intensive and expensive setting close to the ED, if needed for care, to address the inefficiencies of the inpatient setting [20]. Furthermore, the evidence-based cancer supportive care [9] provided in the OETC addressed the most prevalent acute care provided in the OETC (chemotherapy-induced nausea and vomiting (22%), neutropenic fever (17%), cancer pain (19%), and anemia and pneumonia (5%)), as well as eight of the ten conditions (anemia, nausea, emesis, dehydration, neutropenia, diarrhea, pain, pneumonia, fever, and sepsis) targeted by the US CMS measure, OP-35, which was designed to improve the quality of care for oncology patients receiving outpatient chemotherapy [6]. Strategies employed to optimize adherence to evidence-based cancer supportive care included the OETC medical director educating the OETC providers on the use of this care, and making them aware that their adherence would be measured regularly and incorporated into the hospital’s quality improvement program [21].

A possible limitation to our study is that the intervention was not randomized. Therefore, we employed statistical models that risk-adjusted for differences in the study groups by estimating models that included covariates shown to predict hospital admission [13,14]. The covariates for our study’s statistical model included not only patient demographics, payer type, and severity of illness, but also cancer site with stage and comorbidity, which are two of the most important clinical indicators for cancer prognosis [22,23]. Comorbidity has consistently been found to have an adverse impact on cancer survival, and in general, the higher the cancer stage the lower the patient’s chance of survival [24]. Another possible limitation to our study is that the patients in our study could have received acute care at another hospital during the study period, but we would have expected that it would have occurred more frequently in the control group compared to the study group. This is because patients primarily seek acute care at a medical facility not only because of convenience and the likelihood that they will receive more timely care, but also because the after-hours acute care facility is affiliated with their physician, which suggests that the positive effect of our intervention was greater than what our study’s results indicated [25–27].

In summary, our study suggests that in a large urban hospital, the OETC, which provided the optimal use of after-hours evidence-based cancer supportive care to oncology patients in a dedicated acute care setting, can reduce oncology-related unplanned hospitalizations and their related costs. Implementing the OETC concept should also prevent delays in scheduled outpatient treatment for oncology patients, which would also be expected to help improve their disease outcomes and quality of life. Therefore, we encourage the dissemination of quality improvement interventions like ours to support the growing numbers of patients receiving outpatient cancer therapy. Implementing interventions, like ours, will also be an important strategy for hospitals and community oncology to incorporate into their clinical practice, as well as to address the recent introduction of the CMS quality measure, OP-35, in the US.

Contributors

YMC wrote the first draft of the manuscript. YMC and NSF conceived the idea for the study and provided overall guidance. All other authors provided data, developed models or discussed the data, reviewed results and reviewed and contributed to the report.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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