Impact of inpatient radiation on length of stay and health care costs

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Background Health care costs are rising. Identifying areas for health care utilization savings may reduce costs.
Objective To identify oncology patients receiving inpatient radiotherapy with the purpose of measuring length of stay (LoS) and hospital charges.
Methods During July 2013 the oncology service physicians at Mount Sinai Medical Center in New York City were surveyed daily to identify patients receiving inpatient radiation. Actual LoS, acuity LoS were determined from the chart review. Expected LoS was calculated using the University Healthsystem Consortium database. Charges associated with actual LoS, acuity LoS, and expected LoS were then reported. Actual and expected LoS were compared for inpatient radiotherapy and nonradiotherapy groups.
Results 7 patients were identified as having remained in the hospital to receive radiation treatment. In that cohort, the average actual LoS and charges per patient were 40.1 and $48,724, compared with acuity LoS and charges of 25.6 days and $34,089 and expected LoS and charges of 7.7 days and $10,028. Mean LoS and charges attributed to radiation alone amounted to 11 days and $12,514. The mean actual LoS of oncology patients admitted during the same time period who did not receive radiation was 6.7 days, compared with 40.1 days for patients who received radiation ($P < .0001$).
Limitations Inability to access actual reimbursement data prevented exact cost calculations, small sample size, and single-institution focus.
Conclusion Delivery of radiation therapy during inpatient hospitalization extends LoS and contributes to higher health care costs. Methods to facilitate the delivery of outpatient radiotherapy may result in cost savings.

The rising national health expenditures in the United States pose a great challenge. According to the Centers of Medicare and Medicaid, health care costs comprised 5.2% of the American economy in 1960, compared with 17.4% in 2009.[1] In 2009, the US spent $7,960 per capita on health care,[2] whereas Switzerland, which has a gross domestic product that is comparable with that of the US, spent $5,144 per capita on health care. Based on 2009 data, hospitalizations account for 38% of health care spending,[2] with the reported mean cost per hospitalization in the US of $11,095.[3] According to statistics from the Agency for Health care and Quality, hospitalizations principally for cancer resulted in longer length of stay (LoS) compared with hospitalizations for other conditions (6.6 and 5.0 days, respectively). At one institution in Great Britain, the average LoS associated with a cancer diagnosis was 13.5 days, compared with 7 days when accounting for all admissions.[4] On average, cost associated with a cancer-related hospitalization in the US is significantly higher at $16,400 per inpatient stay, compared with $10,700 per inpatient stay for other conditions.[5] The poor functional performance status of patients with progressive cancer, the inadequate availability of caretakers at home, and the difficulties with arranging transportation are some of the barriers to discharge. Data suggest that the poor coordination of home services increases hospitalization rates[6,7] and that interventions to improve management of care at home actually do reduce hospital admissions.[8] The high costs of inpatient care for cancer patients[9] suggest that reducing hospitalizations for appropriate cancer patients would result in decreasing LoS and health care expenditures.

At Mount Sinai Medical Center in New York City, we observed that some patients who were admitted to the oncology units received radiation treatments during the hospitalization, although radiation delivery is generally an outpatient procedure. In the literature, only 1 study noted 5 cases in which inpatient radiation contributed to significantly prolonged LoS.[10] The present study is a pilot investigation with the purpose of examining the

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impact of delivering inpatient radiation on the financial cost of hospitalization and on LoS. We hypothesize that delivering radiation during the hospitalization is costly and contributes to increased length of stay. The study goals are to:

- Identify and characterize patients admitted to Mount Sinai's medical oncology service during July 2013;
- Compare the actual LoS, acuity LoS, and expected LoS for the oncology patients who received inpatient radiation therapy with the same LoS data for oncology patients who did not receive inpatient radiation therapy; and
- Compare the total charges associated with actual, acuity, and expected LoS.

Methods

Between July 1, 2013 and July 31, 2013, the hematology and medical oncology physicians of the 4 oncology services (bone marrow transplant, hematologic malignancies, teaching and nurse practitioner service, and solid oncology service) were surveyed daily at our institution to identify patients who were receiving radiation. This study was reviewed and approved by the Icahn School of Medicine's institutional review board.

Patient charts of patients who received radiation were reviewed for baseline characteristics including age, sex, race, type and stage of malignancy, admission diagnosis, length of stay, type of radiation received, radiation dose, and the site of radiation. Physician provider notes, nursing notes, social work notes, and physical and occupational therapy notes were also reviewed. The date of admission was defined as admission to the oncology service. The date of discharge was defined as the date of discharge from the oncology inpatient service, irrespective of whether the patient was discharged home, to a rehabilitation facility, or transferred to the Mount Sinai's inpatient palliative care unit.

Actual LoS was defined as the number of days for which the patient was admitted to the oncology service. *Acuity* LoS was measured in days and was defined as the number of days needed to evaluate and treat the admitting diagnosis. *Expected* LoS was calculated in days using the University Healthsystem Consortium (UHC) database for the specific patients identified based on the admission diagnosis and documented complication or comorbidity, or a major complication or comorbidity. The number of admissions to the oncology service and the associated LoS (both actual and expected) in 2013 was provided by the Mount Sinai office of operations.

The information about the financial charges for the hospitalization of each patient who received radiation was provided by the financial office of Mount Sinai Medical Center. Reimbursement data is confidential and not disclosed. Charges were calculated for the actual LoS, acuity LoS, expected LoS, and radiation-attributed LoS.

We compared the groups using means, standard deviations, and the 2-tailed unpaired *t* tests with the level of significance defined as $\alpha < .05$. An outlier was calculated using the modified Thompson τ technique.

Results

There were 636 patient admissions to the inpatient solid oncology service during 2013, with 20.8 patients a day being admitted to the hospital July 2013. In July, 50 patients were admitted to the solid oncology service and did not receive radiation therapy, and an additional 7 remained hospitalized for radiation treatment. In the year 2013, 78 of 1,000 radiation treatment protocols were delivered during an inpatient hospitalization, with the remainder delivered in the ambulatory setting.

The average age of the patients who received radiation was 59.7 years (range, 45-79). Of the 7 who received inpatient radiation, 5 were men and 2 were women, and they were ethnically diverse – 2 were white, 2 were black, 2 were Asian, and 1 was Hispanic. The malignancies included head and neck, breast, liver, sarcoma, lung, and prostate cancer. The patient with a head and neck cancer had locally advanced disease, and the remaining 6 patients had distant metastases.

The reasons for admission and radiation, sites of radiation, number of fractions administered, and each patient's travel distance to our institution are shown in Table 1. Three of the 7 patients required radiation therapy as part of the admitting diagnosis management (patients 5, 6, and 7). Palliative treatment ranged from 1-13 fractions, and curative-intent treatment required 35 fractions (Patient 4). On average, the patients lived a distance of 15.7 miles from the hospital (range, 1.5-42.9).

As part of the discharge planning process, the physical therapist recommended that 5 of the 7 patients be discharged home and that 1 patient (Patient 3) be discharged to a subacute rehabilitation center although she had been rejected by the facility while she was actively receiving radiotherapy. One patient elected discharge to a hospice facility (Patient 5). Three of the five patients with a recommendation for home discharge had living quarters that did not require steps to access the home. Despite a recommendation by the physical therapist to discharge home, 5 patients remained in the hospital to receive radiation. Patients 1, 2, 5, and 6 insisted on inpatient treatment because they lived a significant distance from the hospital and their loved ones worked during the day and could not transport them to radiotherapy visits. It was unclear why Patient 7 remained in the hospital after his condition stabilized.

For 6 of the 7 patients, acuity ended before initiation of the radiation treatment. Only Patient 4 with the head

TABLE 1 Admission diagnosis, radiation characteristics, and home distance from the hospital for each of the 7 patients who received inpatient radiation treatment

Patient	Admission diagnosis	Reason for radiation	Radiation site	No. of fractions delivered (during inpatient)	Home distance from hospital, miles (average, 15.7 miles)
1	New diagnosis of cancer with extensive bone and bone marrow metastases resulting in pancytopenia and frequent transfusions	Pain resulting from spine metastases	Spine	10 (10)	42.9
2	Systemic inflammatory response syndrome	Neurologic weakness secondary to brain metastases	Brain	13 (13)	9.7
3	Lower extremity edema, pain, and infection limiting ambulation	Tumor related pain limiting ambulation	Spine	10 (10)	22.3
4	Pneumonia and fungemia	Respiratory compromise secondary to tracheal compression by tumor	Neck	35 (17)	18.1
5	Quadriplegia secondary to cord compression	Cord compression	Spine	1 (1)	7.9
6	Symptomatic intracranial hemorrhage secondary to brain metastases	Hemorrhage secondary to brain metastases	Brain	15 (8)	7.8
7	Symptomatic cerebellar metastases	Dysmetria secondary to cerebellar metastases	Brain	10 (9)	1.5

and neck malignancy continued acute hospitalization to be able to receive intravenous antimicrobials during radiation. Three of the patients were ultimately transferred to the palliative care service. The remaining 4 were discharged home.

The actual LoS in this cohort ranged from 13-135 days (Table 2). Patient 1, whose LoS was 135 days, was an outlier ($\delta_1 > \tau S$, based on modified Thompson τ) whose hospitalization was prolonged because of frequent blood transfusions resulting from bone marrow infiltration by the malignancy. Based on the actual LoS definition, this 7-patient cohort accounted in total for 281 days of hospitalization, with an average of 40.1 days (SD, 43.3) per patient (24.3 days [SD, 12.4], if Patient 1 is excluded). The acuity LoS averaged 25.6 days (SD, 42.8) per patient (9.8 days [SD, 10.6], if Patient 1 is excluded). The expected LoS for this group was 7.6 days. The mean LoS attributed to radiation alone was 10.7 days. By comparison, the actual LoS for the 50 patients admitted to the solid tumor oncology service without radiation treatment, was 6.7 days (SD, 4.9; range, 1-15). The 7 patients who received radiation had a statistically significant longer actual LoS than did the nonradiation threatment patients (40.1 vs 6.7 days, respectively; $P < .0001$). If the outlier (Patient 1) was excluded, actual LoS was 24.3 vs 6.7 days ($P < .0001$), as shown in the Figure.

The expected LoS range derived from the UHC database calculation for patients who received radiation was 6-9 days (Table 2), with an average of 7.7 days compared with 5.2 days in the cohort that did not receive radiation ($P = .0098$). Patients who did not receive radiation had a simi-

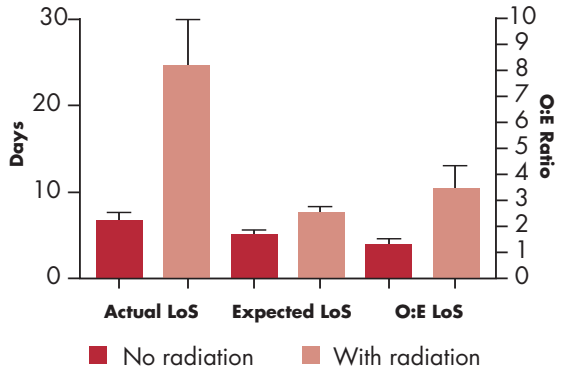

FIGURE Effect of inpatient radiation on actual LoS, expected LoS, and O:E ratio of LoS. Actual LoS with radiation was significantly longer than actual LoS with no radiation (24.3 vs 6.7 days; $P < .0001$). Expected LoS with radiation was significantly longer than expected LoS with no radiation (7.6 vs 5.2 days; $P = .021$). There was no difference between actual LoS no radiation and expected LoS no radiation (6.7 vs 5.2 days; $P = .0609$). Actual LoS with radiation was significantly longer than expected LoS with radiation (24.3 vs 7.6 days, $P = .0156$). O:E ratio for LoS with radiation was significantly longer than O:E LoS no radiation (3.5 vs 1.3, $P = .0002$).

LoS, length of stay; O:E, observed:expected; SEM, standard error of the mean

Note: Outlier (Patient 1) data excluded from this analysis. Error bars represent SEM.

TABLE 2 Length of stay and hospital charges for the actual LoS, acuity LoS, and expected LoS for the 7 patients who received inpatient radiation treatment

Patient	1	2	3	4	5	6[a]	7	Total	Mean per patient	Total (Pt 1 excl)	Average per patient (Pt 1 excl)
Length of stay, d											
Actual LoS	135	25	32	45	13	16	15	281	40.1	146	24.3
Acuity LoS	120	7	12	30	5	0	5	179	25.6	59	9.8
Expected LoS[b]	8	9	8	7	6	na	8	46	7.7	38	7.7
Difference between actual LoS and acuity LoS	15	18	20	15	8	16	10	102	14.6	87	14.5
Difference between actual and expected LoS	127	16	24	38	7	na	7	219	36.5	92	18.4
LoS attributed to radiation alone	15	11	14	16	1	10	12	79 Days	11.3	64	10.7
Hospital charges, $[c]											
Actual LoS charges	174,964	26,897	32,026	60,882	14,821	12,848	18,633	341,071	48,724	166,107	27,685
Acuity LoS charges	158,739	9,674	12,340	43,558	4,496	0	9,814	238,621	34,089	79,882	13,314
Expected LoS charges	15,177	11,979	8,864	7,194	5,563	na	11,388	60,165	10,028	44,988	8,998
Difference between actual and acuity LoS charges	19,308	17,223	19,686	17,324	10,325	12,848	8,819	105,533	15,076	86,225	14,371
Difference between actual and expected LoS charges	159,787	14,918	23,162	53,688	9,258	na	7,245	268,058	44,676	108,271	21,654
Charges for radiation-attributed LoS	16,225	17,223	13,595	18,337	2,190	8,429	11,602	87,601	12,514	71,376	11,896

LoS, length of stay, na, not applicable

[a]Patient 6 was initially admitted to the surgical service prior to the transfer to the medical oncology unit. The measured expected LOS available was applicable only to the surgical admission diagnosis. [b]Expected LOS in days rounded to the nearest integer calculated using UHC database. [c]US dollars.

lar actual and expected LoS (6.7 vs 5.2 days; $P = .0609$), as shown in Figure 1. Patients who received inpatient radiation had a significantly longer actual LoS, compared with that cohort's expected LoS (24.3 vs 7.6 days; $P = .016$). In addition, expected LoS was longer for the group that received radiation (7.6 vs 5.2 days; $P = .021$).

The charges corresponding to their respective LoS are reported in Table 2 for each of the 7 patients. The observed:expected (O:E) LoS ratio for the patients who received radiation was 5.7 (3.4 if Patient 1 is excluded), compared with 1.3 for the 50 patients who did not receive radiation. This difference was statistically significant ($P < .0001$; $P = .0002$ if the outlier was excluded).

Radiation therapy contributed to the 7 patients being hospitalized for an additional 79 days, with an average 11.3 days per patient. These 79 extra days of hospitalization accounted for an additional $87,601 in charges (Table 2), which corresponds to an average of $12,514 per patient. The difference in charges when comparing the actual and acuity LoS was $105,533, an average of $15,076 per patient. The difference in charges when comparing the actual LoS and expected LoS was $268,058, an average of $44,676 per patient. With the exclusion of Patient 1, the charges for radiation-alone hospitalization amounted to $71,376, representing $11,896 per patient.

Discussion

In this pilot study we identified 7 cancer patients who received radiation therapy while hospitalized on an oncology service during the month of July 2013. Hospitalizations account for a large proportion of health care cost spent managing patients with malignancies.[9] In oncologic

patients with bone metastases, inpatient stays have been found to be a leading contributor to the cost of skeletal-related events in Europe,[11] which suggests that the delivery of outpatient services in the inpatient setting may contribute to rising health care expenditures. To our knowledge, this is the first report demonstrating that radiation therapy that is initiated during hospitalization prolongs LoS and increases costs. In our investigation, radiation alone increased the mean LoS by 11.3 days per patient. In 6 of the 7 patients, radiation was administered after the acuity necessitating hospitalization was resolved, suggesting that the subsequent administration of radiation was the principal reason for prolonged LoS. The cohort of patients who received radiation had statistically significant greater increase in both actual and expected lengths of stay, compared with the cancer patients who did not receive radiotherapy (40.1 vs 6.7 days, respectively, and 7.7 vs 5.2 days). The administration of radiation therapy led to $87,601 of additional charges and initiatives to deliver care in an outpatient setting may aid in containing cost.[9,12]

A limitation of this study was the inability to obtain actual reimbursement data, which should provide a more precise estimate of the actual health care expenditures associated with inpatient delivery of radiation. As a surrogate of the actual reimbursement, direct charges for each patient are reported in this manuscript and have been used in other published studies to estimate cost.[13,14] Additional limitations of this work include a small sample size collected in a single institution over a 1-month period. This study serves as a pilot and further investigation over a longer period and in different hospital settings is warranted.

The expected LoS, which is determined by a function of the admitting diagnosis and associated complications and comorbidities, was significantly longer for the cohort of patients who received radiation (7.6 vs 5.2 days). This suggests that the patients who received inpatient radiation were hospitalized for reasons that would take longer to stabilize to a point of discharge. Despite this, the actual LoS for the patients who received radiation was significantly longer than the expected LoS (24.3 vs 7.6 days). This demonstrates that even with comorbid conditions accounted for in the expected LoS calculation, it was still the inpatient radiation that significantly prolonged the hospitalization.

Although there are times when radiotherapy needs to be initiated in the hospital to urgently treat an oncologic emergency, patients with advanced cancer often receive radiation for palliative reasons. Palliative radiotherapy can be initiated and administered on an outpatient basis. Based on the results of our investigation, it is of concern that delivery of radiation during inpatient stay extends LoS and increases overall health care delivery costs. Certain patients may consider it more convenient to receive radiation while they are hospitalized because it obviates transportation concerns for advanced cancer patients who may have poor performance statuses and be experiencing cancer-related symptoms such as pain. Patients who require care in the skilled nursing center may face challenges of being accepted into such facilities because the frequent transportation to radiation may challenge the facility's resources. Of 165 rehabilitation facilities in the 5 boroughs of New York City, where most of our patients are referred, none routinely accepts patients who are undergoing active radiotherapy treatment.

Quality improvement plan and recommendations

Most of the patients receiving radiation were recommended for discharge home or to a rehabilitation facility. One possible solution to limit LoS and reduce costs would be for the hospital or insurer to provide payment for transportation. It has been previously reported that social work and community outreach programs have been able to reduce emergency room visits with the implementation of transportation programs being one component that contributes to that reduction.[15,16] The social work service at our institution estimates the approximate cost of an ambulette for a round trip to radiation treatment would cost $100-$300 daily in our geographic area. Hospitals might be willing to cover these costs because they would benefit from the availability of an acute hospital bed and achieve cost savings through opportunity costs. Medicare and Medicaid reimburse certain transportation services; commercial insurances typically do not. The Medicare Anti-Kickback Statute and Civil Monetary Penalties Law limit hospitals from providing gratuitous services. However, some institutions have transportation policies for patients who need to continue existing treatment but have limited means and are too frail to take public transport. Such services may decrease LoS and reduce overall health expenditures.

Informal surveying of the oncology providers revealed that most of the cases for which inpatient radiation is warranted are not discussed with the radiation oncology attending in a multidisciplinary fashion and the goals of care are not clearly defined. In some cases, shorter treatments maybe appropriate and may lead to a reduction in LoS. For example, uncomplicated bone metastases can be treated with a single fraction of radiation, a recommendation included in the ASTRO [American Society for Radiation Oncology] guidelines.[17] In our series, only 1 of the 3 patients with vertebral metastases received a single radiotherapy fraction.

Our initial study is already laying the groundwork for additional investigation about the impact of inpatient radiation on both patient outcomes and the health care system. In our institution, a retrospective analysis demonstrated that hospitalized patients receiving palliative radiation had a worse functional status, poorer survival, and on average could not tolerate the number of prescribed

doses, compared with the patients receiving ambulatory palliative radiation (personal communication, Kavita Dharmarajan, MD). This study provides additional support that an abbreviated course of radiation should be considered in hospitalized patients. Although data is not yet available, another study in our department is analyzing the impact of palliative radiation in hospitalized patients on nosocomial complications (personal communication, Cardinale Smith, MD).

Since completing this pilot project, our institution already implemented policy changes. Currently all patients who are being considered for inpatient radiation have an expedited social work and physical therapy evaluation to explore the possibility of radiotherapy delivery outside the hospital. Further, our institution established a dedicated palliative radiation oncology consult service and since its introduction, the median LoS for hospitalized patients receiving radiation has improved significantly from 21 to 14 days (P = .04; personal communication, Dharmarajan, MD).

Conclusions

In this pilot study, we identified patients with active cancer who received inpatient radiation therapy. The delivery of radiotherapy during hospitalization is associated with a statistically significant increase in LoS and with higher charges for hospitalization. These findings need to be corroborated over longer periods of time and in multiple hospital settings. Strategies to overcome barriers to transition and implementation of outpatient radiation therapy are greatly needed.

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