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Cost of Tobacco-related Cancer Hospitalizations in the U.S., 2014

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Abstract

Introduction: Smoking has been causally linked to 12 tobacco-related cancers: oral cavity and pharynx, esophagus, stomach, colon and rectum, liver, pancreas, larynx, lung, cervix, bladder, kidney, and acute myeloid leukemia. Tobacco-related cancers–related morbidity and mortality have been well described, but little is known about the prevalence of tobacco-related cancer hospitalizations and associated costs. This study estimates the annual number of tobacco-related cancer hospitalizations and their associated direct medical costs in the U.S.

Methods: This study examined data from the 2014 National Inpatient Sample, the largest publicly available all-payer inpatient care database in the U.S. The authors calculated number of hospitalizations, total costs, length of stay, and cost per stay for tobacco-related cancer hospitalizations and cancer hospitalizations not related to tobacco.

Results: In 2014, there were an estimated 461,295 annual tobacco-related cancer hospitalizations at a cost of \$8.2 billion in the U.S. Tobacco-related cancers accounted for 45% of total cancer hospitalizations and cancer hospitalization costs. Compared with cancer hospitalizations not related to tobacco, tobacco-related cancer hospitalizations had a longer mean length of stay (6.8 vs 5.7 days).

Conclusions: The burden of tobacco-related cancer hospitalizations is substantial in the U.S. These findings highlight the importance of tobacco prevention and cessation efforts to decrease the burden of tobacco-related cancers in the U.S.

INTRODUCTION

Tobacco use is the leading preventable cause of disease and premature death in the U.S., causing more than 480,000 deaths annually.¹ Since the U.S. Surgeon General first linked smoking to cancer in 1964, cigarette smoking has been causally linked to 12 cancers: oral cavity and pharynx; esophagus; stomach; colon and rectum; liver; pancreas; larynx; lung, bronchus, and trachea (lung); uterine cervix (cervix); urinary bladder (bladder); kidney and renal pelvis (kidney); and acute myeloid leukemia.¹ Together, these 12 cancers are defined as tobacco-related cancers (TRCs).¹ Since 1964, more than 6.5 million Americans have died

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as a result of TRCs. Cigarette smoking accounts for approximately 30% of all cancer deaths in the U.S., including nearly 90% of lung cancer deaths.^{1–5} Although the risks of developing cancer among people who use tobacco are well documented, less is known about the prevalence and cost of TRC hospitalizations.^{6–9} This study estimates the annual number of TRC hospitalizations and their associated direct medical costs in the U.S.

METHODS

The authors analyzed the 2014 Healthcare Cost and Utilization Project's National Inpatient Sample (NIS), the largest publicly available all-payer inpatient care database in the U.S.¹⁰ TRCs were defined as those cancers that the U.S. Surgeon General has causally linked to smoking.¹ Because tobacco use is one of many factors that increases the risk of TRCs, tobacco use may not have contributed to each TRC hospitalization, and the estimated number of TRC cases attributable to smoking varies by cancer type.¹¹ TRC cancer hospitalizations among adults aged ≥18 years were identified using the first-listed (primary) diagnosis code from the ICD-9-CM.¹² The following ICD-9 codes were used: oral cavity and pharynx (140.0–149.9); esophagus (150.0–150.9); stomach (151.0–151.9); colon and rectum (153.0–153.9, 154.0–154.8); liver (155.0–155.2); pancreas (157.0–157.9); larynx (161.0–161.9); lung, bronchus, and trachea (162.0–162.9); cervix (180.0–180.9); bladder (188.0–188.9); kidney and renal pelvis (189.0–189.1); and acute myeloid leukemia (205.00–205.02). Because lung cancer comprises the largest group of TRCs, separate analyses for hospitalizations related to lung cancer were conducted.

Patient, payer, and hospital characteristics were examined for each visit. Generalized linear models with a gamma distribution and a log link were used to estimate length of stay and cost per stay. All regressions controlled for age, sex, race/ethnicity, insurance status, number of chronic conditions, and admission through the emergency department. Adjusted estimates are presented as predictive margins. The predicted margins method directly standardizes the outcome of each group to the covariate distribution of the overall population.¹³ The authors estimated the mean length of stay, mean cost per stay, mean cost per day, and total annual costs. The NIS includes hospital charges rather than costs; however, cost-to-charge ratios were used, an accepted method for estimating costs from charges.¹⁴ The NIS excludes physician and professional fees, and does not capture TRCs treated in other healthcare settings. Data were weighted to provide nationally representative estimates and analyzed with Stata, version 14.2. The analysis was conducted in September 2017.

RESULTS

In 2014, there were an estimated 461,295 hospitalizations with a TRC identified as the principal diagnosis (Table 1). Of these hospitalizations, the most common cancer type was colorectal (28%), followed by lung (27%), kidney (10%), pancreas (8%), bladder (6%), liver (5%), and stomach (5%). There were an estimated 573,550 cancer hospitalizations not related to tobacco. Compared with individuals hospitalized for cancers not related to tobacco, individuals hospitalized for TRCs were older, had lower household income, more chronic conditions, experienced higher in-hospital mortality rate, and a higher proportion were hospitalized in the South and Midwest.

In 2014, the total cost of TRC hospitalizations was \$8.2 billion (Table 2). Of this, 23% was due to lung cancer (\$1.8 billion). The total annual cost of cancer hospitalizations not related to tobacco was \$10.1 billion. Compared with cancer hospitalizations not related to tobacco, TRC hospitalizations had a longer mean length of stay (6.8 vs 5.7 days).

DISCUSSION

This report presents national estimates of direct medical costs of TRC hospitalizations using the largest all-payer inpatient care database in the U.S. The study found 461,295 TRC annual hospitalizations in the U.S. with an estimated cost of \$8.1 billion. TRCs accounted for 45% of total cancer hospitalizations and hospitalization costs in the U.S. in 2014.

TRC hospitalizations account for a significant proportion of smoking-related costs. Smoking-attributable healthcare spending is estimated to account for 6%–14% of total annual healthcare expenditures in the U.S.^{15–17} Annual smoking-related direct medical care costs in the U.S. have been estimated at \$132 billion to \$175 billion.^{3,16–19} These estimates suggest that TRC hospitalizations account for a significant portion of smoking-related direct medical care costs in the U.S. The current results indicate that the higher cost of TRC hospitalizations is primarily because of longer hospital stays. Although comorbid conditions were not included in this analysis, they may be a significant contributor to longer length of stays and associated costs.

Even though this study reports the cost of TRC hospitalizations, it also highlights opportunities to reduce TRC-related burden and cost through prevention programs. From 2005 to 2015, smoking among adults in the U.S. decreased from 21% to 15%.²⁰ Despite this decrease, smoking still accounts for approximately 30% of all cancer deaths in the U.S., including nearly 90% of lung cancer deaths.^{1–4} The National Academy of Medicine recommends implementing strategies shown to decrease cigarette sales and smoking prevalence.^{1,2} As the preventive impact of smoking cessation varies by age, smoking prevention may have greater long-term results when initiated at earlier ages.^{21,22} Supporting tobacco quitline interventions and comprehensive statewide tobacco control and cancer programs would also be beneficial.^{1,23–25} Support for programs such as the Centers for Disease Control and Prevention's TIPS Campaign, which has demonstrated the effectiveness of media campaigns in increasing quit attempts, may also contribute to decreasing smoking prevalence.²⁶ Increasing the availability of inpatient tobacco cessation services, which result in higher rates of smoking cessation and are cost effective, may lead to further decreases in smoking.^{27–29} These efforts may be particularly effective in states in the South and Midwest, which have the most TRC hospitalizations, highest smoking prevalence, and highest lung cancer rates in the U.S.²⁵ Despite serious health risks, cigarette smoking prevalence is higher among cancer survivors compared with people without a history of cancer.^{29,30} Although tobacco cessation can improve prognosis and survival, evidence-based smoking cessation services are not available in many oncology settings.²⁹

Limitations

This study has several limitations. These estimates may differ from a complete accounting of costs. Individual tobacco use information was not available in this dataset. Because smoking

is one of many factors that increase cancer risk, tobacco use may not have contributed to each TRC hospitalization. This may have resulted in some overestimation, especially for TRCs that have stronger associations with risk factors other than tobacco. The NIS contains discharge-level records but not patient-level records. Thus, individual patients discharged multiple times in one year are not able to be identified. Although including hospitalizations not caused by tobacco may have caused an overestimation of costs, excluding physician and professional services, and other treatments may have led to underestimation of total costs.

CONCLUSIONS

In summary, the authors estimate that the \$8.1 billion annual cost of TRC hospitalizations accounts for 45% of all cancer hospitalization costs. National estimates of TRC hospitalization costs have the potential to inform program and policy development for cancer prevention, treatment, surveillance, and end-of-life care.³¹ This report highlights the importance of tobacco prevention and cessation efforts to reduce the cost and burden of TRC hospitalizations.

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Table 1

Characteristics of TRC^a Hospitalizations Compared to Other Cancer-related Hospitalizations Among Adults (Aged ≥18 Years), NIS, 2014

Characteristics	TRC hospitalizations	Hospitalizations related to lung cancer	TRC hospitalizations excluding lung cancer	Cancer hospitalizations not related to tobacco
<i>n</i> , unweighted (weighted) ^b	92,259 (461,295)	25,126 (125,630)	67,133 (335,665)	114,710 (573,550)
Patient characteristics				
Age				
18–44 years	5.6 (5.3, 5.8)	1.6 (1.4, 1.8)	7.0 (6.8, 7.3)	10.8 (10.4, 11.2)
45–64 years	37.4 (36.8, 37.9)	33.8 (33.1, 34.6)	38.7 (38.1, 39.3)	43.7 (43.2, 44.1)
65 years	57.1 (56.4, 57.7)	64.6 (63.8, 65.3)	54.3 (53.6, 55.0)	45.5 (44.8, 46.3)
Sex				
Male	55.4 (55.0, 55.7)	50.7 (50.1, 51.4)	57.1 (56.7, 57.5)	46.3 (45.6, 47.1)
Female	44.6 (44.2, 45.0)	49.3 (48.6, 49.9)	42.9 (42.5, 43.3)	53.7 (52.9, 54.4)
Race/ethnicity				
Non-Hispanic white	69.6 (68.1, 71.0)	74.1 (72.6, 75.5)	67.9 (66.4, 69.4)	67.6 (65.9, 69.3)
Non-Hispanic black	11.6 (10.9, 12.2)	11.7 (11.0, 12.5)	11.5 (10.9, 12.2)	12.0 (11.3, 12.7)
Asian or Pacific Islander	3.2 (2.8, 3.6)	2.6 (2.3, 2.9)	3.4 (3.1, 3.8)	3.1 (2.8, 3.5)
Hispanic	7.6 (7.0, 8.3)	4.4 (3.9, 5.0)	8.8 (8.1, 9.6)	8.4 (7.7, 9.2)
Other	2.9 (2.6, 3.3)	2.4 (2.1, 2.8)	3.1 (4.0, 6.7)	3.2 (2.8, 3.7)
Household income				
Lowest quartile	26.6 (25.6, 27.7)	27.9 (26.7, 29.2)	26.2 (25.2, 27.2)	23.3 (22.3, 24.4)
All other quartiles	71.2 (70.2, 72.2)	70.0 (68.8, 71.2)	71.6 (70.6, 72.7)	74.4 (73.4, 75.4)
No. of chronic conditions				
0–1	11.5 (11.2, 11.8)	6.1 (5.7, 6.4)	13.5 (13.1, 13.9)	17.1 (16.6, 17.6)
2–3	22.3 (21.9, 22.7)	18.5 (18.0, 19.1)	23.7 (23.3, 24.1)	26.1 (25.7, 26.5)
4–5	25.2 (24.8, 25.5)	25.7 (25.1, 26.3)	24.9 (24.6, 25.3)	24.5 (24.1, 24.8)
6	41.1 (40.4, 41.7)	49.7 (48.8, 50.5)	37.8 (37.2, 38.5)	32.3 (31.7, 32.9)
Received ED services				
Yes	34.8 (33.7, 35.9)	43.5 (42.3, 44.8)	31.5 (30.5, 32.6)	33.9 (32.7, 35.2)
Patient disposition				
Routine	55.8 (55.0, 56.5)	50.6 (49.6, 51.7)	57.7 (56.9, 58.5)	61.0 (60.1, 61.8)
Transfer	15.3 (14.9, 15.8)	15.8 (15.2, 16.4)	15.2 (14.7, 15.6)	15.4 (14.9, 15.9)
Home health care	22.5 (21.9, 23.1)	24.0 (23.1, 24.8)	21.9 (21.2, 22.6)	18.9 (18.2, 19.6)
Died in hospital	5.8 (5.6, 6.1)	9.0 (8.5, 9.4)	4.7 (4.5, 4.9)	4.4 (4.2, 4.6)
Other	0.5 (0.4, 0.6)	0.6 (0.5, 0.8)	0.4 (0.4, 0.5)	0.4 (0.3, 0.4)
Payer information				
Expected primary payer				
Medicare	54.7 (54.0, 55.3)	61.8 (61.0, 62.6)	52.0 (51.3, 52.7)	44.8 (44.0, 45.5)
Medicaid	10.4 (9.9, 11.0)	9.5 (9.0, 10.0)	10.8 (10.2, 11.4)	10.6 (10.0, 11.3)

Characteristics	TRC hospitalizations	Hospitalizations related to lung cancer	TRC hospitalizations excluding lung cancer	Cancer hospitalizations not related to tobacco
Private	29.1 (28.3, 29.9)	23.2 (22.4, 24.1)	31.2 (30.4, 32.1)	38.9 (37.9, 40.0)
Self-pay	2.7 (2.4, 2.9)	2.4 (2.2, 2.7)	2.8 (2.5, 3.1)	2.5 (2.2, 2.7)
Other	3.0 (2.7, 3.2)	2.9 (2.6, 3.2)	3.0 (2.8, 3.3)	2.9 (2.7, 3.2)
Hospital characteristics				
Region				
Northeast	20.6 (19.0, 22.4)	20.7 (19.1, 22.4)	20.6 (18.9, 22.4)	22.1 (19.7, 24.7)
Midwest	22.5 (20.9, 24.0)	23.6 (22.2, 25.1)	22.0 (20.3, 23.7)	21.8 (19.7, 24.1)
South	39.1 (37.3, 40.9)	41.0 (39.3, 42.7)	38.3 (36.4, 40.3)	36.1 (33.6, 38.8)
West	17.9 (16.8, 19.1)	14.7 (13.7, 15.7)	19.1 (17.8, 20.5)	19.9 (18.2, 21.8)
Location/teaching status				
Rural	6.4 (5.9, 7.0)	7.0 (6.2, 7.9)	6.2 (5.7, 6.8)	4.2 (3.7, 4.7)
Urban non-teaching	21.3 (20.3, 22.4)	23.6 (22.4, 24.8)	20.5 (19.5, 21.6)	17.1 (15.9, 18.2)
Urban teaching	72.2 (71.0, 73.4)	69.4 (68.0, 70.8)	73.3 (72.0, 74.5)	78.8 (77.4, 80.1)

Note: Values are % (95% CI) unless otherwise noted.

^aTRC sites include oral cavity and pharynx; esophagus; stomach; colon and rectum; liver; pancreas; larynx; lung, bronchus, and trachea; uterine cervix; urinary bladder; kidney and renal pelvis; and acute myeloid leukemia.

^bWeighted averages may not add up to total.

ED, emergency department; NIS, National Inpatient Sample; No., number; TRC, tobacco-related cancer.

Table 2

Average Annual Cost and Length of Hospital Stays for TRCs, NIS 2014

Hospitalizations	<i>n</i>	Length of stay, days (95% CI)	Cost per stay, \$ (95% CI)	Cost per day, \$ (95% CI)	Total cost, \$ (95% CI)
TRC hospitalizations	461,295	6.8 (6.7, 6.9)	17,677 (17,194, 18,160)	2,604 (2,569, 2,638)	8.15 (7.93, 8.38)
Hospitalizations related to lung cancer	125,630	5.7 (5.7, 5.8)	14,632 (14,306, 14,957)	2,548 (2,532, 2,564)	1.84 (1.80, 1.88)
TRC hospitalizations excluding lung cancer	335,665	7.2 (7.1, 7.3)	18,804 (18,230, 19,379)	2,622 (2,584, 2,660)	6.31 (6.12, 6.50)
Cancer hospitalizations not related to tobacco	573,550	5.7 (5.6, 5.8)	17,617 (16,978, 18,256)	3,068 (3,014, 3,121)	10.10 (9.74, 10.47)

Note: Weighted averages may not add up to total. Adjusted for age, sex, race/ethnicity, insurance status, number of chronic diseases, and admission through the emergency department. All costs are in 2014 dollars.

NIS, National Inpatient Sample; TRC, tobacco-related cancer.