

Economic Burden of Illness of Malignant Lung Neuroendocrine Tumors (NET)

Beilei Cai, PhD¹; Maureen P. Neary, PhD¹; Michael S. Broder, MD, MSHS²; Eunice Chang, PhD²; Elya Papoyan, MPH²; Al B. Benson III, MD³

¹Novartis Pharmaceuticals Corporation, East Hanover, NJ 07936; ²Partnership for Health Analytic Research, LLC, Beverly Hills, CA 90212; ³Northwestern University, Chicago, IL

BACKGROUND

- Neuroendocrine tumors (NET) comprise a broad set of tumors that are rare and slow-growing.
- Lung NETs, including well- and poorly-differentiated, comprise 20-30% of NETs.
- U.S. incidence of all NET has increased from 10.9 cases per million person-years (PMPY) in 1973 to 52.5 PMPY in 2004.¹
- With the incidence of lung NET tumors increasing, it is important to understand the burden of the disease.
- The objective of this study is to describe the economic burden of malignant lung NET patients using commercial claims data from 2014.

METHODS

- Retrospective, cross-sectional study using 2014 data from 2 U.S. commercial claims databases: Truven Health Analytics MarketScan and IMS PharMetrics.

Inclusion Criteria:

- Age ≥ 18, AND
- ≥ 1 inpatient or ≥ 2 outpatient claims for lung NET in 2014, AND
- ≥ 1 claim (inpatient or outpatient) with malignant lung NET or secondary (2°) malignant neoplasm of liver (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] 197.7) in 2014, AND
- continuously enrolled in 2014.

Study Measures:

- Demographics and comorbidities
 - Charlson comorbidity index, which includes a total of 22 conditions and can predict 10-year mortality risks, was used to evaluate the patient's prognosis.²
 - Number of chronic conditions based on a validated index which captures chronic conditions that last at least one year, and place limitations on self-care or require ongoing medical care.³
- Presence of carcinoid syndrome (ICD-9-CM 259.2) in any claim.
- Systemic therapies: somatostatin analogues, targeted therapies, cytotoxic chemotherapies, and interferon.
- Lung resection.
- Liver directed therapies: liver surgery excluding transplant, liver transplant, liver lesion ablation (includes radio, cryo, microwave and thermal; laparoscopic, open and percutaneous), embolization (includes bland, radio and chemo) and radiation therapy (includes typical source plus LINAC).
- All-cause and lung NET-specific utilization (claims with primary diagnosis of lung NET).
- All-cause and lung NET-specific healthcare, pharmacy, inpatient, ED, and outpatient costs.
- Descriptive statistics, including mean, median, standard deviation, and percentage are reported for all study measures.
- Analyses were repeated for 2009-2013. Results were similar and are not presented.

RESULTS

Demographic and Clinical Characteristics

- 736 lung NET patients were identified (Table 1).
 - Mean (SD) age was 54.1 (8.1).
 - 65.4% were female.
 - 15.1% had a claim with secondary malignant neoplasm of the liver.
 - 13.9% had a claim with carcinoid syndrome.
- 13.0% (n=96) of patients had liver directed therapy (e.g., surgery, embolization) and 15.2% (n=112) systemic therapy (Table 2).
 - Among the 112 patients who received systemic therapy, 82.1% (n=92) used somatostatin analogues, 20.5% (n=23) cytotoxic chemotherapy, and 17.9% (n=20) targeted therapy.

Table 2. Lung NET Treatment

All Patients, No.	736
Systemic therapies, no. (%)	112 (15.2)
Somatostatin analogues	92 (12.5)
Octreotide LAR	87 (11.8)
Octreotide SA	23 (3.1)
Lanreotide ^a	1 (0.1)
Targeted therapies	20 (2.7)
Everolimus	17 (2.3)
Sunitinib	5 (0.7)
Cytotoxic Chemotherapies^a	23 (3.1)
Temozolomide	14 (1.9)
Capecitabine	9 (1.2)
Fluorouracil or 5-FU	5 (0.7)
Doxorubicin	4 (0.5)
Streptozocin	1 (0.1)
Interferon	1 (0.1)
Non-systemic therapies, no. (%)	332 (45.1)
Lung resection	240 (32.6)
Liver directed therapies^b	96 (13.0)
Radiation therapy	83 (11.3)
Embolization	11 (1.5)
Liver lesion ablation	4 (0.5)
Liver surgery	3 (0.4)

^aDacarbazine, liposomal doxorubicin, oxaliplatin and thalidomide were included in cytotoxic chemotherapy; however, the search did not yield any results for these patients; ^bLiver transplants were included in liver directed therapies; however, the search did not yield any results for these patients.

Table 1. Demographics and Comorbidities

All Patients, No.	736
Age (years), mean (SD)	54.1 (8.1)
Female, no. (%)	481 (65.4)
Region, no. (%)	
South	292 (39.7)
Midwest	196 (26.6)
Northeast	183 (24.9)
West	65 (8.8)
Charlson comorbidity index, mean (SD)	6.0 (4.1)
No. of chronic conditions, mean (SD)	6.1 (2.3)
2° malignant neoplasm of liver, no. (%)	111 (15.1)
Carcinoid Syndrome, no. (%)	102 (13.9)

Healthcare Utilization and Costs (Table 3; Figure 1)

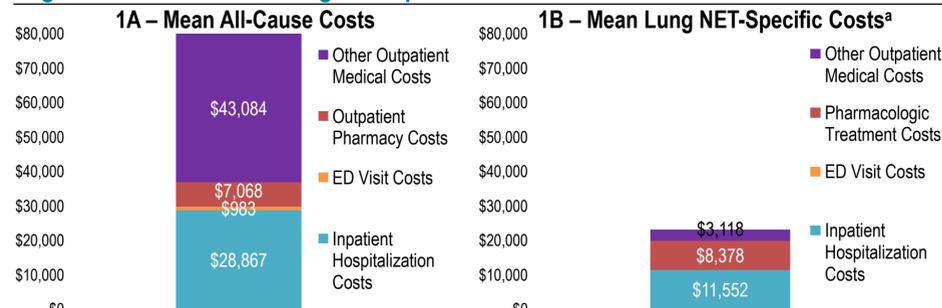
- Overall, patients had a mean (SD) 21.1 (17.4) office visits, 37.1% had ≥1 ED visit, and 58.4% ≥1 hospitalization.
- Mean (SD) length of stay (LOS) was 9.2 (11.5) days among hospitalized patients for any cause.
- Annual all-cause costs were \$80,002, comprising \$7,068 in pharmacy and \$72,934 in medical costs (\$43,084 outpatient, \$28,867 inpatient, \$983 ED).
- Lung NET-specific utilization and costs were a fraction of the overall, however, it should be taken into consideration that only claims with lung NET as the primary diagnosis code were considered lung NET-specific. ICD-9-CM codes for disease related complications were not included.
 - One percent of patients had lung NET-specific ED visits, and 30.2% experienced at least one lung NET-specific hospitalization.
 - Mean (SD) LOS was 5.1 (2.1) days for lung NET-specific hospitalizations.
 - Annual lung NET-specific costs were \$23,055 of which lung NET-specific pharmacologic treatments comprised 36.3%.

Table 3. Annual Healthcare Utilization and Costs

All Patients, No.	736
No. of office visits, mean (SD)	21.1 (17.4)
No. of ED visits, mean (SD)	0.84 (2.5)
0, no. (%)	463 (62.9)
1	152 (20.7)
2	59 (8.0)
3+	62 (8.4)
No. of inpatient hospitalizations, mean (SD)	0.96 (1.2)
0, no. (%)	306 (41.6)
1	273 (37.1)
2	94 (12.8)
3+	63 (8.6)
Length of stay (days), mean (SD)	9.2 (11.5)
No. of lung NET-specific office visits, mean (SD)	1.8 (4.2)
No. of lung NET-specific ED visits, mean (SD)	0.01 (0.1)
0, no. (%)	728 (98.9)
1+	8 (1.1)
No. of lung NET-specific inpatient hospitalizations, mean (SD)	0.32 (0.5)
0, no. (%)	514 (69.8)
1+	222 (30.2)
Length of stay (days), mean (SD)	5.1 (2.1)
All-cause costs, mean (SD)	\$80,002 (82,516)
Outpatient pharmacy costs ^a	\$7,068 (17,736)
Medical costs (excludes outpatient pharmacy)	\$72,934 (76,982)
Lung NET-specific^b costs, mean (SD)	\$23,055 (36,964)
Pharmacologic treatment costs ^c	\$8,378 (31,396)
Medical costs (excludes pharmacologic treatments)	\$14,677 (23,468)

^aPharmacy cost calculations only reflect outpatient pharmacy claims; ^bLung NET-specific costs were calculated by summing the claims with lung NET as the primary diagnosis; ^cPharmacologic treatment costs include all inpatient, outpatient and pharmacy claims that include one of the therapies specified in the methods section.

Figure 1: All-Cause and Lung NET-Specific Costs



^aLung NET specific costs reflect costs of claims with lung NET as the primary diagnosis code and do not include any claims with diagnosis codes for disease related complications; Pharmacy costs only reflect outpatient pharmacy claims while pharmacologic treatment costs include all inpatient, outpatient and pharmacy claims that include one of the therapies specified in the methods section; Lung NET-specific ED visit costs were \$7 on average (not labeled in Figure 1B).

CONCLUSIONS

- Mean annual cost for patients with malignant lung NET (>\$80,000/year) were double the national average of ~\$38,000 among all cancers in the first year.⁴
- More than half of the patients were admitted to the hospital, with mean stays of 9.2 days, leading to mean inpatient costs of almost \$30,000/year.
- Interventional treatments such as surgery and chemoembolization were common.
- One-third of patients received systemic therapy, most commonly with somatostatin analogues, and lung NET-specific pharmacology costs represented approximately 10% of the total.
- The development of more therapies is needed. Additional effective therapies may lead to better outcomes for patients and may mitigate healthcare resource and cost utilization.

LIMITATIONS

- Lung NET specific health care utilization and costs are likely to be significantly underestimated as they exclude hospitalizations with a primary diagnosis of disease related complications (e.g., pneumonia as the primary diagnosis).
- These results only reflect patients with commercial insurance and do not include those with Medicaid, Medicare, or uninsured individuals. Results may not be nationally representative.
- Costs were calculated based on patients with lung NET diagnosis code in year 2014, as it is possible patients were newly diagnosed during the year, the costs calculated here may be an underestimation.
- Lung NET patients were identified using ICD-9-CM codes; neither pathologic diagnosis nor stage could be confirmed in this administrative database.

REFERENCES

- Yao JC, Hassan M, Phan A, Dagohoy C, Leary C, Mares JE, Abdalla EK, Fleming JB, Vauthey JN, Rashid A, Evans DB. One hundred years after "carcinoid": epidemiology of and prognostic factors for neuroendocrine tumors in 35,825 cases in the United States. *Journal of Clinical Oncology*. 2008 Jun 20;26(18):3063-72.
- Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; 40: 373-383
- Chronic Condition Indicator (CCI) for ICD-9-CM. Rockville, MD: Agency for Health Care Policy and Research, 2009. Available from: URL: <http://www.hcup-us.ahrq.gov/toolssoftware/chronic/chronic.jsp>
- Mariotto AB, Yabroff KR, Shao Y, Feuer EJ, Brown ML. Projections of the cost of cancer care in the United States: 2010–2020. *Journal of the National Cancer Institute*. 2011 Jan 12;103(2):117-128.

