



## Introduction

### Background

- Bronchiolitis obliterans syndrome (BOS) is an obstructive airway disease of the lungs commonly associated with lung transplantation
- BOS is characterized by T-cell mediated inflammation and fibrosis of bronchiolar walls that reduce the diameter of the bronchioles and result in progressive and irreversible airflow obstruction, respiratory failure and death
- BOS is a well described complication of lung transplantation typically appears 1-2 years post transplantation and affects, 50% of recipients within 5 years of transplantation<sup>1,2</sup>
- Lung transplantation is estimated to cost over \$500,000, but little is known about the impact of BOS on healthcare resource use (HRU) and costs in lung transplant patients in the United States with Medicare coverage<sup>3</sup>
- There is currently no approved therapy for BOS

### Study Goal

- Quantify the economic burden of BOS in lung transplant patients in the United States with Medicare coverage

## Methods

### Data Source

- Medicare Limited Data Set, 100% sample, with enrollment, demographic and medical claims data for age-eligible ( $\geq 65y$ ) and disability eligible ( $< 65y$ ) Medicare beneficiaries

### Study Patient Identification

- Fee-for-service Medicare patients with inpatient admission for lung transplantation at least one year before BOS diagnosis
- BOS was identified using International Classification of Diseases (ICD) diagnosis codes for severe lung disease because there is no diagnosis code specific to BOS (Table 1)

Table 1. Clinical codes<sup>a</sup> used for BOS

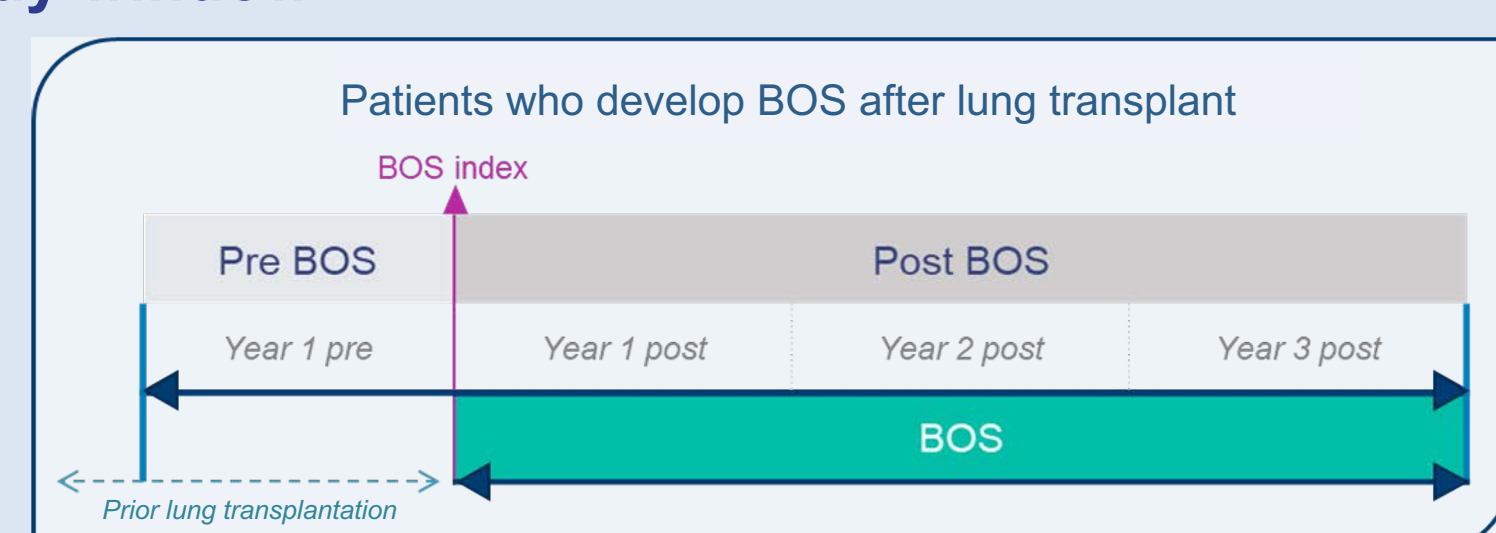
ICD version	Diagnosis codes for BOS
ICD-9	491.8, 491.9, 515, 516.34, 516.8 99684
ICD-10	J41.8, J42, J84.09, J84.115, J84.89

<sup>a</sup>International Classification of Disease (ICD) diagnosis codes

### Study Design

- Longitudinal retrospective analysis
- Study period was 1/1/2010 to 12/31/2017 (Figure 1)
- Outcomes were patient characteristics, costs paid by Medicare, and HRU in patients who survived at least 1 year following lung transplantation
  - Analyses repeated for patients surviving up to 3 years
  - HRU includes: inpatient admissions, emergency department visits, non emergency outpatient services, home health visits, and skilled nursing facility stays

Figure 1. Study window



## References

- Hadjiliadis D, Davis RD, Palmer SM. Is transplant operation important in determining posttransplant risk of bronchiolitis obliterans syndrome in lung transplant recipients? *Chest*. 2002 Oct;122(4):1168-1175. DOI: 10.1378/chest.122.4.1168.
- Christie JD, et al. The registry of the International Society for Heart and Lung Transplantation: 29th Adult lung and heart-lung transplant report—2012. *J Hear Lung Transplant*. 2012 Oct;31(10):1073-86.
- Bentley TS, et al. 2017 US organ and tissue transplant cost estimates and discussion. 2017.

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## Results

### Study Patients

- There were 565 patients with an initial diagnosis used for BOS at least 1 year following lung transplant; all were observable for 1+ years after BOS diagnosis
- Mean age was  $63.9 \pm 10.4$  years; 39% were female
- Among the 565 patients, 180 (32%) were  $< 65y$  and would have received Medicare coverage because of disability; very few ( $N=31/565$ ; 5%) were age 75 or older (Figure 2)
- The average Charlson Comorbidity Index score was  $1.9 \pm 1.7$
- Slightly more than half of all patients ( $306/565$ ; 54%) were observable at least 3 years after BOS diagnosis, reflecting high mortality rates

Figure 2. Distribution of patient age (n=565)



### Healthcare Resource Use

- Patients were hospitalized  $1.5 \pm 2.2$  times, on average, in the first year after BOS diagnosis, with a mean length of stay of  $26.0 \pm 35.1$  days
- Hospitalization rates declined in years 2 and 3
- Outpatient hospital encounters, ED and home health visits were also highest in year 1
- Rates of Intensive Care Unit (ICU) stays per inpatient admission were similar across all years. (Table 2)

Table 2. Health Care Resource Use, (annual, per patient)

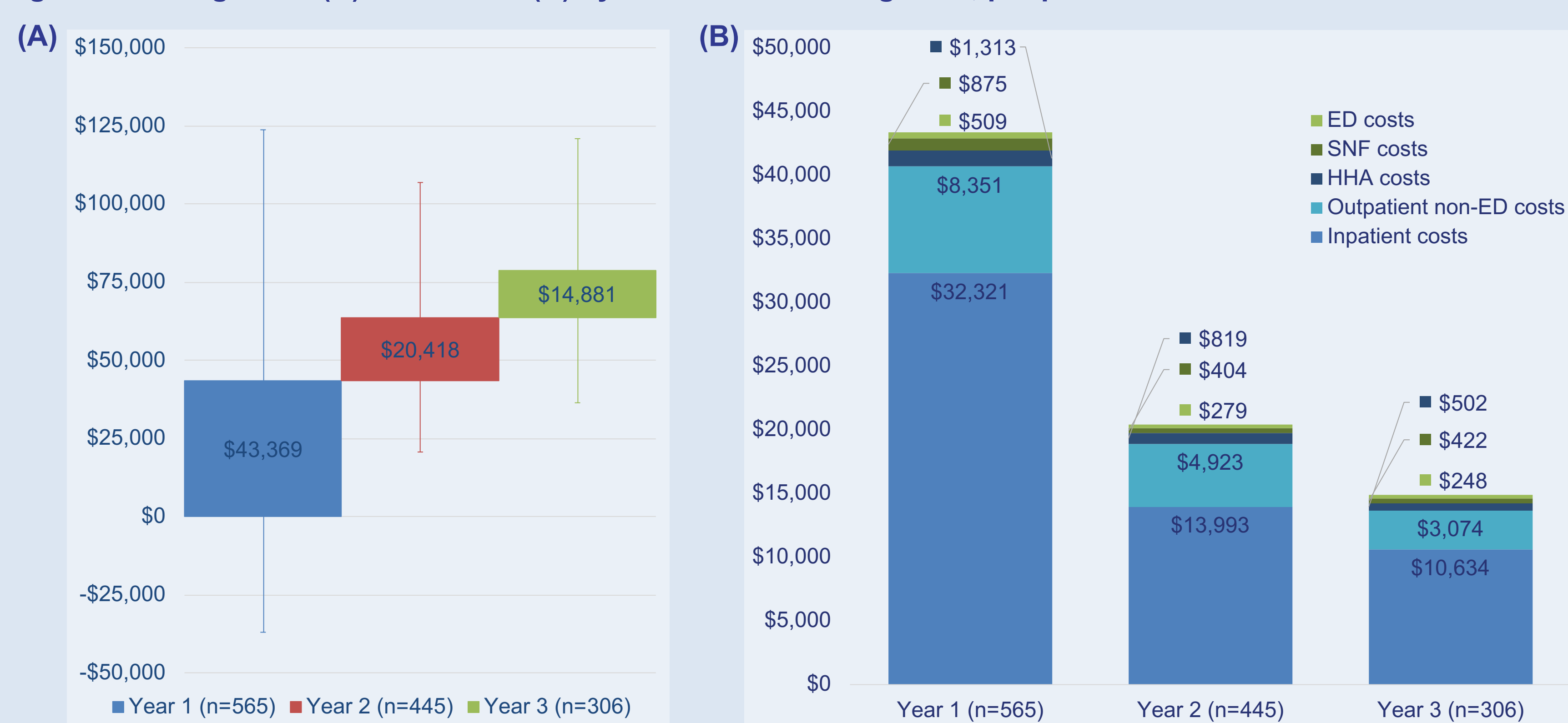
	Year 1 (n=565)	Year 2 (n=445)	Year 3 (n=306)
	Mean SD	Mean SD	Mean SD
Inpatient admissions	1.5±2.2	0.8±1.6	0.6±1.5
LOS, per admission	26.0±35.1	18.0±20.5	21.4±26.8
ICU stay, per admission	1.0±1.3	1.0±1.2	1.0±1.2
ICU LOS, per admission	17.7±22.8	12.9±14.7	13.4±18.9
Outpatient non-ED visits	17.0±15.2	11.6±14.4	7.6±12.1
ED visits	0.7±1.7	0.5±1.7	0.4±1.5
HHA visits	0.4±0.9	0.2±0.6	0.1±0.5
SNF stays	0.1±0.4	0.0±0.3	0.0±0.3
SNF LOS, per SNF admission	29.5±57.6	0.0±0.0	0.0±0.0

LOS = Length of stay; ED = Emergency department; HHA = Home health aid; SNF = Skilled nursing facility

### Costs

- In the year following BOS diagnosis, mean per-patient costs were  $\$43,369 \pm 80,391$  (Figure 3.A)
- Among those who survived, mean per patient costs were  $\$20,418 \pm 43,120$  (n=445) in year 2 and  $\$14,881 \pm 42,251$  (n=306) in year 3
- Inpatient admission costs averaged  $\$32,321 \pm 73,865$  in the first year post-diagnosis, decreasing to  $\$13,993 \pm 35,878$  (year 2) and  $\$10,634 \pm 35,601$  (year 3) (Figure 3.B)

Figure 3. Average cost (A) overall and (B) by HRU after BOS diagnosis, per patient



## Conclusion

Among Medicare patients with an ICD diagnosis code that is used for BOS following lung transplantation, more than 30% were age  $< 65$  and disability-eligible for Medicare coverage. Across all patients, medical costs were highest in the first year following BOS diagnosis, reflecting lengthy hospitalizations and ICU stays. Hospitalizations and expenditures were lower in subsequent years, and may reflect survival of healthier patients. Because there is no specific ICD diagnosis for BOS, these results may reflect the burden of severe lung disease, including BOS, following lung transplantation. These estimates are in addition to the costs of lung transplantation and do not reflect indirect costs of BOS, which would add to the overall burden of this disease.