



Facility volume and postoperative outcomes for malignant pleural mesothelioma: A National Cancer Data Base analysis



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ABSTRACT

Purpose: This study of a large, contemporary national database evaluated postoperative outcomes and overall survival (OS) for malignant pleural mesothelioma (MPM) by facility volume.

Methods: The National Cancer Database was queried for newly-diagnosed non-metastatic MPM undergoing definitive surgery (extrapleural pneumonectomy (EPP) or pleurectomy/decortication (P/D)). Patients were dichotomized into those receiving therapy at a high-volume facility (HVF), defined a priori at the 90th percentile of case volume, with all others categorized as lower-volume facilities (LVFs). Statistics included multivariable logistic regression, Kaplan-Meier analysis, propensity-matching, and multivariable Cox proportional hazards modeling. Sensitivity analysis varied the dichotomized HVF-LVF cutoff and evaluated effects on postoperative outcomes and OS.

Results: Of 1307 patients, 621 (48%) were treated at LVFs and 686 (52%) at HVFs. HVFs were more often in the Middle/South Atlantic regions, and less likely in New England, South, and Midwest. Notably, 75% of procedures at HVFs were P/Ds, versus 84% at LVFs ($p < 0.001$). Patients treated at HVFs experienced shorter length of postoperative hospitalization ($p = 0.035$), lower 30-day readmission rates (4.6% vs. 6.1%, $p = 0.021$), and lower 90-day mortality rates (10.0% vs. 14.6%, $p = 0.029$). Median OS for respective groups were 18 versus 15 months ($p = 0.010$), which were not significant following propensity-matching ($p = 0.540$). On multivariable analysis, facility volume did not independently predict for OS. Sensitivity analyses confirmed the postoperative outcomes and OS findings.

Conclusions: This is the largest investigation to date assessing facility volume and outcomes following surgery for MPM. Although no independent effects on OS were observed, postoperative outcomes were more favorable at HVFs. These findings have implications for postoperative management, patient counseling, referring providers, and cost-effectiveness.

1. Introduction

Although malignant pleural mesothelioma (MPM) is relatively uncommon, it is a highly aggressive neoplasm associated with a very poor prognosis. Gross macroscopic resection is perhaps the most important aspect of management along with chemotherapy, provided technical and medical candidacy for surgery [1]. Definitive surgery is most commonly performed using two approaches: extrapleural pneumonectomy (EPP) or extended pleurectomy/decortication (P/D).

Both of these procedures are technically challenging and can cause

serious postoperative complications, irreversible morbidities, and mortality. Postoperative complications occur in 13–38% of patients, with postoperative 30-day mortality occurring in 3–8% [2–5]; owing to publication bias, these rates could very well underestimate the true incidences. In the randomized MARS trial, postoperative complications in the surgery (EPP) arm occurred in 69% of patients, with a mortality rates of 13% (intention to treat) to 16% (any patient in whom surgery was attempted) [6].

Owing to these and other reasons, it may be hypothesized that receiving surgery at a high-volume facility (HVF) may be advantageous

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over lower-volume facilities (LVFs) in terms of postoperative complications and possibly even survival. Improvements in postoperative outcomes and/or survival at HVFs have been shown for numerous surgical procedures, including sarcoma excision [7], pancreaticoduodenectomy [8], breast reconstruction [9], low anterior/abdominoperineal resection [10], lobectomy/pneumonectomy [11], esophagectomy [12], and colectomy [13]. To date, such an analysis has not been performed for MPM. Such a study could have important consequences considering the technical expertise required for a major surgical procedure and the particularly high perioperative mortality rate associated with MPM surgery.

Investigating the large, contemporary National Cancer Data Base (NCDB), this study sought to address the influence of facility volume on differences in the four postoperative outcomes given by the NCDB (length of hospital stay, 30-day readmission, 30-day mortality, and 90-day mortality), and secondarily, overall survival (OS).

2. Materials and methods

The NCDB is a joint project of the Commission on Cancer (CoC) of the American College of Surgeons and the American Cancer Society that consists of information regarding tumor characteristics, patient demographics, and patient survival for approximately 70% of the United States population [14–19]. The NCDB contains information not included in the Surveillance, Epidemiology, and End Results (SEER) database, including details pertaining to systemic therapy usage. The data used in this study were derived from a de-identified NCDB file. The American College of Surgeons and the CoC have not verified and are neither responsible for the analytic or statistical methodology employed nor the conclusions of the authors drawn from these data. As all patient information in the NCDB database is de-identified, this study was exempt from institutional review board evaluation.

The NCDB Participant User File corresponding to mesothelioma (2004–2012) was utilized for this study. Inclusion criteria for this investigation were patients with newly-diagnosed MPM who received definitive surgery (EPP or P/D). Definitive surgery was defined by a board-certified thoracic surgeon with notable mesothelioma surgical experience (J.S.F.) as surgery of the primary intrathoracic site with codes 20–23, 30, 33, 40, 45–48, and 50 for P/D and codes 55–56, 60, 66, and 70 for EPP [20]. Patients with all other types of surgery (including those with ambiguous surgical codes/labels) were eliminated. Patients without proper TNM staging were also removed, as were patients designated in the NCDB as metastatic (stage M1) or receiving palliative care. In accordance with the variables in NCDB files, information collected on each patient broadly included demographic, clinical, and treatment data.

The definition of a HVF was similar to other established work [21,22]. Briefly, facility volume was dichotomized into HVF or LVF based on a threshold corresponding to the 90th percentile of patient numbers treated per facility over the time period. Similar to previously published work, this cutoff was utilized in order to evaluate a roughly 1:1 ratio of patients [21,22]. However, in order to evaluate whether this a priori definition was significant at other cutoffs, sensitivity analysis was performed post hoc to evaluate whether altering the HVF definition affected the association with postoperative outcomes and OS. This was performed by repeating the multivariable analyses for each given threshold of HVF definition.

Statistical analysis was performed with R [23]. Tests were two-sided, with a threshold of $p < 0.05$ for statistical significance. First, clinical characteristics between HVF and LVF groups were tabulated. Multivariable logistic regression analysis was performed to ascertain factors independently associated with treatment at a HVF. The chi-squared or Fisher’s exact tests evaluated differences in 30-day readmission, 30-day mortality, and 90-day mortality. The Mann-Whitney *U* test assessed differences between groups in length of postoperative hospitalization. Kaplan-Meier curves were calculated to evaluate OS,

Table 1
Demographic characteristics of the overall cohort and factors associated with receiving treatment at a high volume facility in the final multivariable logistic regression model.

Parameter	LVF (N = 621)	HVF (N = 686)	Final multivariable model	
			OR (95% CI)	p-value
Age (years)				
Median (IQR)	69 (61–75)	67 (61–74)		
Gender				
Male	489 (79%)	541 (79%)		
Female	132 (21%)	145 (21%)		
Race				
White	585 (94%)	644 (94%)		
Black	24 (4%)	19 (3%)		
Other	3 (0%)	16 (2%)		
Unknown	9 (1%)	7 (1%)		
Charlson Deyo score				
0	431 (69%)	534 (78%)	REF	REF
1	148 (24%)	129 (19%)	0.777 (0.568–1.061)	0.112
≥ 2	42 (7%)	23 (3%)	0.487 (0.260–0.896)	0.022
Insurance type				
Private	225 (36%)	272 (40%)		
Medicare	355 (57%)	380 (55%)		
Medicaid	14 (2%)	10 (1%)		
Other government	6 (1%)	8 (1%)		
Uninsured	11 (2%)	4 (1%)		
Unknown	10 (2%)	12 (1%)		
Income (US dollars/year)				
< \$30,000	87 (14%)	65 (9%)		
\$30,000–\$34,999	134 (22%)	105 (15%)		
\$35,000–\$45,999	164 (26%)	151 (22%)		
≥ \$46,000	219 (35%)	343 (50%)		
Unknown	17 (3%)	22 (3%)		
Percentage of adults in zip code without high school diploma				
≥ 21%	83 (13%)	54 (8%)	REF	REF
13–20.9%	142 (23%)	143 (21%)	1.745 (1.083–2.825)	0.023
7–12.9%	227 (37%)	227 (33%)	1.496 (0.947–2.374)	0.085
< 7%	152 (24%)	240 (35%)	2.708 (1.685–4.376)	< 0.001
Unknown	17 (3%)	22 (3%)	–	–
Patient residence				
Urban	94 (15%)	62 (9%)		
Metro	490 (79%)	584 (85%)		
Rural	11 (2%)	8 (1%)		
Unknown	26 (4%)	32 (5%)		
Facility location				
East North Central	117 (19%)	128 (19%)	REF	REF
East South Central	40 (6%)	11 (2%)	0.361 (0.162–0.757)	0.009
Middle Atlantic	84 (14%)	232 (34%)	2.536 (1.729–3.737)	< 0.001
Mountain	24 (4%)	17 (2%)	0.510 (0.239–1.068)	0.077
New England	62 (10%)	10 (1%)	0.131 (0.059–0.266)	< 0.001
Pacific	78 (13%)	86 (13%)	1.040 (0.672–1.612)	0.860
South Atlantic	118 (19%)	162 (24%)	1.543 (1.055–2.263)	0.026
West North Central	56 (9%)	16 (2%)	0.245 (0.125–0.460)	< 0.001
West South Central	35 (6%)	15 (2%)	0.579 (0.278–1.168)	0.134
Unknown	7 (1%)	9 (1%)	–	–
Facility type				
Academic	166 (27%)	579 (84%)		
Community	447 (72%)	98 (14%)		

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