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Recent Evolution in the Management of Lymph Node Metastases in Melanoma

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ABSTRACT

Introduction. Based upon two large randomized international clinical trials (German Dermatologic Cooperative Oncology Group (DeCOG-SLT) and Multicenter Selective Lymphadenectomy Trial II (MSLT-II)) published in 2016 and 2017, respectively, active surveillance has been demonstrated to have equivalent survival outcomes to completion lymphadenectomy (CLND) for a subset of patients who have microscopic lymph node disease. In this study, the changes in national practice patterns were examined regarding the utilization of CLND after positive sentinel lymph node biopsy (SLNB).

Methods. Using the National Cancer Database, CLND utilization was examined in SLN-positive patients diagnosed with melanoma between 2012 and 2016. A hierarchal logistical regression model with hospital-level random intercepts was constructed to examine the factors associated with SLNB followed by observation vs. SLNB with CLND.

Results. Of the 148,982 patients identified, 43% (n = 63,358) underwent SLNB and 10.3% (n = 6,551) had a SLNB with microscopic disease. CLND was performed for 57% (n = 2,817) of these patients. Patients were more likely to undergo CLND if they were ≤ 55 years of age (OR, 1.454; $p \leq 0.0001$), ages 56 - 65 (OR, 1.127; $p = 0.026$), Charlson Deyo Score = 0 (OR, 2.088; $p = 0.043$), or were diagnosed with melanoma in 2012 (OR, 2.259, $p \leq 0.0001$).

Conclusions. The utilization of CLND among patients with microscopic nodal melanoma was significantly lower in 2016 compared to 2012. Younger age, lack of comorbidities, and primary tumor location on the trunk or head/neck were associated with higher utilization of CLND. ***Kans J Med 2021;14:64-72***

INTRODUCTION

Melanoma is a malignant tumor typically of the skin that arises from the proliferation of melanocytes.[1] The incidence of melanoma in the United States has increased from 10.51 cases per 100,000 persons in 1980 to 25.83 cases per 100,000 persons in 2016,[2] and is predicted to rise in the United States and worldwide for the foreseeable future.[1,3,4] In 2019, there were approximately 96,000 new cases and an estimated 7,300 deaths due to melanoma in the United States.[5]

Melanoma has the propensity to spread via the lymphatic system, and the status of the sentinel lymph node (SLN) is amongst the most important prognostic factors for patients.[6,7] Early regional lymph node evaluation with sentinel lymph node biopsy (SLNB) has been standard of care since the early 1990s, with putative benefits including decreased lymph node basin relapse and improved disease-free survival with less morbidity than full lymphadenectomy.[8-10] Following a positive SLNB, completion lymph node dissection (CLND) had been the standard recommendation in an effort to remove other lymph nodes with metastases and to control disease.[7,10,11]

CLND can be associated with high morbidity, with the occurrence of complications ranging from 11 - 73%.[9,12-15] Consequently, there have been several studies that have sought to determine if it is safe to avoid CLND for patients following a positive SLNB, including two large randomized control trials (RCTs): the German Dermatologic Cooperative Oncology Group (DeCOG-SLT) and the Multicenter Selective Lymphadenectomy Trial II (MSLT-II).[9,16] The results of these two RCTs comparing CLND with observation demonstrated no difference in overall survival at three years, suggesting that CLND did not provide additional benefit among patients diagnosed with nodal metastasis.[9,17] Both trials were limited by relatively short follow-up, and the favorable histologic characteristics of the patients enrolled.

A study evaluating the usage of CLND among patients diagnosed with melanoma from 2004 to 2005 reported that 50% of patients with a positive SLNB underwent a CLND,[18] suggesting that clinicians were foregoing CLND for some patients. However, few studies have examined the practice patterns and trends in the performance of CLND among patients after a positive SLNB, with respect to frequency and patient factors. Our study objectives were to: 1) examine the national trends and practice patterns regarding the utilization of CLND among patients after a positive SLNB, and 2) identify which patient and tumor characteristics were associated with undergoing a CLND and those associated with observation after a positive SLNB.

METHODS

Participants. A cross-sectional study was conducted using the National Cancer Database (NCDB) to include patients 18 years or older who were diagnosed with melanoma between 2012 and 2016, as classified by the World Health Organization's International Classification of Disease for Oncology (ICD-O), 3rd edition.[19] Patients with metastatic disease, clinically positive lymph nodes, and carcinoma in situ were excluded.

Instrument. This study was considered "Not Human Subjects" by the Human Subjects Committee at the University of Kansas School of Medicine-Wichita. The NCDB, established in 1988, is a joint program of the American College of Surgeons Commission on Cancer (CoC) and the American Cancer Society (ACS) that collects data on approximately 70% of all cancer diagnoses annually.[20] Cases were abstracted from the 2016 NCDB Adult Participant Use Data File, the most recent year of available data. The NCDB Participant Use Data File contains de-identified, Health Insurance Portability, and Accountability Act (HIPPA)-compliant data and are available to investigators affiliated with CoC-accredited programs.

Clinically relevant factors included gender, age (≤ 55 years, 56 - 65 years, 66 - 75 years, > 75 years), race (white, non-white), insurance status (private, not insured, Medicaid, Medicare, other government insurance), quartile of median household income (< $38,000, $38,000 - $47,999, $48,000 - $62,999, and ≥ 63,000), the number of comorbid conditions based on the Charlson-Deyo Score (0, 1, 2, and ≥ 3), year of melanoma diagnosis (2012 - 2016), Breslow thickness (< 1.00 mm, 1.01 - 2.00 mm, 2.01 - 4.00 mm, ≥ 4.01 mm), the presence or absence of tumor ulceration, and the primary location of the tumor (head, trunk, upper extremity, and lower extremity).

Surgical Procedure and Nodal Evaluation. The Facility Oncology Registry Data Standards (FORDS) were used to define regional lymph node evaluation and the surgical procedure(s) performed.[21] Before January 1, 2012, the variable, "Scope of Regional LN Surgery", had been used. However, the coding instructions for this variable led to the inability to distinguish SLNB alone or SLNB + CLND, leading to concerns of the under-reporting of procedures performed. A joint committee comprised of the Commission on Cancer (CoC), National Cancer Institute's Surveillance Epidemiology and End Results (SEER), and North American Association of Central Cancer Registries (NAACCR) created a new variable, "Scope of Regional LN Surgery 2012",[22] that created the distinction between type of surgeries performed. "Scope of Regional LN Surgery 2012", which was used in the current study, was coded as SLNB alone or SLNB with CLND. Cases were abstracted by Certified Tumor Registrants using NAACCR-approved software.[21] Breslow thickness, primary site, and presence or absence of ulceration were evaluated using the Collaborative Stage Data Collection System.[21]

Statistical Analysis. Data were analyzed using SAS version 9.4 (SAS Int. Inc., Carry, NC). Frequencies and percentages were reported for all categorical data. A hierarchal logistic regression model with hospital-level random intercepts that accounted for the clustering of patients within hospitals was constructed to examine the factors associated with SLNB followed by observation vs. SLNB with CLND. Maximum Likelihood Estimation Based on Adaptive Gauss-Hermite quadrature rule was used for model parameter estimates and Hannan-Quinn information criterion (HQIC) was conducted to decide the model that better fit the outcome variables. Odds ratios were generated with 95% confidence intervals (CI). All statistical tests at $p \leq 0.05$ were considered significant.

RESULTS

A total of 265,127 patients were diagnosed with melanoma between January 1, 2012, and December 31, 2016. After excluding patients with distant metastatic disease, clinically positive lymph nodes, and carcinoma in situ or unknown American Joint Committee on Cancer (AJCC) staging, the final cohort contained 148,982 patients from 1,343 CoC-accredited facilities.

Of these patients, 42.5% (n = 63,358) underwent a SLNB (Table 1). Among patients who underwent a SLNB, 10.3% (n = 6,551) also had at least one lymph node with metastatic disease. Among those with a positive SLNB, 60% (n = 3,928) were male, and their mean age was 59 (SD = 15) years. Fifty-four percent (n = 3,517) of those with a positive SLNB were privately insured, 37% (n = 2,395) had Medicare, and 3% percent (n = 185) were uninsured. For 37% (n = 2,448) of patients, the trunk was the location of the primary site, making it the most common location in those with a positive SLNB. The head region comprised 14% (n = 949) of primary site cases.

Forty-three percent (n = 2,817) of patients with a positive SLNB had no further surgery, whereas 57% (n = 3,737) of patients with a positive SLNB underwent CLND. Among those who underwent CLND, 61% (n = 2,265) were male, and their mean age was 56 (SD = 15) years. Among those who underwent observation after positive SLNB, 59% (n = 1,663) were male, and their mean age was 62 (SD = 16) years. Fifty-nine percent (n = 2,186) of patients who underwent CLND were privately insured, whereas 48% (n = 1,331) of those who underwent observation after a positive SLNB were privately insured. Twenty-six percent (n = 966) of patients who underwent CLND had a Breslow thickness of ≥ 4.01 mm, whereas 31% (n = 875) of patients who underwent observation after positive SLNB had a Breslow thickness of 2.01 - 4.00 mm. In the unadjusted analysis, patient sex, age, insurance status, median household income, education, year of diagnosis, Breslow thickness, ulceration, and location were significantly different between individuals forgoing CLND after a positive SLNB and patients receiving a CLND after a positive SLNB (all p values < 0.05). Additional patient and tumor characteristics are detailed in Tables 1 and 2.

Use of Completion Lymph Node Dissection. Of the 148,982 patients identified, 42.5% underwent a SLNB (63,358), and 43% (n = 6,551) of those had a metastatic lymph node on final pathology (Figure 1). Overall, CLND was performed in 57% of cases (n = 3,734), but this frequency decreased over time. In 2012, 63% (n = 716) of patients underwent CLND after positive SLNB, decreasing to 48% (n = 719; $p \leq 0.0001$) of patients undergoing CLND after positive SLNB in 2016.

Logistic regression analysis was employed to assess the impact of several predictor variables on the likelihood that a patient would or would not undergo CLND after a positive SLNB (Table 3). Patients were significantly more likely to undergo CLND if they were younger than or equal to 55 years of age (OR =1.454; $p \leq 0.0001$), between the ages of 56 - 65 (OR = 1.127; p = 0.026) or had a Charlson-Deyo Score of 0 (OR = 2.088; p = 0.043). Regarding location, patients were significantly more likely to undergo CLND if the primary tumor was located in the head region (OR =1.238; p = 0.0002) or on the trunk region (OR =1.71; p = 0.0002). Patients were more likely to undergo CLND if they were diagnosed with melanoma in 2012 (OR =1.172; $p \leq 0.0001$). Patients were more likely to undergo CLND if they had private insurance (OR = 1.172; p =0.026). There was no statistical difference between those individuals who had Medicaid and Medicare.

Table 1. Characteristics of 63,358 patients with melanoma who underwent SLNB.

	All Patients Receiving a SLNB[a] (n = 63,358) n[b],%	All Patients Receiving a SLNB with a Metastatic Lymph Node on SLNB (n = 6,551) n[b],%	Observation After Positive SLNB (no CLND) (n = 2,817) n[b],%	CLND After Positive SLNB (n = 3,734) n[b],%	p value*
Gender					
Male	36,870 (58.2%)	3,928 (60.0%)	1,663 (59.0%)	2,265 (60.7%)	<0.001
Female	26,488 (41.2%)	2,623 (40.0%)	1,154 (41.0%)	1,469 (39.3%)	<0.001
Age					
Median, y (IQR)	60.6	58.7	61.6	56.4	<0.001
<55 y	21,798 (34.4%)	2,625 (40.1%)	940 (33.4%)	1,685 (45.1%)	
56 - 65 y	15,837 (23.3%)	1,558 (23.8%)	641 (22.7%)	917 (24.6%)	
66 - 75 y	14,763 (23.3%)	1,349 (20.6%)	616 (22.0%)	733 (19.6%)	
>75 y	10,960 (17.3%)	1,019 (15.5%)	620 (22.0%)	399 (10.7%)	
Race					0.289
White	62,115 (98.7%)	6,387 (98.0%)	2,746 (98.0%)	3,641 (98.0%)	
Non-White	801 (1.3%)	130 (2.0%)	56 (2.0%)	74 (2.0%)	
Insurance Status					<0.001
Not-insured	1,281 (2.0%)	185 (2.8%)	67 (2.4%)	118 (3.2%)	
Private	33,842 (54.0%)	3,517 (54.2%)	1,331 (47.7%)	2,186 (59.1%)	
Medicaid	1,903 (3.0%)	312 (4.8%)	121 (4.3%)	191 (5.2%)	
Medicare	24,906 (39.7%)	2,395 (36.9%)	1,235 (44.3%)	1,160 (31.4%	
Other Government	807 (1.3%)	77 (1.2%)	36 (1.3%)	41 (1.1%)	
Median Household Income					
>$63,000	25,830 (40.1%)	2,374 (36.3%)	1,067 (38.0%)	1,307 (35.0%)	<0.001
$48,000 - $62,000	17,992 (28.5%)	1,963 (30.0%)	814 (28.9%)	1,149 (30.8%)	<0.001
$38,000 - $47,999	12,940 (20.5%)	1,456 (22.2%)	600 (21.3%)	856 (23.0%)	<0.001
<$38,000	6,488 (10.3%)	750 (11.5%)	333 (11.8%)	417 (11.2%)	0.001
Education (% without a HS diploma)					
<7%	21,204 (33.5%)	1,994 (30.5%)	876 (31.1%)	1,118 (30.0%)	<0.001
7% - 12.9%	22,764 (33.4%)	2,433 (37.2%)	1,015 (36.1%)	1,418 (38.0%)	<0.001
13% - 20.9%	13,457 (21.3%)	1,417 (22.5%)	614 (21.2%)	857 (23.0%)	<0.001
>21%	5,858 (9.3%)	647 (4.9%)	310 (11.0%)	337 (9.0%)	0.004
Charlson-Deyo Score					
0	53,136 (83.9%)	5,362 (81.8%)	2,250 (79.9%)	3,112 (83.3%)	<0.001
1	8,027 (12.7%)	913 (13.9%)	415 (14.7%)	498 (13.3%)	0.001
2	1,573 (2.5%)	185 (2.8%)	102 (3.6%)	83 (2.2%)	0.112
>3	622 (0.9%)	91 (1.4%)	50 (1.8%)	41 (1.1%)	0.239
Year of Diagnosis					
2012	11,316 (17.7%)	1,133 (17.3%)	417 (14.8%)%	716 (19.2%)	0.001
2013	12,048 (19.0%)	1,224 (18.7%)	498 (17.7%)	726 (19.4%)	<0.001
2014	12,902 (20.4%)	1,330 (20.3%)	545 (19.3%)	785 (21.0%)	<0.001
2015	13,437 (21.2%)	1,363 (20.8%)	575 (20.4%)	788 (21.1%)	<0.001
2016	13,655 (21.5%)	1,501 (22.9%)	782 (27.8%)	719 (19.3%)	<0.001

Table 1. Characteristics of 63,358 patients with melanoma who underwent SLNB. *continued.*

	All Patients Receiving a SLNB[a] (n = 63,358) n[b],%	All Patients Receiving a SLNB with a Metastatic Lymph Node on SLNB (n = 6,551) n[b],%	Observation After Positive SLNB (no CLND) (n = 2,817) n[b],%	CLND After Positive SLNB (n = 3,734) n[b],%	p value*
Tumor Characteristic					
Breslow Thickness					<0.001
Median, mm (IQR)	2.02	3.12	3.05	3.17	
<1.00mm	21,621 (34.4%)	850 (13.1%)	382 (13.7%)	468 (12.6%)	
1.01 - 2.00mm	22,283 (35.5%)	1,956 (30.1%)	854 (30.6%)	1,102 (29.7%)	
2.01 - 4.00mm	11,841 (18.9%)	2,044 (31,5%)	875 (31.4%)	1,169 (31.5%)	
>4.01mm	7,039 (11.2%)	1,645 (25.3%)	679 (24.3%)	966 (26.1%)	
Ulceration					
Present	14,946 (24.0%)	2,750 (42.4%)	1,167 (41.8%)	1,583 (42.8%)	<0.001
Absent	47,456 (76.0%))	3,742 (57.6%)	1,624 (58.2%)	2,118 (57.2%)	<0.001
Location					<0.001
Head/Ear/Lip/Neck	12,148 (19.2%)	949 (14.4%)	378 (13.4%)	571 (15.3%)	
Trunk	20,077 (31.7%)	2,448 (37.4%)	921 (32.7%)	1527 (40.1%)	
Upper Extremity	18,347 (29.0%)	1,452 (22.2%)	613 (21.8%)	839 (22.5%)	
Lower Extremity	12,786 (20.1%)	1,702 (26.0%)	905 (32.1%)	797 (21.3%)	

[a]Missing data for race (n = 442), insurance status (n = 619), median household income (n = 588), education (n = 75), Breslow Thickness (n = 574), Ulceration (n = 956)
[b]Percentages do not add up to 100% due to missing data
*p values were estimated with program-level cluster-adjusted chi square tests of association for comparisons between positive SLNB without CLND and positive SLNB with CLND

Table 2. Factors associated with CLND (compared with observation).

Predictor	p value	Odds Ratio
Sex		
Male	(Ref)	(Ref)
Female	0.993	1.00
Age		
>75	(Ref)	(Ref)
<55	<.001	0.687
56 - 65	0.023	0.886
66 - 74	0.137	0.919
Race		
White	(Ref)	(Ref)
Non-White	0.507	0.939
Insurance Status		
Other Government	(Ref)	(Ref)
Not-insured	0.837	0.972
Private	0.02	0.853
Medicaid	0.5756	0.938
Medicare	0.500	1.060
Median Household Income		
>$63,000	(Ref)	(Ref)
<$38,000	0.235	0.919
$38,000 - $47,999	0.410	0.959
$48,000 - $62,000	0.868	0.992

Table 2. Factors associated with CLND (compared with observation). *continued.*

Predictor	p value	Odds Ratio
Education (% without a HS diploma)		
<7%	(Ref)	(Ref)
>21%	<0.001	1.301
13% - 20.9%	0.415	0.958
7% - 12.9%	0.005	0.881
Charleson Deyo Score		
3	(Ref)	(Ref)
0	0.043	0.859
1	0.086	0.862
2	0.246	1.164
Year of Diagnosis		
2016	(Ref)	(Ref)
2012	<.001	0.794
2013	0.123	0.92
2014	0.119	0.922
2015	0.863	1.01
Breslow Thickness		
>4.01 mm	(Ref)	(Ref)
<1.00mm	0.017	1.153
1.01 - 2.00mm	0.388	1.04
2.01 - 4.00mm	0.672	0.982
Ulceration		
Present	(Ref)	(Ref)
Absent	0.081	1.052
Primary Site		
Lower Extremity	(Ref)	(Ref)
Head/Ear/Lip/Neck	<0.001	0.807
Trunk	<0.001	0.853
Upper Extremity	0.081	0.919

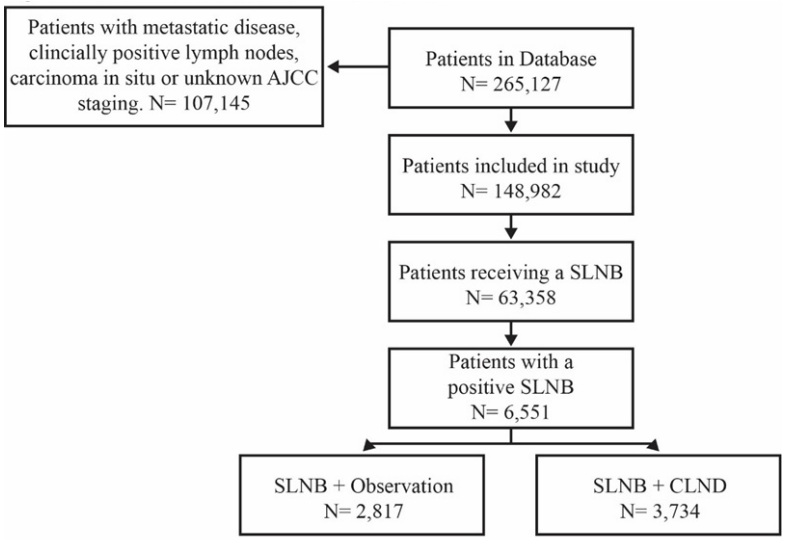

Figure 1. Flowchart of inclusion and exclusion criteria.

Table 3. Factors associated with undergoing CLND.

Predictor	β	Wald χ^2	p	Odds Ratio
Sex				
Male	(Ref)	(Ref)	(Ref)	(Ref)
Female	0.001	0.002	0.968	1.001
Age				
> 75	(Ref)	(Ref)	(Ref)	(Ref)
≤ 55	0.374	43.16	< 0.0001	1.454
56 - 65	0.119	4.974	0.026	1.127
66 - 74	0.085	2.227	0.136	1.089
Race				
White	(Ref)	(Ref)	(Ref)	(Ref)
Non-White	0.061	0.462	0.519	1.063
Insurance Status				
Other Government	(Ref)	(Ref)	(Ref)	(Ref)
Not-insured	0.284	0.041	0.839	1.03
Private	0.159	4.939	0.026	1.172
Medicaid	0.067	0.339	0.561	1.067
Medicare	-.0.060	0.480	0.488	0.941
Median Household Income				
≥ $63,000	(Ref)	(Ref)	(Ref)	(Ref)
< $38,000	0.085	1.401	0.236	1.088
$38,000 - $47,999	0.042	0.683	0.408	1.043
$48,000 - $62,000	0.007	0.026	0.872	1.008
Education (% without a HS diploma)				
< 7%	(Ref)	(Ref)	(Ref)	(Ref)
> 21%	-0.264	12.306	0.0005	0.768
13% - 20.9%	0.042	0.065	0.419	1.043
7% - 12.9%	0.127	7.834	0.005	1.136
Charleson Deyo Score				
3	(Ref)	(Ref)	(Ref)	(Ref)
0	0.152	4.067	0.043	1.164
1	0.149	2.971	0.084	1.161
2	-0.152	1.352	0.244	0.859
Year of Diagnosis				
2016	(Ref)	(Ref)	(Ref)	(Ref)
2012	0.231	16.685	< 0.0001	1.259
2013	0.082	2.312	0.128	1.086
2014	0.082	2.426	0.119	1.085
2015	-0.008	0.002	0.867	0.991
Breslow Thickness				
≥ 4.01 mm	(Ref)	(Ref)	(Ref)	(Ref)
< 1.00 mm	-0.142	5.682	0.017	0.867
1.01 - 2.00 mm	-0.039	0.744	0.388	0.962
2.01 - 4.00 mm	0.018	0.179	1.019	0.982

Table 3. Factors associated with undergoing CLND. *continued.*

Predictor	β	Wald χ^2	p	Odds Ratio
Ulceration				
Present	(Ref)	(Ref)	(Ref)	(Ref)
Absent	-0.051	2.966	0.085	0.951
Primary Site				
Lower Extremity	(Ref)	(Ref)	(Ref)	(Ref)
Head/Ear/Lip/Neck	0.213	13.712	0.0002	1.238
Trunk	0.157	14.035	0.0002	1.71
Upper Extremity	0.085	3.058	0.080	1.088

DISCUSSION

CLND has been the standard of care for clinically node-negative patients with SLN positive melanoma since the early 1990s.[10] However, there has been a growing trend in favor of omitting CLND for melanoma patients with a positive SLNB. Given that more than 80% of sentinel lymph node-positive patients have disease limited to the sentinel node, SLNB is thought to have both diagnostic and therapeutic value, potentially eliminating the need for a further, more extensive surgery.[9,10,23,24]

The first objective of this study was to examine the national trends and practice patterns regarding the utilization of CLND in patients after a positive SLNB. From 2012 to 2016, 57% of patients underwent a CLND following a positive SLNB. Patient age (≤ 55 years of age, and between 55 and 65 years of age), tumor location (head/neck region and trunk), year of diagnosis (2012), and total number of comorbidities (Charlson-Deyo Score = 0) were significantly associated with patients electing to undergo a CLND after a positive SLNB.

Two landmark clinical trials, DeCOG-SLT and MSLT-II, were conducted to determine what, if any, therapeutic role CLND had in the treatment of melanoma patients with lymph node metastases.[25] These trials demonstrated that CLND provided no melanoma-specific survival advantage compared to observation following a positive SLNB, suggesting that SLNB in concordance with observation may be sufficient for a subset of patients.[9,17,26] As evidence grows that continues to support observation in lieu of CLND, our study sought to examine practice patterns with respect to CLND after SLNB before the results of the two clinical trials were published or disseminated. Our results showed that there was a significant decline in the usage of CLND from 2012 to 2016, and those who were diagnosed in 2012 were significantly more likely to undergo CLND than observation following a positive SLNB, consistent with another study by Hewitt et al.[27] These similarities may be attributed to the possibility that surgeons and patients already were aware or at least anticipated the impending results of DeCOG-SLT and MSLT-II trials, with surgeons adopting a more selective approach to CLND based on established predictors of non-sentinel lymph node involvement, such as sentinel lymph node tumor burden, number of sentinel lymph nodes removed, and primary tumor thickness.[28]

SLN tumor burden is a well-established predictor of non-SLN metastasis, and patients with non-SLN metastasis have an increased risk of mortality compared to patients with disease confined only to the SLNs.[27,29-33] Therefore, the patients with non-SLN metastasis are the ones that potentially could benefit the most from CLND. Several models exist to predict non-SLN positivity, but there is no consensus on an optimal model that could be applied in clinical practice.[10,25,28,34-36] Therefore, the fact that the DeCOG-SLT and MSLT-II trials enrolled patients with a very low tumor burden (≤ 1 mm) brings into question the ability to generalize those with a higher tumor burden.[9,17]

The NCDB does not provide data to evaluate CLND utilization among patients with low SLN disease burden. The are two variables used to assess regional lymph node disease burden. Those variables are regional lymph nodes examined and regional lymph nodes positive. However, these two variables are cumulative. The variables report the total number of regional lymph nodes from all procedures that removed regional lymph nodes.[21] Therefore, it is not possible to differentiate between the number of positive lymph nodes from a SLNB from a patient that received both a SLNB and CLND. A new variable that allows for the reporting of the total number of positive lymph nodes after SLNB, and the total number of positive lymph nodes after CLND would be valuable. Additionally, the size of the metastatic deposit should be reported in cancer registries, as this will be an essential factor driving clinical decision-making. With these additions, further evaluation of the impact of SLNB disease burden on CLND utilization will be possible.

The second objective of our study was to examine factors associated with undergoing CLND versus electing observation after a positive SLNB. Our research found that patients were more likely to undergo a CLND if they were younger (< 65 years), had a primary tumor on the trunk or head/neck, had no comorbidities, or underwent primary resection in 2012. Previous studies have identified multiple factors associated with undergoing CLND including age, tumor location, and Breslow thickness.[37-39] One study suggested that patients were more likely to forgo a CLND if they were older (> 55 years), had multiple comorbidities, had a lower extremity primary tumor location, or underwent primary resection in 2015.[27] Another study found a lower likelihood of undergoing CLND in patients with a positive SLNB if the patients were older (> 75 years), had a primary tumor location

on the lower extremity and Breslow thickness ≤ 1.00 mm.[18] CLND is avoided in older patients due to the high postoperative risks.[37] The finding that patients were more likely to undergo CLND if the primary tumor was on the trunk or head/neck likely reflects the high complication rate following inguinal node dissection and a tendency to avoid those dissections. Inguinal node dissections are associated with more extended hospital stays, increased wound infection, and delayed wound healing.[15] Finally, though we described the alternative to surgery to be observation, we did not have documentation of the observation strategy implemented for each patient. In fact, the alternative to surgery may have been, for at least some patients, no further evaluation of the concerning lymph node basin.

In the future, it will be essential to continue to monitor the change in national practice patterns concerning the utilization of CLND, in particular, that patients with minimal tumor burden are offered the choice of nodal observation via ultrasound (active surveillance) versus CLND. Additionally, the utilization of CLND should be monitored in patients with more significant tumor burden who are considered a "high risk" subgroup.[40]

CONCLUSIONS

The utilization of CLND among patients with microscopic nodal melanoma was significantly lower in 2016 compared to 2012. Younger age, lack of comorbidities, and primary tumor location on the trunk or head/neck were associated with higher utilization of CLND.

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