Proposed Quality Standards for Regional Lymph Node Dissections in Patients With Melanoma

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Objective: The experience of the Sydney Melanoma Unit (SMU) is documented to offer quality assurance (QA) standards and an acceptable range for lymph node yield for regional lymph node dissection (RLND) in melanoma patients.

Summary Background Data: Surgery is the most effective treatment for melanoma involving lymph nodes (LN). QA for RLND procedures, including adequacy of surgery and histopathology, is not well developed. The number of LN removed is one auditable measurement, known as a reliable predictor of surgical quality in other tumors.

Methods: Data were retrieved from the SMU prospective database for patients treated from 1993 to 2006. There were 2039 RLND by SMU surgeons and 324 by non-SMU surgeons. The axilla, groin, cervical dissections of ≤3 levels (CD ≤3) and cervical dissections ≥4 levels (CD ≥4) were assessed.

Results: At axillary dissection the mean number of LN resected by SMU surgeons was 21.9 (median 21; range 1–83; 90% of cases ≥10 LN), groin dissection mean 14.5 LN (median 13; range 1–54; 90% of cases ≥7 LN), CD ≤3 dissection mean 19.5 LN (median 18.5; range 1–52; 90% of cases ≥6 LN) and CD ≥4 dissection mean 38.9 LN (median 36; range 5–103; 90% of cases ≥20 LN). SMU surgeons retrieved significantly more LN than non-SMU surgeons for axillary and groin dissections ($P < 0.0005$).

Conclusions: These data benchmark performance for melanoma RLND. Cases with a low node count (below the 90^{th} percentile) should be assessed critically. Standard RLND operations should have a reproducible mean and predictable distribution of LN retrieved.

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The standard treatment for metastatic melanoma with clinically involved lymph nodes is complete regional lymph node dissection (RLND).[1–4] Following the pioneering work of Morton and colleagues developing sentinel node biopsy (SNB), the management of regional node fields has been revolutionized.[5] The majority of patients now have subclinical disease identified before it is detectable by either clinical examination or radiologic imaging techniques. Completion RLND of the involved lymph node field has also been widely accepted as the standard of care for microscopically positive lymph nodes.[6] This recommendation is currently being reassessed for patients with microscopically involved lymph nodes as part of the second Multicenter Selective Lymphadenectomy Trial (MSLT II).[7] Some authors have recommended not undertaking RLND if the size of the metastasis is <0.1 mm.[8] However, the study by van Akkooi et al[8] and other studies questioning the significance of minimally involved lymph nodes[9] have relatively short follow up periods and are likely to be confounded by lead time bias.[10] Furthermore, the authors appear to discount the real possibility of a potential therapeutic benefit resulting from the SNB itself and the subsequent complete RLND.[10] For now RLND remains the standard management for gross nodal disease and is generally considered to be the appropriate treatment recommendation for those patients with a positive SN who are unable or not willing to enter the MSLT II or other relevant clinical trial.[1,10] A recent publication of data derived from the National Cancer Data Base suggested that in 2004–2005 only 50% of melanoma cases with a positive SNB in the United States had a completion RLND.[11] This is despite clear National Comprehensive Cancer Network (NCCN) guidelines recommending RLND as the standard of care.[12] Bilimoria et al recommended quality surveillance measures to monitor, standardize and improve the care of patients with melanoma.[11]

Determinants of survival in patients with American Joint Committee for Cancer (AJCC) stage III melanoma include the number of positive lymph nodes at nodal dissection,[13] the size of the largest metastasis and the tumor penetrative depth of the nodal metastases.[14] Micromorphometric features of positive sentinel nodes have been shown to predict involvement of nonsentinel nodes in melanoma patients.[15] The relative tumor burden,[16] the presence of extranodal disease, and, in several studies, primary lesion characteristics have been associated with nonsentinel node involvement.[2,3] There has been the recent description of "N- ratio," which equates the percentage of positive lymph nodes to total number of lymph nodes removed. This parameter had a significant correlation with survival and again suggests an impact from quality and extent of surgery on survival.[17] Galliot et al[18] and Chan et al[19] also reported an association between the numbers of lymph nodes resected at RLND and improved overall survival. These authors also suggested that less thorough RLND might compromise survival in melanoma patients. The concept that quality of surgery may impact on overall survival has also been addressed in other types of cancer. In his 1994 Karnovsky Lecture, Hellman proposed that rather than the Fisher "systemic" concept of breast cancer spread or the earlier Halstedian "step-wise" model, there is a spectrum of biologic behavior between these 2 models.[20] The recently reported Oxford Overview data assessing the impact of local recurrence events on survival in breast cancer patients further support the importance of high quality local therapy in avoiding local recurrence events and thus improving survival.[21] The concept is also strongly supported by the relationship between local recurrence events and survival in rectal cancer.[22,23]

At present, there are no widely promoted standards, guidelines or quality assurance (QA) measures to determine the adequacy of RLND in patients with melanoma. The NCCN guidelines give a general indication that a "thorough lymph node dissection is required" and when to do an ilio-inguinal dissection rather than an inguinal dissection.[12] Furthermore, the NCCN guidelines stated that,

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although number of lymph nodes examined is one indication of the thoroughness of RLND, there is insufficient evidence available currently to set standards based on this.[12] Balch et al demonstrated the importance of thorough surgery in melanoma control in terms of disease free and overall survival rates.[24] This group defined lymph node retrieval counts that they classified as adequate surgery. The data sourced to develop these standards was not indicated.[24] Morton and colleagues set standards for RLND based on consensus by experienced surgeons from major melanoma treatment centers in the MSLT trial management committee.[7] These were not based on the type of data analysis undertaken in the present study.

The importance of QA was also demonstrated by Kretschmer et al, who found that after lymphadenectomy was standardized throughout their unit, the median number of lymph nodes identified in axillary dissection specimens increased from 6 to 12. This resulted in improved local disease control.[25] This type of quality standardization requires the support and adequate training of surgical staff. It also requires the anatomic pathology staff processing the specimens to have standardized procedures for macroscopic specimen dissection as well as high levels of diligence in assessing specimens.

Accepting lymph node retrieval as a QA measure, this study aims to document the performance of the Sydney Melanoma Unit (SMU) in each commonly performed RLND (neck, axilla, and groin), in terms of the individual SMU surgeons and the combined SMU standard. We propose acceptable parameters of performance. In a research orientated unit, it is especially important to confirm that there is integrity of surgical technique being demonstrated by the individual surgeons within the unit. If there is an outlier surgeon, this has potential relevance in terms of the validity of that individual contributing to the surgical trials undertaken by the unit. There were also a large number of cases referred to the SMU after RLND was completed by non-SMU surgeons and the histopathology reported by non-SMU anatomic pathologists. Even though comparison with other melanoma services was not the primary objective of this study, this enabled analysis of the combined performance of these surgeons and pathologists as well. These data have been evaluated as part of the process used to set quality benchmarks for an evolving informatics system for the SMU. This system will involve increasing the robustness of QA and internal auditing processes. The evaluation is offered as a benchmark for other units to consider treating melanoma patients for their use in QA.

METHODS

The SMU database contains prospectively recorded data for all patients managed for over 40 years. There are currently over 27 000 cases in the database. The data collected include information on patient demographics, their primary tumor characteristics, details and timing of regional and distant disease, investigations, staging, any surgery performed, follow up, and survival. Surgery for patients seen at the SMU is almost always performed or supervised by SMU surgeons. SMU affiliated pathologists in the Department of Anatomic Pathology at the Royal Prince Alfred Hospital invariably handle histopathologic assessment of surgical specimens. Additionally, included in the database are a number of patients who have been managed initially by non-SMU surgeons and had their surgery performed at other institutions and their pathologic specimen examined and reported elsewhere. This was prior to the patients being referred to the SMU for other aspects of oncological management.

Information was retrieved on the number of lymph nodes excised at each RLND procedure for the period 1993 to 2006. In the early part of this period, some surgeons at the SMU were still selectively using elective lymph node dissection. The total number of lymph nodes recorded for any RLND included all lymph nodes removed as part of an earlier excision biopsy or SNB. These data were sorted into different regional lymph node fields, and individualized for the operating surgeon and for the reporting pathologist. Surgeons and pathologists who were not part of the SMU were analyzed as a separate combined non-SMU group. The types of RLND with sufficient cases to perform analysis were the axillary, groin (inguinal and ilio-inguinal), cervical dissections involving up to 3 neck lymph node levels (CD $\leq$3), and cervical dissections involving 4 levels or more (CD $\geq$4).[26] Groin dissections involving inguinal or combined ilio-inguinal dissections were analyzed as a single group. The structure of the SMU database did not allow sufficiently accurate subanalysis of inguinal and ilio-inguinal node dissections. However, to develop a standard for audit purposes, this distinction is acknowledged as important, and therefore a retrospective subset analysis of 66 inguinal and ilio-inguinal dissections was included to define lymph node counts for the individual procedures. The 2 categories for cervical dissections were considered the same regardless of whether or not a parotidectomy was carried out. The lymph nodes in the parotidectomy specimen were included in the neck dissection count if done together.

Maximum, minimum, median, mean, and 90th percentile bands for each type of RLND for each surgeon were calculated. Pearson product moment coefficient was used to determine the level of correlation between number of lymph nodes and other variables. Correlation with the date of surgery was used to determine if there was any learning curve or change in retrieval rates with the changes in staff over the 14 years assessed. Correlation with time of year was calculated to determine if the timing in the rotation of trainee pathologists undertaking retrieval of lymph nodes from the specimen had any influence on the number of lymph nodes retrieved. Confidence intervals were calculated where relevant. Independent sample t-tests were carried out to compare results between surgeons and pathologists at the SMU and those who were non-SMU specialists. These calculations were carried out using the statistical package contained within Microsoft Excel 2003.

RESULTS

During the study period, 2363 consecutive RLND procedures were retrieved from the database. These dissections were carried out in 2141 patients. Sixty five percent of the patients were male. The age of the patients at first diagnosis of melanoma ranged from 1 to 93 years, with the mean age being 56 years. Twenty-five were aged less than 18 at diagnosis. The mean age of surgery for the first lymph node field dissected was 57 years old.

There were 1023 axillary dissections, 716 groin dissections, 163 neck dissections of between 1 and 3 levels, and 367 neck dissections of 4 or 5 levels. Because of the small number of cases, the 32 patients who had a parotidectomy but no synchronous neck dissection were excluded from the auditable sample. Assessing the 32 cases with parotidectomy alone in more detail, in 24 it was the sole treatment, 5 had a prior neck dissection, and 3 had a subsequent neck dissection. The mean number of lymph nodes removed at parotidectomy (alone) was 5.9 (median 5, range 0–15). There were 9 iliac only RLND excluded from the assessment. Sixteen RLND from other sites such as the popliteal fossa were also excluded from analysis, as were 37 cases where the number of lymph nodes removed was inadequately recorded.

Demographic data and details of the primary melanomas (mean and median Breslow thickness as well as proportion of primary melanomas $\leq$1 mm, 1.01–2 mm, 2.01–4 mm, and $>$4 mm thick) and percentage of cases with positive lymph nodes for each type of RLND are presented in Table 1. There were 9 SMU surgeons whose data was included in this analysis. Two surgeons were trained in plastic and reconstructive surgery, while the remainder were originally trained in general surgery with subspecialization in sur-

TABLE 1. Demographic Data for Each Lymph Node Field

	Axilla	Groin*	CD ≤3	CD ≥4
Male	72%	49%	76%	78%
Female	28%	51%	24%	22%
Median Age	58	58	62	61
Median Breslow (mm)	2.3	2.5	2.5	2.4
Mean Breslow (mm)	3.2	3.5	3.4	3.5
Range (mm)	0.1–50	0.15–40	0.25–23	0.15–27
Primary ≤1mm	14%	12%	14%	13%
Primary 1.01–2 mm	28%	25%	20%	26%
Primary 2.01–4 mm	36%	36%	39%	32%
Primary >4 mm	22%	27%	27%	29%
Cases with +ve nodes	75.6%	86.3%	62.0%	86.9%

Abbreviations: +ve, positive; CD ≤3, cervical dissections 3 levels or less; CD ≥4, cervical dissections 4 levels or more.
*Groin denotes inguinal and combined ilio-inguinal dissections.

gical oncology. Two of these surgeons had specialist head and neck training in addition to general surgical oncological training. Two of the surgeons have subsequently retired, one has moved to another hospital, and the other 6 remain in practice at the SMU. There were 10 Royal Prince Alfred Hospital Anatomic Pathology Department pathologists who reported most of the cases. There was a group of other pathologists from that department who reported very small numbers of cases. The non-SMU pathologists were assessed as a single group.

Axillary Dissections

The axillary dissection patients had a mean age of 58 years and 72% were male. Their primary melanomas had a mean Breslow thickness of 3.2 mm (median 2.4 mm) with a range of 0.1–50 mm. Further data are summarized in Table 1. The primary melanoma was located on the skin of the thorax in 49% of cases, on the upper limb in 34% (11% shoulder, 13% arm, 10% forearm and hand) and a mixture of neck, ear, abdomen and flank in 4.4% of patients. In 12.6% of cases, they were stage 3 disease from an unknown primary.

The 1023 axillary dissections included 863 carried out by SMU surgeons. Within this group, the recorded number of lymph nodes retrieved ranged from 1 to 83. The mean number retrieved was 21.9, the median 21, and 10 or more lymph nodes were identified within the dissection specimens in 90% of cases. Comparison of the individual SMU surgeons indicated that the mean number of lymph nodes resected ranged from 19.7 to 27. For non-SMU surgeons, the mean number of nodes resected was 17.8, the median was 17, and 8 or more nodes were resected in 90% of cases. The difference in mean number of lymph nodes resected between SMU and non-SMU surgeons was statistically significant ($P < 10^{-7}$). Further information on the axillary dissection analysis is presented in Table 2. The number of patients with positive lymph nodes, the number of positive lymph nodes per case, and the number of cases with greater than 5 positive lymph nodes are also presented in Table 2.

Groin Dissections

The groin dissection patients had a mean age of 58 years and 49% were male. There was a mean Breslow thickness of 3.5 mm (median 2.5 mm) with a range of 0.15–40 mm. Further data are summarized in Table 1. The primary melanoma was located on the lower limb in 78% of cases (19% thigh, 3% knee area, 30% leg, 26% ankle and foot). In 10% of cases, there was stage 3 disease from an unknown primary site. The remaining 12% were located on the abdomen (2.9%), thorax (1.9%), flank (3.8%), groin, vulva or vagina, anus, buttock, scrotum, rectum, and shoulder.

The 716 inguinal and ilio-inguinal dissections included 595 performed by SMU surgeons. Within this group, the recorded number of lymph nodes resected ranged from 1 to 54. The mean number resected was 14.5, the median was 13, and 7 or more lymph nodes were resected in 90% of cases. Comparison of the individual SMU surgeons indicated the mean number of lymph nodes resected ranged from 11 to 17.9 (excluding Surgeon 7 who only had one case on the database). There were 121 cases performed by non-SMU surgeons. The mean number of nodes resected by non-SMU surgeons was 12.0, with a median of 11, and 5 or more lymph nodes were resected in 90% of cases. The difference in mean number of lymph nodes resected between SMU and non-SMU surgeons was

TABLE 2. Axillary Lymph Node Dissections–Statistics for Individual Surgeons at the SMU, for the SMU as a Group, and for Non-SMU Surgeons

	Surg 1	Surg 2	Surg 3	Surg 4	Surg 5	Surg 6	Surg 7	Surg 8	Surg 9	SMU Total	Non-SMU Surgeons	Total
No. cases	320	36	62	40	43	59	16	266	21	863	160	1023
Min. LN	1	14	9	7	8	6	8	4	6	1	1	1
Max. LN	60	42	39	45	58	45	40	83	43	83	46	83
Median	21	27	22	26	23	20	14	19	24	21	17	20
Mean	21.8	27.0	21.9	24.8	26.0	20.5	19.7	20.4	23.6	21.9	17.8	21.2
90th Percentile*	10	16.5	14	16.8	12.4	10.8	9	9	11	10	8	10
Percentile rank of 10 LN†	9.7	#	1.6	5.8	4.7	8.6	13.3	10.9	4.0	8.5	15.7	9.6
No. cases with +ve LN	242	35	58	30	39	48	6	159	20	637	139	773
% cases with +ve LN	75.6	97.2	93.5	75.0	90.7	81.4	37.5	59.8	95.2	73.8	86.9	75.6
Mean No +ve LN per case	2.4	1.6	2.3	1.9	2.8	1.6	2.3	1.9	1.6	2.1	2.9	2.2
Median No +ve LN	1	1	1	1	1	1	0	1	1	1	1	1
No. cases with +ve LN ≥5	37	2	4	2	3	4	1	21	1	75	31	105
% cases with +ve LN ≥5	11.6	5.6	6.5	5.0	7.0	6.8	6.3	7.9	4.8	8.7	19.4	10.3

Abbreviations: LN, lymph nodes; No., number of; +ve, positive; %, percentage of; SMU, Sydney Melanoma Unit; surg, surgeon.
*In 90% of cases, the number of lymph nodes excised equals or exceeds the number stated.
†Percentage of cases where the number of lymph nodes excised was less than 10 lymph nodes (# denotes a situation where the number of lymph nodes excised exceeded 10 in all recorded dissections for that surgeon).

statistically significant ($P = 0.0005$). The number of cases with positive lymph nodes, the number of positive lymph nodes per case, and the number of cases with greater than 5 positive lymph nodes are also presented in Table 3.

The subset analysis of 66 groin dissections included 37 cases who had inguinal dissection with a mean of 11.9 nodes removed (range 6–21) and 29 ilio-inguinal dissections who had a mean of 17.1 nodes removed (range 9–54). The overall mean for this 66 patient subset was 14.8, which is very similar to the mean of the overall groin dissection group noted above. There was a mean of 1.7 positive nodes per case (range 0–15).

Cervical Dissections Involving Up to 3 Levels (CD ≤3)

Patients undergoing cervical dissection involving removal of up to 3 levels had a mean age of 62 years and 76% were male. There was a mean Breslow thickness of 3.4 mm (median 2.5 mm) with a range of 0.25–23 mm. Further data are summarized in Table 1. In addition to this, the primary lesion was located on the face (including the ear) in 38%, the scalp in 19.6%, shoulder in 14.1%, thorax 11.7%, and neck in 11.7% of cases. The patients had metastatic stage 3 disease from an unknown primary site in 4.9% of cases.

The 163 CD ≤3 dissections comprise 140 performed by SMU surgeons. Within this group, the number of lymph nodes resected ranged from 1 to 52. The mean number resected was 19.5, the median 18.5, and 6 or more lymph nodes were resected in 90% of cases. Comparison between the individual SMU surgeons indicated the mean number of lymph nodes resected ranged from 12.4 to 36. There were 23 cases performed by non-SMU surgeons. The mean number of nodes resected by non-SMU surgeons was 16.4, with a

TABLE 3. Inguinal and Ilio-inguinal Lymph Node Dissections–Statistics for Individual Surgeons at the SMU, for the SMU as a Group, and for Non-SMU Surgeon

	Surg 1	Surg 2	Surg 3	Surg 4	Surg 5	Surg 6	Surg 7	Surg 8	Surg 9	SMU Total	Non-SMU Surgeons	Total
No. cases	307	22	45	24	30	29	1	126	11	595	121	716
Min. LN	2	7	6	8	8	5	9	1	5	1	3	1
Max. LN	54	45	39	27	24	30	9	40	25	54	38	54
Median	13	13	14	15	17	10	9	11	13	13	11	12
Mean	14.8	14.6	17.9	16.1	17.1	11.0	9.0	12.3	13.4	14.5	12.0	14.1
90th percentile*	7	7	8.4	9.9	11.9	7		6	7	7	5	7
Percentile rank of 10†	24.5	23.8	13.6	10.1	5.1	50.0		32.0	33.3	25.2	40.8	27.8
No. cases with +ve LN	270	21	43	22	30	21		102	10	519	105	618
% cases with +ve LN	87.9	95.5	95.6	91.7	100.0	72.4		81.0	90.9	87.2	86.8	86.3
Mean no. +ve LN per case	3.1	2.0	3.2	2.2	3.0	1.5		1.7	2.7	2.6	2.7	2.7
Median no. +ve LN	2	1	2	2	1	1		1	2	1	1	1
No. cases with +ve LN ≥5	51	3	8	2	6	1		7	2	80	21	100
% cases with +ve LN ≥5	16.6	13.6	17.8	8.3	20.0	3.4		5.6	18.2	13.4	17.4	14.0

Abbreviations: LN, lymph node; no., number of; +ve, positive; %, percentage of; SMU, Sydney Melanoma Unit; surg, surgeon.
*In 90% of cases, the number of lymph nodes excised equals or exceeds the number stated.
†Percentage of cases where the number of lymph nodes excised was less than 10 lymph nodes.

TABLE 4. Cervical Lymph Node Dissections 3 levels or Less–Statistics for Individual Surgeons at the SMU, for the SMU as a Group, and for Non-SMU Surgeons

	Surg 1	Surg 2	Surg 3	Surg 4	Surg 5	Surg 6	Surg 7	Surg 8	Surg 9	SMU Total	Non-SMU Surgeons	Total
No. cases	19		3	44	6		47	20	1	140	23	163
Min. LN	1		28	3	8		2	2	13	1	3	1
Max. LN	43		51	52	42		52	38	13	52	47	52
Median	12		29	21	19.5		19	10	13	18.5	14	18
Mean	14.8		36.0	21.7	20.7		21.3	12.4	13.0	19.5	16.4	19.1
90th percentile*	6.8		28.2	6.3	11		8.2	3.8	13	6	6.6	6
Percentile rank of 10 LN†	27.7		#	23.8	6.6		13.0	47.3	#	23.0	20.4	22.8
No. cases with +ve LN	11		2	31	6		27	8	1	86	15	101
% cases with +ve LN	57.9		66.7	70.5	100.0		57.4	40.0	100.0	61.4	65.2	62.0
Mean no. +ve LN per case	0.7		1.0	1.6	8.0		1.1	0.6	2.0	1.4	1.4	1.4
Median no. +ve LN	1		1	1	2		1	0	2	1	1	1
No. cases with +ve LN ≥5	0		0	4	1		1	0	0	6	0	6
% cases with +ve LN ≥5	0.0		0.0	9.1	16.7		2.1	0.0	0.0	4.3	0.0	3.7

Abbreviations: LN, lymph node; no., number of; +ve, positive; %, percentage of; SMU, Sydney Melanoma Unit; surg, surgeon.
*In 90% of cases, the number of lymph nodes excised equals or exceeds the number stated.
†Percentage of cases where the number of lymph nodes excised was less than 10 lymph nodes (# denotes a situation where the number of lymph nodes excised exceeded 10 in all recorded dissections for a particular surgeon).

median of 14, and 6.6 or more lymph nodes were resected in 90% of cases. The difference in mean number of lymph nodes resected between SMU and non-SMU surgeons was not statistically significant ($P = 0.24$). The number of cases with positive lymph nodes, the number of positive lymph nodes per case and the number of cases with greater than 5 positive lymph nodes are also presented in Table 4.

Cervical Dissections Involving 4 Levels or More (CD ≥4)

The patients who had cervical dissection involving removal of 4 or more levels had a mean age of 61 years and 78% were male. There was a mean Breslow thickness of 3.5 mm (median 2.4 mm) with a range of 0.15 – 27 mm. Further data are summarized in Table 1. The primary lesion was located on the face (including the ear) in 39.2%, scalp in 18.3%, neck in 17.7% of cases, shoulder/upper arm 4.9%, and thorax 3.8%. The patients were classified metastatic stage 3 disease from an unknown primary site in 16.1% of cases.

The 367 CD ≥4 dissections comprise 347 performed by SMU surgeons. Within this group, the number of lymph nodes retrieved ranged from 5 to 103. The mean number resected was 38.9, the median 36 and in ninety percent of cases, 20 or more lymph nodes were resected. Comparison between individual SMU surgeons indicated the mean number of lymph nodes resected ranged from 19.5 to 46. There were 20 cases performed by non-SMU surgeons. The mean number of nodes resected by non-SMU surgeons was 36.3, with a median of 35 and in ninety percent of cases 19.7 or more lymph nodes were resected. The difference in mean number of lymph nodes resected between SMU and non-SMU surgeons was not statistically significant ($P = 0.49$). The number of patients with positive lymph nodes, the number of positive lymph nodes per case and the number of cases with greater than 5 positive lymph nodes are also presented in Table 5.

Other Variables

There was no group where there was a significant correlation between the year of the procedure and number of lymph nodes excised. However, there was a trend towards an increase in the number of lymph nodes excised over time for inguinal and ilio-inguinal dissections carried out by SMU surgeons. This mostly likely reflects the increasing number of ilio-inguinal dissections carried out.

There was no significant correlation between the time of year the procedure was done or the reporting pathologist and number of lymph nodes excised. Pearson correlation coefficients for the 4 lymph node fields (axilla, groin, CD ≤3, and CD ≥4) were 0.051, 0.062, −0.011 and −0.007 respectively.

DISCUSSION

It is well established that the number of positive lymph nodes resected at RLND has prognostic value.[2,3,13,27] Complete regional lymph node surgery should increase the chance of removing all regional disease as well as more accurately assessing the number of involved nodes. This has obvious benefits in terms of regional disease control. There is a suggestion that the total number of lymph nodes removed relates to a survival benefit.[18,19,24,28] In developing a new informatics system for the presently expanding SMU, a more robust quality assurance and internal auditing process is planned. Accordingly, this project was aimed primarily at setting benchmarks for the surgeons within the SMU. Given the large, well documented experience of the SMU, it appeared reasonable to take these standards and offer them as a QA measure for other surgeons conducting melanoma surgery. The principle of defining benchmarks is that surgeons or units that deviate from the agreed parameter should search for an underlying cause. This may be related to the quality of the surgery or the quality of the specimen assessment by the pathologists involved in reporting the cases. Over a period of time, a unit could compare the results against the benchmark mean and median for each RLND. On a case-to-case basis, surgeons could use the 90th percentile benchmark as a minimum acceptable lymph node count. If a standard procedure has been completed but a lesser number of lymph nodes obtained, the pathology department should perhaps be asked to re-examine the specimen. Re-examining the pathology specimen after a longer period of fixation may enable additional lymph nodes to be retrieved because they are more easily identified in well-fixed tissue. There are circumstances and easily explainable situations where low node counts are inevitable. An example is when the RLNB specimen contains a single coalescing tumor mass or where multiple metastasis-containing lymph nodes have become matted together to form one tumor mass. However this is relatively uncommon compared with cases with lower volume tumor

TABLE 5. Cervical Lymph Node Dissections 4 Levels or More–Statistics for Individual Surgeons at the SMU, for the SMU as a Group, and for Non-SMU Surgeons

	Surg 1	Surg 2	Surg 3	Surg 4	Surg 5	Surg 6	Surg 7	Surg 8	Surg 9	SMU Total	Non-SMU Surgeons	Total
No. cases	76	0	20	137	0	2	103	7	2	347	20	367
Min. LN	7		15	5		17	5	15	46	5	13	5
Max. LM	88		71	103		22	74	60	46	103	67	103
Median	34		35	43		19.5	33	29	46	36	35.5	36
Mean	36.0		35.0	44.0		19.5	35.6	31.4	46.0	38.9	36.3	38.7
90th percentile*	19.5		22.7	24		17.5	18.2	16.8	46	20	19.7	20
Percentile rank of 10 LN†	0.50		‡	0.40		‡	1.40	‡	‡	1.00	‡	0.90
No. cases with +ve LN	69		17	128		2	79	3	2	300	19	319
% cases with +ve LN	90.8		85.0	93.4		100.0	76.7	42.9	100.0	86.5	95.0	86.9
Mean no. +ve LN per case	3.2		1.8	2.8		1.0	2.4	1.6	1.5	2.7	2.9	2.7
Median no. +ve LN	2		1	1		1	1	0	1.5	1	1	1
No. cases with +ve LN ≥5	12		1	17		0	15	1	0	46	3	49
% cases with +ve LN ≥5	15.8		5.0	12.4		0.0	14.6	14.3	0.0	13.3	15.0	13.4

Abbreviations: LN, lymph node; no., number of; +ve, positive; %, percentage of; SMU, Sydney Melanoma Unit; surg, surgeon.

*In 90% of cases, the number of lymph nodes excised equals or exceeds the number stated.

†Percentage of cases where the number of lymph nodes excised was less than 10 lymph nodes (‡ denotes a situation where the number of lymph nodes excised exceeded 10 in all recorded dissections for a particular surgeon or group).

in regional lymph nodes. Other parameters have been assessed in an attempt to better define surgical quality. These appear in Tables 2–5 and include the percentage of cases where ≥10 nodes were removed, which is a useful parameter of quality when a sufficient volume of cases are done. The percentage of cases with positive nodes and percentage of cases with ≥5 positive nodes removed. All the parameters help to better define the caseload of individual surgeons but do not seem to improve the QA assessment value of the procedures performed.

Anecdotally, surgeons often comment that the anatomic pathology department's reporting of their RLND specimens can be variable. Most surgical oncologists would be able to recall instances where an unexpectedly low lymph node count was significantly revised upwards when a request was made for the specimen to be re-examined. This issue has been studied in axillary clearance for breast surgery.[28] Cserni audited the analysis of axillary clearance specimens in breast cancer and found that over the audit period the number of lymph nodes missed at the first examination decreased.[28] Often it is a junior trainee pathologist who dissects the specimen, identifies and counts the lymph nodes, and prepares the lymph nodes for processing and subsequent microscopic examination by the consultant pathologist. For a study to examine the variability between members of the histopathology department for lymph node count variability, the pathology consultants and trainee pathologists involved as well as their experience levels would have to be recorded. Only the consultant pathologist was recorded on the SMU database. As trainee anatomic pathologists tend to rotate so that most are new or start a new position at the start of each calendar year in Australia, one might speculate that unless they are more heavily supervised, the number of lymph nodes retrieved at the start of the year might be lower than at the end of the year. However, no correlation was found between the number of lymph nodes identified and the time of year. From a technical perspective, it has been suggested that fixing RLND specimens in Carnoy's solution or using other more complicated fixation methods prior to pathologic examination may assist in the retrieval of lymph nodes by partly dissolving the adipose tissue in the specimen and therefore allowing easier identification of lymph nodes.[29]

Other groups have made attempts at setting standards for adequacy of RLND. The NCCN guidelines recommend thorough clearance of lymph node basins. They comment that even though it has been suggested by some that lymph node retrieval numbers are related to quality of surgery, currently there are inadequate data available to use lymph node numbers as the basis of setting standards.[12] Morton and colleagues in the MSLT trial management committee recommended standards of lymph node retrieval for RLND for their studies. These parameters specify ≥30 lymph nodes for full neck dissection, ≥15 lymph nodes for axillary dissections, ≥8 nodes for inguinal dissection, and ≥6 lymph nodes for pelvic node dissection.[30] These parameters were based on the recommendations of experienced melanoma surgeons who were members of the trial management committee and were not derived from a data set as has been done in this study. As would be anticipated, it turns out these parameters seem reasonable if not overly rigorous based on our cut off points for the 90th percentile limits for lymph node counts.

In 1983, Balch et al presented evidence that adequacy of lymph node surgery in patients with melanoma was related to outcome, establishing the concept of thorough lymph node surgery being important in melanoma local control and perhaps survival.[24] These authors recommended retrieval of 5 or more lymph nodes from a "superficial" inguinal dissection, 10 or more from an axillary dissection, and 20 or more from a cervical node dissection.[24] Standard teaching in surgical oncology is that the extent of a procedure is based on defined anatomic boundaries.[31] SMU surgeons have agreed to comply with the established standard extent of surgery. This is not a commitment to increased "aggressiveness" by our group of surgeons, as standard regional lymph node dissections should be just that. Lesser surgery is highly unlikely to be of benefit to the patient in terms of local control. Similarly, surgery outside the confines of where nodal or intransit disease is likely to be located is highly unlikely to be of additional benefit. On the other hand, a more complete operation is often perceived as having greater morbidity. The evidence for this is lacking. An example is the lack of any demonstrated difference in morbidity between inguinal and ilio-inguinal dissection.[32] Another example is the lack of evidence that a full level 3 axillary dissection has more long term morbidity than level 1and 2 dissection.[32,33] More concern should be associated with a surgeon or group recommending lesser surgery. What is not known to date from the melanoma literature is how much of a modification involving a reduction in standard procedures is safe without compromising local control and/or survival, or indeed if any modification will adversely affect outcome.

Although it was not the initial intention of this study, the collection of records for melanoma patients who had a RLND performed by non-SMU surgeons and reported by non-SMU pathologists has allowed for comparisons in lymph node retrieval. In axillary and groin dissections, the mean number of lymph nodes excised was significantly higher in patients whose surgery was performed at the SMU. This result may reflect the specific skill sets that reach higher levels in centers that specialize in a particular area of medicine and have a higher case load. This has been well demonstrated in both breast cancer management[33] and rectal cancer.[34,35] The verdict as to whether this outcome is clinically relevant in melanoma remains debatable. At present there are no conclusive data to indicate exactly how many lymph nodes need to be excised from a particular lymph node field to confer optimal regional control. The difference in number of nodes removed at groin dissection with time and the difference between SMU and non-SMU surgeons may also reflect more common use of ilio-inguinal dissections in both situations. It is matched by a trend for SMU surgeons to remove more nodes over time, again likely to be indicating more frequent ilio-inguinal dissection.

Kretschmer et al found that axillary lymphadenectomy carried out after the procedure was standardized at a particular institution decreased local recurrence rates in melanoma patients. Nonstandardized lymphadenectomy yielded a median number of 6 nodes, while standardized lymphadenectomy yielded 12 nodes.[25] Both SMU and non-SMU surgeons exceeded this total. Such differences in mean numbers of nodes removed are difficult to explain when radical axillary lymphadenectomy is a well documented procedure with standard anatomic landmarks for adequacy of surgery.[36]

Neck dissections done by non-SMU surgeons are usually performed by specialist head and neck surgeons in Australia. There was no significant difference in the number of lymph nodes retrieved in lymphadenectomies performed by these surgeons and the SMU surgeons, suggesting that it is likely that thorough and complete surgery is being done by both groups of surgeons. Other contemporary series for other pathologies report similar nodal yields. Shah reported a mean yield of 39 lymph nodes from 699 radical neck dissections for squamous cell carcinomas of the upper aerodigestive tract, which is similar to the mean obtained for CD ≥4 RLND in this series.[37] Many of the dissections in our series were comprehensive neck dissections with preservation of the internal jugular vein, sternocleidomastoid,muscle and accessory nerve.

We are currently further investigating these and supplementary data to try to correlate node counts from the various RLND with regional recurrence rates and also survival. These data are beyond the scope of this audit, which was designed to validate individual surgeon's standards of surgery for QA. What is really required to

demonstrate a survival difference related to lymph node retrieval is a range of quality of the surgery. These data demonstrate that the SMU surgeons perform within a reasonably narrow band of performance. Survival differences, if they exist, would require a larger data set from different centers that perform a range of "thoroughness" of surgery. Galloit-Repkat et al calculated survival benefit in melanoma patients depending on whether or not ten or more nodes were excised at RLND. This benchmark of ten was applied regardless of the lymph node field.[18] Using this parameter as a quality standard, the SMU did well, with greater than 90% of RLND recording more than 10 lymph nodes in the axilla. The corresponding figure for patients operated by non-SMU surgeons was 84%. For groin dissections, 75% of SMU patients recorded more than 10 lymph nodes, while for non-SMU surgeons, the figure was 59%. For CD ≥4 neck dissections, 99% of SMU operated patients had more than 10 lymph nodes excised versus 100% for non-SMU surgeons.

Chan et al also set benchmarks that did not differentiate between different regional lymph node fields. After collating the number of lymph nodes collected from each dissection, the numbers were separated into quartiles. There was a survival advantage for patients in the fourth quartile who had more than 33 lymph nodes resected.[19] Though the paper's utility is in its demonstration of survival benefit when more lymph nodes are resected, a single benchmark spread across all fields (which are anatomically very distinct) is unusable for audit as is clearly demonstrated in this data analysis.

Rossi et al described applying the N-ratio in melanoma. This is the number of positive lymph nodes divided by the number of lymph nodes removed at RLND. They combined all the 213 RLND from different lymph node fields. There was a mean of 3.2 metastatic lymph nodes (range 1–47) from dissections that had a mean of 18 lymph nodes removed (range 9–49). The N-ratio was found to be an independent prognostic factor for these patients including maintaining significance in a multivariate analysis including TNM stage.[17] These data are supportive of the concept that adequacy of surgery is related to outcome and is further justification of total lymph node retrieval from RLND being an auditable outcome measurement.

The rates of ≥5 positive nodes in the dissection specimens varied moderately between individual surgeons within the SMU. This is likely to indicate several things. Firstly, that early on in this series, fewer patients would have had SNB at the point of diagnosis of their disease. Thus, when they presented with symptomatic lymph node involvement there would have been more bulky disease present. Secondly, it is likely that there is a bias for external referrals but also a tendency within the SMU to refer the potentially more difficult cases to the surgeons considered to be more experienced or suitable. One of the benefits of this audit was to demonstrate the remarkably consistent standards across the whole group of surgeons who undertook the operations.

A shortcoming of this study was the inability to separate inguinal from ilio-inguinal dissections. These data were not available in the database for the majority of the cases studied. We have attempted to overcome this deficiency to some degree by including the detailed subset of 66 cases where the distinction had been made. This demonstrated mean number of nodes for inguinal dissection at 11.9 whereas it was 17.1 for ilio-inguinal dissection. The overall mean number of nodes removed was 14.8 for this subset. This was similar to the overall group and may indicate that this is a reasonable estimate for the 2 operations. For the moment, the benchmarks set for inguinal and ilio-inguinal dissection will reflect this fact, but more work will be carried out at the SMU to clarify the differences and standards for the 2 operations. Meanwhile, there continues to be debate about the indications for ilio-inguinal dissection.[32,38,39]

CONCLUSIONS

The number of positive lymph nodes excised at RLND has important prognostic value. There is accumulating evidence that total number of lymph nodes excised also has prognostic value or could even be related to survival. Thus the quality of a RLND is important and accordingly, surgeons should routinely record the number of lymph nodes retrieved at RLND as part of their audit process. Comparison with benchmarks is the foundation of clinical audit.

The results obtained by the SMU could serve as a guide and a target for other surgeons performing RLND for melanoma. From our data, axillary dissections should aim for a minimum of 10 nodes and a mean of 21. Inguinal and ilio-inguinal dissections should aim for a minimum of 7 nodes and a mean of 14. Cervical lymph node dissections involving 4 or more levels should aim for a minimum of 20 nodes and a mean of 39.

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