Journal of Carcinogenesis
Covering Genesis to Therapeutics

Journal of Carcinogenesis, ISSN: 1477-3163
2014; Vol 13: Issue 1, https://carcinogenesis.com/

Sentinel Lymph Node Biopsy in Melanoma: Who and When? A Literature Review

Shilpa Gopinath[1], Mike N Lacher[1], Elaine S Cyrus[2], Ulrich Rodeck[3], Richard Wang[1]

[1]MD, Department of Surgery, Saint Barnabas Medical Center, Livingston, NJ

[2]MD, Department of Dermatology, Rutgers New Jersey Medical School, Newark, NJ

[3]MD, P.dD, Department of Dermatology, Thomas Jefferson University, Philadelphia, PA

ABSTRACT

Melanoma is the mostdeadly form of skin cancer globally and causes considerable morbidity if not detected early. Sentinel lymph node biopsy (SLNBx) is an important staging technique used to guide prognosis and therapy; however, its application in thin and thick melanomas remains controversial. This review examines evidence from studies identified through PubMed, Cochrane Review, and Google Scholar that address SLNBx techniques, outcomes, and indications. The findings indicate that SLNBx should be considered standard practice for intermediate-thickness melanomas (1.0–4.0 mm). In thin melanomas (<1.0 mm), it should be used selectively in patients with high-risk pathological features, while in thick melanomas (>4.0 mm), it provides staging value, although its impact on survival remains unclear. The MSLT-I trial demonstrated improved disease-free survival with early nodal treatment in sentinel node–positive patients with intermediate-thickness melanoma. In conclusion, SLNBx is a valuable tool in melanoma management and should be applied based on tumor thickness and associated risk factors.

Keywords: *Melanoma, Sentinel Lymph Node Biopsy, Lymphatic Mapping, Tumor Thickness, Clinical Algorithm, Staging*

How to Cite: Shilpa Gopinath, Mike N Lacher, Elaine S Cyrus, Ulrich Rodeck, Richard Wang, (2014) Sentinel Lymph Node Biopsy in Melanoma: Who and When? A Literature Review, *Journal of Carcinogenesis, Vol.13, No.1*,

1. INTRODUCTION

Melanoma is an aggressive neoplasm capable of metastasizing unpredictably to virtually any organ. It is the most commonly fatal skin cancer worldwide and the fifth leading cancer in men in the United States [1]. Its incidence has risen faster than nearly any other preventable malignancy, with US rates increasing by 3.1 percent per year from 1992 to 2004 [5]. Projections for 2013 estimated 76,690 new invasive diagnoses and approximately 9,480 deaths [1].

Prognosis is strongly stage-dependent. Patients with thin lesions (<2.0 mm) often achieve cure with surgery alone, while those with thicker or nodally involved disease face significantly worse outcomes [14,15]. Despite stable or rising overall mortality, effective early-stage identification and surgical management including accurate nodal staging remains the cornerstone of improved survival [15].

Risk factors for melanoma include both genetic predisposition (atypical nevi, fair phenotype) and environmental exposures, particularly ultraviolet radiation from sunlight and tanning bed use [20,21,27]. The four recognized histological subtypes, superficial spreading, nodular, lentigo maligna, and acral lentiginous melanoma differ in growth pattern, clinical behavior, and demographic distribution [43,44]. These biological differences have implications for staging and management.

Accurate regional lymph node staging is central to determining prognosis, eligibility for adjuvant therapy, and surgical planning. Physical examination alone is unreliable: roughly 20 percent of clinically node-negative patients harbor occult metastases, while 20 percent of clinically positive nodes are pathologically negative at dissection. Sentinel lymph node biopsy (SLNBx) has emerged as the preferred method for definitive nodal evaluation [62–64].

This literature review synthesizes available evidence on the use of SLNBx in cutaneous melanoma including its technique, diagnostic accuracy, clinical impact by tumor thickness, and the results of key trials with the aim of proposing a practical clinical decision algorithm for patient selection.

2. STAGING OF CUTANEOUS MELANOMA

Staging is based on the 2010 AJCC/UICC TNM system, which stratifies patients by primary tumor characteristics, regional lymph node involvement, and distant metastases [59,60]. Stage I–II disease is confined to the primary tumor without nodal involvement. Stage III denotes pathologically confirmed regional lymph node disease or in-transit metastases, subclassified as IIIA–IIIC by extent of nodal burden. Stage IV indicates distant metastatic disease [61].

Nodal status is the most powerful independent prognostic variable in patients without distant metastases. In a retrospective analysis of 760 node-positive patients, conditional disease-specific survival improved markedly over five years from 78 to 90 percent in Stage IIIA and from 54 to 79 percent in Stage IIIB underscoring the value of early and accurate nodal staging [61].

Tumor thickness (Breslow depth), ulceration, and mitotic rate are the primary determinants of T-category and correlate strongly with sentinel node positivity. These variables form the clinical rationale for risk-stratified use of SLNBx.

3. SENTINEL LYMPH NODE BIOPSY

Rationale and Technique

Lymphatic mapping and SLNBx is based on the principle that melanoma metastasizes in an orderly fashion to a predictable "sentinel" node before involving other nodes in the regional basin [65,66]. If the sentinel node is histologically negative, the remainder of the basin can be presumed tumor-free, sparing patients unnecessary complete lymph node dissection. The technique pioneered by Morton et al. [66] and subsequently refined combines preoperative lymphoscintigraphy with intraoperative blue dye and radiocolloid injection to reliably identify the sentinel node.

Initial studies identified the sentinel node in 75 to 90 percent of cases, with only 1 to 2 percent of negative SLNBx patients subsequently developing regional recurrence [65,66]. With technical refinement, identification rates rose to 97 to 98 percent [69]. The reported false-negative rate ranges from 11 to 12.5 percent, with a negative predictive value of approximately 97 percent [69–71]. These figures compare favorably with elective lymph node dissection and fine-needle aspiration, which carry higher morbidity and lower sensitivity for occult disease, respectively [63,64].

When the sentinel node is positive, completion lymph node dissection (CLND) is the standard next step, restricting formal nodal surgery to patients most likely to benefit and thereby reducing morbidity in the majority [68].

Key Evidence: MSLT-I and MSLT-II

The Multicenter Selective Lymphadenectomy Trial-I (MSLT-I) is the largest randomized controlled trial to evaluate SLNBx in melanoma. Patients were randomized to wide excision plus SLNBx (with CLND if positive) versus wide excision alone with nodal observation. In patients with intermediate-thickness melanomas, SLNB-positive patients who underwent immediate CLND had significantly improved 10-year disease-free and melanoma-specific survival compared with those who underwent delayed lymphadenectomy after clinical nodal relapse [77]. Sentinel node status emerged as the strongest predictor of recurrence and survival across all thickness groups [77].

Several retrospective studies corroborate these findings. Leiter et al. demonstrated that SLNBx with early nodal excision reduced both regional and distant metastatic rates in sentinel node–positive patients [73]. Kretschmer et al. similarly reported survival benefits from early nodal clearance in node-positive patients [76]. In contrast, Roka et al. found that sentinel node status was not independently predictive of overall survival on multivariate analysis [75], highlighting ongoing controversy particularly for thick melanomas.

The Multicenter Selective Lymphadenectomy Trial-II (MSLT-II), designed to determine whether CLND after a positive sentinel node confers survival benefit over close ultrasound surveillance alone, was underway at the time of this review. Its results are expected to resolve the most clinically significant outstanding question in nodal management for melanoma.

Evidence by Tumor Thickness

Most studies consistently demonstrate that SLNBx is of clear benefit in intermediate-thickness disease. However, conflicting evidence exists for thin and thick melanomas, and data remain limited for high-risk subgroups within each category.

Thin melanomas (<1.0 mm): Sentinel node positivity in this group is generally low (3 to 7 percent), making routine SLNBx difficult to justify on cost-benefit grounds. However, a subset of thin melanomas with ulceration, mitotic rate ≥1/mm², or Clark level IV–V invasion carry substantially higher positivity rates and worse prognosis. Several retrospective analyses

support selective SLNBx in high-risk thin tumors, though prospective data validating specific cutoffs are lacking.

Intermediate-thickness melanomas (1.0–4.0 mm): Evidence most consistently supports routine SLNBx in this group. Sentinel node positivity rates of 15 to 25 percent justify the procedure, and MSLT-I demonstrated measurable survival benefit from early nodal management in sentinel node–positive patients [77].

Thick melanomas (>4.0 mm): Sentinel node positivity exceeds 30 to 40 percent in this group, but the high rate of concurrent distant micrometastases limits the staging impact of regional nodal status. Most published series show that SLNBx provides prognostic information and may guide adjuvant therapy selection [73,76], though no randomized trial has demonstrated a survival benefit specific to this thickness group. MSLT-I included thick melanoma patients and found sentinel node status to be prognostically significant, supporting continued use for staging purposes.

4. PROPOSED SLNB DECISION ALGORITHM

Based on the synthesized evidence, the following decision framework is proposed for clinical use. Patient selection for SLNBx should be individualized according to tumor thickness, pathological risk features, and patient fitness for surgery.

Tumor Category	Recommendation	Basis / Evidence
Thin (<1.0 mm) — Standard risk	SLNBx not routinely recommended. Observe clinically.	Low positivity rate (~3–7%). Risk/benefit does not support routine use.
Thin (<1.0 mm) — High risk (any of: ulceration, mitoses ≥1/mm², Clark IV–V, regression)	Consider SLNBx. Discuss with patient; shared decision-making advised.	Higher nodal positivity; retrospective data support selective use. Prospective evidence lacking.
Intermediate (1.0–4.0 mm)	SLNBx recommended for all eligible patients.	MSLT-I [77]; clear staging benefit; improved DFS with early CLND in node-positive patients.
Thick (>4.0 mm) — No palpable nodes	SLNBx recommended for staging and adjuvant therapy planning.	High positivity rate (>30%). Prognostic value confirmed [73,76]; survival benefit uncertain.
Thick (>4.0 mm) — Palpable nodes	Proceed directly to formal lymph node dissection. SLNBx not indicated.	Clinically overt nodal disease; direct dissection is standard of care [62].

Table 1. Proposed clinical decision algorithm for sentinel lymph node biopsy in cutaneous melanoma. CLND = completion lymph node dissection; DFS = disease-free survival.

Completion lymph node dissection is indicated following a positive sentinel node, consistent with current ASCO/SSO guidelines [68], pending the results of MSLT-II. All patients with positive nodes should be referred for multidisciplinary evaluation and considered for available adjuvant therapy trials.

5. METHODS

A structured literature review was conducted using PubMed, Cochrane Review, and Google Scholar. Search terms included: “melanoma,” “sentinel lymph node biopsy,” “lymphatic mapping,” “prognosis,” “survival,” “surgical resection,” “completion lymphadenectomy,” “wide excision,” “MSLT-1,” and “MSLT-2.”

Inclusion criteria encompassed randomized controlled trials, prospective cohort studies, and large retrospective series reporting on SLNBx technique, nodal identification rates, false-negative rates, regional recurrence, disease-free survival, or overall survival in adult patients with primary cutaneous melanoma. Studies were limited to English-language publications through December 2013. Case reports, editorials, and studies with fewer than 50 patients were excluded unless they addressed unique or underrepresented clinical scenarios.

Articles were screened by title and abstract for relevance, then retrieved in full text for critical appraisal. Data were synthesized narratively, given the heterogeneity of study designs, patient populations, and reported outcome measures.

Where possible, findings are characterized by strength and consistency of evidence across the literature.

6. RESULTS

Sentinel Node Identification and Diagnostic Accuracy

Across the reviewed literature, sentinel node identification rates improved substantially with increasing procedural experience and technical refinement from 75 to 90 percent in early series [65,66] to 97 to 98 percent in more recent large cohorts [69]. Most studies consistently demonstrate that a negative SLNBx reliably reflects basin-wide disease absence, with a negative predictive value of approximately 97 percent [71]. The reported false-negative rate of 11 to 12.5 percent [69,71] is consistent across institutions and is primarily attributable to anatomical variability in lymphatic drainage and multi-basin disease.

Clinical Outcomes by Thickness Group

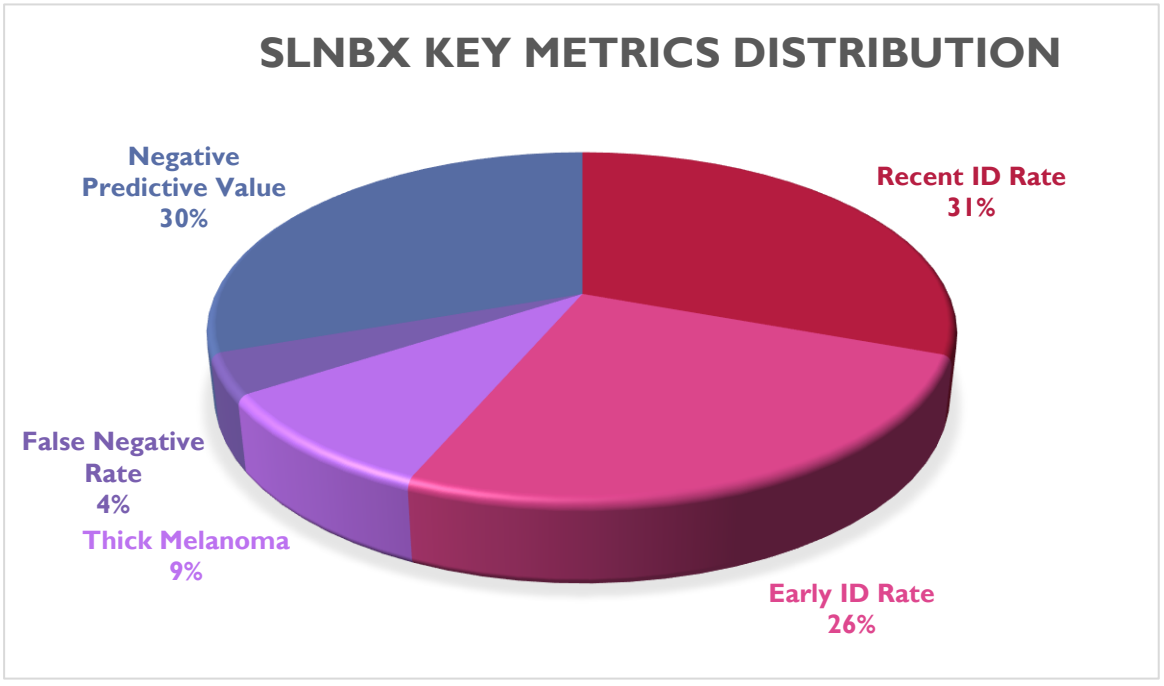
For intermediate-thickness melanomas, evidence is most consistent and robust. MSLT-I demonstrated statistically significant improvements in disease-free survival among sentinel node–positive patients who underwent immediate CLND versus delayed dissection at clinical relapse [77]. Multiple retrospective series corroborate early nodal clearance as beneficial in this group [73,76].

For thin melanomas, conflicting evidence exists regarding which pathological features reliably predict sentinel node positivity. While ulceration and elevated mitotic rate are the most frequently cited risk factors for nodal involvement, no prospective study has defined a validated threshold for SLNBx in thin disease. Data remain limited for this subgroup, and practice varies considerably across institutions.

For thick melanomas, most published series show sentinel node positivity rates exceeding 30 percent, confirming high-risk biology [73]. However, the prognostic impact of sentinel node status in this group is less consistent: while some studies identify it as an independent predictor of survival [73,76], others find it superseded by distant disease burden [75]. The strength of evidence supporting routine SLNBx in thick melanoma is therefore moderate and rests primarily on staging and therapeutic selection rather than demonstrated survival benefit.

Morbidity Considerations

SLNBx itself carries low procedural morbidity compared with elective lymph node dissection. Complications of CLND including lymphedema, wound infection, seroma, and pain are well-documented and site-dependent, with inguinal dissection carrying higher complication rates than axillary dissection [72]. These morbidity considerations reinforce the importance of accurate patient selection: the goal of SLNBx is to identify the subset of patients who will genuinely benefit from CLND while sparing the majority.



MSLT-I Summary and Pending Evidence from MSLT-II

MSLT-I established SLNBx as a standard staging procedure for intermediate-thickness melanoma and demonstrated that early nodal management in sentinel node–positive patients improves outcomes [77]. The pending MSLT-II data are expected to determine whether CLND remains necessary following a positive sentinel node, or whether active ultrasound surveillance is a safe alternative. Resolution of this question will have direct implications for clinical practice and may further narrow the therapeutic indications for CLND.

7. DISCUSSION

This review supports the pivotal role of sentinel lymph node biopsy (SLNBx) as a safe and valuable staging procedure in cutaneous melanoma, especially when combined with tumor thickness and other pathological features. The high sentinel node identification rates (approaching 97–98%) and negative predictive value (~97%) demonstrate the technical refinement and diagnostic reliability of the procedure across institutions. However, the false-negative rate (11–12.5%) highlights inherent limitations due to lymphatic variability and indicates the need for ongoing technical improvement and optimized patient selection in SLNBx.

The benefits of SLNBx differ among melanomas of varying thickness. The strongest evidence exists for intermediate-thickness melanomas. The MSLT-I trial and supporting retrospective studies show that early detection and treatment of nodal disease improve disease-free survival, establishing SLNBx as the standard of care in this group. These findings emphasize the benefits of early nodal management and support the concept of orderly lymphatic spread.

In contrast, the role of SLNBx in thin melanomas has not been definitively established. Although most thin melanomas have low rates of nodal involvement, the presence of high-risk features such as ulceration and increased mitotic rate suggests that a subset of patients may benefit from SLNBx. The lack of prospective data to define clear thresholds contributes to variability in clinical practice and highlights the need for further research. Future studies should aim to establish standardized criteria for improved risk stratification in this group.

For thick melanomas, high sentinel node positivity rates confirm aggressive tumor biology; however, the prognostic and therapeutic role of SLNBx is more complex. While sentinel node status is an important staging factor, its independent prognostic impact on survival is variable, likely due to the greater burden of occult distant metastases. Therefore, the value of SLNBx in this group lies more in prognostication and guiding adjuvant therapy than in providing a direct survival benefit.

Morbidity considerations also support a selective approach to SLNBx. The procedure carries significantly lower morbidity compared with completion lymph node dissection (CLND). The well-documented complications of CLND, including lymphedema and wound infection, emphasize the importance of accurately identifying patients who are most likely to benefit from additional lymph node surgery. This reinforces the role of SLNBx as a triage procedure to minimize unnecessary surgical morbidity.

The evolving evidence base, including the anticipated results of MSLT-II, is likely to influence future clinical practice. The necessity of CLND following a positive sentinel node remains a critical question. If active surveillance proves equivalent to immediate dissection, the role of SLNBx may shift further toward staging and prognostication rather than guiding additional surgical intervention. Overall, this review highlights the value of SLNBx while emphasizing the need for continued research and a carefully applied, evidence-based approach in melanoma management.

8. CONCLUSION

Sentinel lymph node biopsy is an established and essential staging procedure in the management of cutaneous melanoma. The evidence most clearly supports its routine use in intermediate-thickness disease (1.0–4.0 mm), where it provides accurate nodal staging and based on MSLT-I enables early nodal management associated with improved disease-free survival. For thin melanomas, selective application in the presence of high-risk features (ulceration, elevated mitotic rate, Clark level IV–V) is reasonable and increasingly practiced, though prospective evidence to define precise thresholds is still needed. In thick melanomas, SLNBx retains value for staging and adjuvant therapy planning, though its survival benefit remains to be definitively established.

The proposed algorithm (Table 1) provides a structured, evidence-based framework for clinical decision-making. Limitations of this review include the retrospective nature of most included studies, heterogeneity in patient selection criteria, and variability in technical approaches across institutions. The anticipated results of MSLT-II will likely refine current recommendations, particularly regarding the role of CLND in sentinel node–positive patients. Until that evidence is available, SLNBx guided by the stratified approach outlined here remains the standard of care for regional staging in

melanoma.

REFERENCES

1. Siegel R, Naishadham D, Jemal A. Cancer statistics, 2013. CA Cancer J Clin. 2013;63(11):11–30.
2. Jemal A, et al. Annual Report to the Nation on the Status of Cancer, 1975–2009. J Natl Cancer Inst. 2013;105(175).
3. Ferlay J, et al. Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008. Int J Cancer. 2010;127(12):2893–917.
4. Parkin DM, Pisani P, Ferlay J. Estimates of the worldwide incidence of 25 major cancers in 1990. Int J Cancer. 1999;80(6):827–41.
5. Linos E, et al. Increasing burden of melanoma in the United States. J Invest Dermatol. 2009;129(7):1666–74.
6. Altekruse SF, et al. SEER Cancer Statistics Review, 1975–2007. National Cancer Institute. Bethesda, MD, 2010.
7. Kohler BA, et al. Annual report to the nation on the status of cancer, 1975–2007. J Natl Cancer Inst. 2011;103(9):714–36.
8. Jemal A, et al. Recent trends in cutaneous melanoma incidence and death rates in the United States, 1992–2006. J Am Acad Dermatol. 2011;65(1):17–25.
9. Welch HG, Woloshin S, Schwartz LM. Skin biopsy rates and incidence of melanoma. BMJ. 2005;331(7515):481.
10. Cockburn MG, et al. Melanoma underreporting: why does it happen, how big is the problem, and how do we fix it? J Am Acad Dermatol. 2008;59(6):1081–5.
11. Howlader N, et al. The impact of underreported Veterans Affairs data on national cancer statistics. J Natl Cancer Inst. 2009;101(7):533–6.
12. Kopf AW, Rigel DS, Friedman RJ. The rising incidence and mortality rate of malignant melanoma. J Dermatol Surg Oncol. 1982;8(9):760–1.
13. Rigel DS, Russak J, Friedman R. The evolution of melanoma diagnosis: 25 years beyond the ABCDs. CA Cancer J Clin. 2010;60(5):301–16.
14. Balch CM, et al. Prognostic factors analysis of 17,600 melanoma patients. J Clin Oncol. 2001;19(16):3622–34.
15. Geller AC, et al. Melanoma incidence and mortality among US whites, 1969–1999. JAMA. 2002;288(14):1719–20.
16. US National Center for Health Statistics (NCHS) and SEER. Available at: http://seer.cancer.gov/canques/.
17. Lange JR, et al. Melanoma in children and teenagers. J Clin Oncol. 2007;25(11):1363–8.
18. Strouse JJ, et al. Pediatric melanoma: risk factor and survival analysis of the SEER database. J Clin Oncol. 2005;23(21):4735–41.
19. Cormier JN, et al. Ethnic differences among patients with cutaneous melanoma. Arch Intern Med. 2006;166(17):1907–14.
20. Tucker MA, et al. Clinically recognized dysplastic nevi: a central risk factor for cutaneous melanoma. JAMA. 1997;277(18):1439–44.
21. Veierød MB, et al. A prospective study of pigmentation, sun exposure, and risk of cutaneous malignant melanoma in women. J Natl Cancer Inst. 2003;95(20):1530–8.
22. Olsen CM, Carroll HJ, Whiteman DC. Estimating the attributable fraction for cancer: a meta-analysis of nevi and melanoma. Cancer Prev Res (Phila). 2010;3(2):233–45.
23. Halpern AC, et al. A cohort study of melanoma in patients with dysplastic nevi. J Invest Dermatol. 1993;100(3 Suppl):346S–349S.
24. Kang S, et al. Melanoma risk in individuals with clinically atypical nevi. Arch Dermatol. 1994;130(8):999–1001.
25. Tsao H, Pehamberger H, Sober AJ. Precursor lesions and markers for increased risk of melanoma. In: Balch CM, et al., eds. Cutaneous Melanoma. Quality Medical Publishing; 1998:65.
26. Eide MJ, Weinstock MA. Association of UV index, latitude, and melanoma incidence in nonwhite populations. Arch Dermatol. 2005;141(4):477–81.
27. El Ghissassi F, et al. A review of human carcinogens—part D: radiation. Lancet Oncol. 2009;10(8):751–2.
28. International Agency for Research on Cancer Working Group. The association of use of sunbeds with cutaneous malignant melanoma. Int J Cancer. 2007;120(5):1116–22.
29. Lazovich D, et al. Indoor tanning and risk of melanoma. Cancer Epidemiol Biomarkers Prev. 2010;19(6):1557–68.
30. Cust AE, et al. Sunbed use during adolescence and early adulthood is associated with increased risk of early-onset melanoma. Int J Cancer. 2011;128(10):2425–35.
31. Vajdic CM, et al. Artificial ultraviolet radiation and ocular melanoma in Australia. Int J Cancer. 2004;112(5):896–900.
32. Stern RS; PUVA Follow up Study. The risk of melanoma in association with long-term exposure to PUVA. J

Am Acad Dermatol. 2001;44(5):755–61.
33. Kvaskoff M, et al. Personal history of endometriosis and risk of cutaneous melanoma. Arch Intern Med. 2007;167(19):2061–5.
34. Somigliana E, et al. Association between endometriosis and cancer. Gynecol Oncol. 2006;101(2):331–41.
35. Bertoni JM, et al. Increased melanoma risk in Parkinson disease. Arch Neurol. 2010;67(3):347–52.
36. Inzelberg R, Israeli-Korn SD. The particular relationship between Parkinson's disease and malignancy. J Neural Transm. 2009;116(11):1503–7.
37. Elwood JM, Jopson J. Melanoma and sun exposure: an overview of published studies. Int J Cancer. 1997;73(2):198–203.
38. Tsao H, et al. The transformation rate of moles into cutaneous melanoma. Arch Dermatol. 2003;139(3):282–8.
39. Skender-Kalnenas TM, English DR, Heenan PJ. Benign melanocytic lesions: risk markers or precursors of melanoma? J Am Acad Dermatol. 1995;33(6):1000–7.
40. Nelemans PJ, et al. Effect of intermittent exposure to sunlight on melanoma risk. Environ Health Perspect. 1993;101(3):252–5.
41. Gilchrest BA, et al. The pathogenesis of melanoma induced by ultraviolet radiation. N Engl J Med. 1999;340(17):1341–8.
42. Ward E, et al. Industries and cancer. Cancer Causes Control. 1997;8(3):356–72.
43. McGovern VJ, et al. The classification of malignant melanoma and its histologic reporting. Cancer. 1973;32(6):1446–57.
44. Jelfs PL, et al. Cutaneous malignant melanoma in Australia, 1989. Med J Aust. 1994;161(3):182–7.
45. Clark WH Jr, et al. The histogenesis and biologic behavior of primary human malignant melanomas of the skin. Cancer Res. 1969;29(3):705–27.
46. Clark WH Jr, Elder DE, Van Horn M. The biologic forms of malignant melanoma. Hum Pathol. 1986;17(5):443–50.
47. Weinstock MA, Sober AJ. The risk of progression of lentigo maligna to lentigo maligna melanoma. Br J Dermatol. 1987;116(3):303–10.
48. Swetter SM, et al. Increasing incidence of lentigo maligna melanoma subtypes. J Invest Dermatol. 2005;125(4):685–91.
49. Cohen LM. Lentigo maligna and lentigo maligna melanoma. J Am Acad Dermatol. 1995;33(6):923–36.
50. Bulliard JL, Cox B, Elwood JM. Latitude gradients in melanoma incidence and mortality. Cancer Causes Control. 1994;5(3):234–40.
51. Devesa SS, et al. Atlas of Cancer Mortality in the United States 1950–1994. NIH Publication No. 99-4564; 1999.
52. Pennello G, Devesa S, Gail M. Association of surface ultraviolet B radiation levels with melanoma in United States blacks. Cancer Epidemiol Biomarkers Prev. 2000;9(3):291–7.
53. Abbasi NR, et al. Early diagnosis of cutaneous melanoma: revisiting the ABCD criteria. JAMA. 2004;292(22):2771–6.
54. Wolff T, Tai E, Miller T. Screening for skin cancer: an update of the evidence for the USPSTF. Ann Intern Med. 2009;150(3):194–8.
55. Breitbart EW, et al. Systematic skin cancer screening in Northern Germany. J Am Acad Dermatol. 2012;66(2):201–11.
56. U.S. Preventive Services Task Force. Screening for skin cancer: USPSTF recommendation statement. Ann Intern Med. 2009;150(3):188–93.
57. US Preventive Services Task Force. Guide to Clinical Preventive Services, 3rd ed. Available at: www.ahrq.gov/clinic/preview.htm.
58. American Academy of Dermatology. Melanoma fact sheet. http://www.aad.org/public/exams/screenings.
59. Melanoma of the Skin. In: AJCC Cancer Staging Manual, 7th ed. Edge SB, et al., eds. Springer; 2010:325.
60. Balch CM, et al. Final version of 2009 AJCC melanoma staging and classification. J Clin Oncol. 2009;27(36):6199–206.
61. Melanoma of the Skin. In: AJCC Cancer Staging Manual, 7th ed. Edge SB, et al., eds. Springer; 2010:325.
62. NIH Consensus Conference. Diagnosis and treatment of early melanoma. JAMA. 1992;268(10):1314–9.
63. Rodrigues LK, et al. Fine needle aspiration in the diagnosis of metastatic melanoma. J Am Acad Dermatol. 2000;42(5):735–40.
64. Voit C, et al. Rotterdam Criteria for sentinel node tumor burden and accuracy of ultrasound-guided FNAC. J Clin Oncol. 2009;27(30):4994–5000.
65. Reintgen D, et al. The orderly progression of melanoma nodal metastases. Ann Surg. 1994;220(6):759–67.
66. Morton DL, et al. Technical details of intraoperative lymphatic mapping for early stage melanoma. Arch Surg. 1992;127(4):392–9.
67. Krag DN, et al. Minimal-access surgery for staging of malignant melanoma. Arch Surg. 1995;130(6):654–8.
68. Sentinel lymph node biopsy for melanoma: ASCO and SSO Joint Clinical Practice Guideline. J Clin Oncol.

2012.
69. Valsecchi ME, et al. Lymphatic mapping and sentinel lymph node biopsy in patients with melanoma: a meta-analysis. J Clin Oncol. 2011;29(11):1479–87.
70. Sondak VK, Zager JS. Who is to blame for false-negative sentinel node biopsies in melanoma? Ann Surg Oncol. 2010;17(1):6–7.
71. Scoggins CR, et al. Factors associated with false-negative sentinel lymph node biopsy in melanoma patients. Ann Surg Oncol. 2010;17(3):709–17.
72. Shaw JH, Rumball EM. Complications and local recurrence following lymphadenectomy. Br J Surg. 1990;77(7):760–4.
73. Leiter U, et al. Sentinel lymph node dissection in primary melanoma reduces subsequent regional and distant metastasis. Ann Surg Oncol. 2010;17(1):129–37.
74. Nowecki ZI, et al. Sentinel lymph node biopsy in melanoma patients with clinically negative regional lymph nodes. Melanoma Res. 2003;13(1):35–43.
75. Roka F, et al. Sentinel node status in melanoma patients is not predictive for overall survival upon multivariate analysis. Br J Cancer. 2005;92(4):662–7.
76. Kretschmer L, et al. Patients with lymphatic metastasis of cutaneous malignant melanoma benefit from sentinel lymphonodectomy and early excision of nodal disease. Eur J Cancer. 2004;40(2):212–8.
77. Morton DL, et al. Sentinel-node biopsy or nodal observation in melanoma. N Engl J Med. 2006;355(13):1307–17.