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Utilization of Routine Pathology Evaluation of Non-Malignant Lesions in Hand Surgery – A National Study

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Abstract

Background—Most lesions of the upper extremity are common and benign, and many have questioned the need for routine pathology evaluation of these specimens. We aim to examine the national utilization of routine pathology examination of non-malignant hand lesions to help guide healthcare policy and practice patterns.

Methods—We used a national level MarketScan database to form a cohort of adult patients who underwent excision of non-malignant upper extremity lesions. We calculated the rate of submission for each surgical procedure and separately for each diagnosis. We also investigated demographic and clinical characteristics associated with the submission of surgical specimens using a multivariable logistic regression model. We calculated total cost of routine pathology evaluation.

Results—The final study cohort included 222,947 patients and 182,962 specimens from 153,518 cases. The mean rate of submission was 69%. Older age, Northeast region, and high comorbidity scores showed significant correlation with the odds of having a specimen submitted for pathology evaluation. Excision of primary wrist ganglion was the most performed procedure, and benign lesions over 4.0cm in size were most frequently submitted for pathology. The mean cost of routine pathology exam was \$133 per specimen and annual expenditure of \$5 million.

Conclusions—The routine pathology examination of benign hand lesions is utilized frequently while providing limited clinical benefit at a cost. To increase efficiency and improve quality of care, surgeons should be aware of the low value of routine pathology evaluation and be more selective for cases for which diagnostic testing will change management.

Keywords

Routine pathology; excision of benign hand lesions; cost-benefit analysis; value-based care; practice guideline; health policy; resource utilization

The American College of Surgeons stipulated in 1926 that all tissues removed during an operation must be examined by laboratory pathology service.¹ This policy has since become the standard of practice that many surgeons still follow today.^{2–4} The practice of defensive medicine, estimated to cost \$46 billion annually in the U.S.,⁵ is one of the main reasons for the reflexive submission of specimens.^{6–9} In 1999, the College of American Pathologists and the Joint Commission on Accreditation of Healthcare Organizations published a set of updated recommendations by including the list of specimen types exempt from routine pathological evaluation: those that “by nature or condition do not permit productive examination,” and those with which “the quality of care has not been compromised by the exception.”¹⁰ Based on these guidelines, many institutions have devised their own policies on surgical pathology exemption.^{2,3,11} In the same year, a national survey on pathology labs showed a wide variation of specimen types in both the exempt (2–40) and the gross only category (6–57).¹² Evidently, surgeons and pathologists did not share a general consensus on what qualifies as productive examination.

Lesions of the upper extremity are common with an estimated 15% of all soft tissue tumors found in the human body localized to the hand.^{13,14} Among all benign upper extremity tumors, ganglions are noted to be the most prevalent (50–70%), followed by giant cell tumor of tendon sheath (14%), and mucous cysts (11%).¹⁵ The risk of an upper extremity lesion being malignant is very low at 1–2%^{16,17} for both soft tissue tumors¹⁸ and bony tumors.¹⁹ Several authors have stated that because malignant lesions of the upper extremity are so uncommon, histopathological tissue analysis is rarely beneficial to warrant routine examination.^{20,21}

Routine pathologic evaluation of excised specimen has been questioned in many surgical fields including plastic surgery, orthopedic surgery, urology, otolaryngology, and general surgery.^{1–4,6,7,13,21–27} Previous works have uniformly found that routine surgical pathology diagnosis did not change the treatment plan and thus concluded the practice neither cost-effective²⁵ nor cost-beneficial.^{1–4,6,7,13,21–27} In the field of hand surgery, the value of pathology examination of benign tumors of the upper extremity has been investigated in a few case series demonstrating minimal clinical benefit.^{2,6,13} These studies had limited external validity, because they were restricted to a single institution or a local network of healthcare centers. They also submitted all of their excised specimens for pathology evaluation.^{2,6,13} This study design does not reflect a realistic practice pattern, because a 100% submission rate is highly unlikely especially if the surgeon is not suspecting malignancy.

A wide variation already existed among institutional policies regarding specimens exempt from surgical pathology in 1999.¹² To investigate the current pattern of utilization of routine surgical pathology examination in hand surgery, we designed a retrospective cohort study with cross-sectional analysis of national claims data for excision of non-malignant lesions of

the upper extremity. We hypothesize that routine examination of hand surgical specimen with little to no clinical gain is still practiced routinely. Furthermore, we will demonstrate an estimate of the national expenditure on this routine practice to quantify the potential monetary saving and to guide healthcare policy towards improving efficiency and quality of care.

Methods

Data source

This study is exempt from Institutional Review Board oversight. We investigated claims data from the Truven Health MarketScan Research Databases: the Commercial Claims and Encounters Database and Medicare Supplement and Coordination of Benefits Database from 2009 to 2015. MarketScan Databases capture person-specific clinical utilization, cost, and enrollment across inpatient and outpatient services. The data come from a large selection of employers and represent medical experiences for insured employees, their dependents, and early retirees. Each claim can be connected to a specific patient through a unique identification number; patient can be followed through multiple clinical encounters.

Inclusion criteria

We included patients age 18 years or older who underwent outpatient excision of non-malignant lesions of the upper extremity between 2009 and 2015, using the Current Procedural Terminology (CPT®) codes. We defined “non-malignant lesion” as those that were not diagnosed malignant at the time of excision, but not necessarily labeled benign. For surgical CPT codes that are not specific to the upper extremity - for example, code 11400 “excision, benign lesion, except skin tag, trunk, arms or legs; lesion diameter 0.5cm or less,” we included only claims that had an International Classification of Diseases, Ninth and Tenth Revisions, Clinical Modification procedure codes (ICD-9-CM, ICD-10-CM) specific to the upper extremity (e.g. ICD-9-CM 2166: benign neoplasm of skin of upper limb, including shoulder). (See Appendix A, Supplemental Digital Content 1, which shows Inclusion Criteria, [INSERT HYPER LINK](#).) We captured the first outpatient excision of these hand lesions for each patient and required a 12-month continuous enrollment before this surgical procedure to make sure we only included new cases.

Exclusion criteria

We excluded patients who underwent excision of malignant lesion of the upper extremity within two months before the surgery; the excision may be to assess margins and if so, pathology examination is necessary. We also excluded biopsy procedures as the purpose of the surgery is to produce a specimen for a pathology evaluation for a definitive diagnosis to guide treatment.^{15,21} Using ICD-CM codes, we excluded patients with previously diagnosed malignancy. Also, we excluded patients who underwent incision and drainage or debridement procedures of the upper extremity within two months of the outpatient hand surgery of interest because infectious diseases clinically indicate specimen submission for microbial culture and antibiotic sensitivities (See Appendix B, Supplemental Digital Content 2, which shows the Exclusion Criteria: Appendix B-1. Excision of Malignant Lesion; Appendix B-2. Malignant Diagnoses; Appendix B-3. Infectious Diseases of the Upper

Extremity – Diagnoses; Appendix B-4. Infectious Diseases of the Upper Extremity – Procedures; Appendix B-5. Chemotherapy Procedures; Appendix B-6. Radiation Procedures, [INSERT HYPER LINK](#)).

Independent and dependent variables

The outcomes of interest were the rate of specimen submission for excision of non-malignant hand lesions and the cost of this routine practice during the five years between 2010 and 2015. The independent variables in this study includes patients' age in groups (18–34 years, 35–44 years, 45–54 years, 55–64 years, and 65 years and older), sex, median household income within the metropolitan statistical area (MSA) where the patient resided, insurance plan type, and geographical region where the surgery took place. We calculated a comorbidity score for each patient using the Modified Elixhauser Comorbidity Measures, a condensed version of the comorbidity system shown to be superior to the widely used Charlson comorbidity system.^{28,29}

Data analysis

We calculated the rate of specimen submission for pathology evaluation per surgical procedure and diagnosis, then performed a univariate analysis for the correlation between specimen submission and each patient characteristic. We examined the patient characteristics that influenced surgical pathology submission with a multivariable logistic regression model. We reported adjusted odds ratios (OR) of getting specimen submitted for each patient characteristic and the corresponding confidence intervals. We calculated the risk of malignancy revealed by routine pathology examination by capturing the number of patients who had a new diagnosis of malignancy localized to the upper extremity dated after the initial surgery. Then we found the number of patients who either underwent a second excision of a malignant upper extremity lesion within two months from the initial procedure or received chemotherapy or radiation (See Appendix B-5 and B-6 of Supplemental Digital Content 2, for Chemotherapy Procedures and Radiation Procedures, [INSERT HYPER LINK](#)). We inferred that a re-excision would indicate that the original lesion was found to be malignant by pathology evaluation, because it is unusual to excise another benign-appearing lesion separately within two months' time. We also examined patient characteristics to find any that were significantly correlated with malignant diagnosis by calculating odds ratios in another multivariable logistic regression model. Lastly, we determined the national total and mean cost of pathology examination per each pathology procedure during the observed period.

Results

Sample characteristics

The final study cohort analyzed 222,947 patients who underwent excision of benign upper extremity lesion. We found that 182,962 specimens from 153,518 cases were submitted for pathology evaluation, resulting in overall submission rate of 69% (See Appendix D, Supplemental Digital Content 4, which shows the rate of Specimen Submission per Surgical Procedure, [INSERT HYPER LINK](#)). There were no significant association between specimen submission and sex, median house income, or insurance type (Table 1). The odds

of having specimens sent for surgical pathology decreased as the patient's age increased. For example, the odds of a patient older than 65 years getting his/her benign hand lesion submitted for pathology was 0.64 times less compared to patients 18 to 34 years old (Table 2). This trend illustrates how patients' age influences treatment plans, that the number of life-years potentially gained by intervention is valued less for the elderly compared to younger patients. The submission of specimen was also significantly influenced by the geographical region. Patients treated in the Northeast were most likely to have specimens evaluated by pathology (OR 1), followed by the North Central region (OR 0.83), the South (OR 0.67), and lastly the West (OR 0.50) (Table 2). This may be a result of the high number of medical litigations in the Northeast region. Lastly, patients with higher comorbidity scores were more likely to have the pathology examination of the specimen (Table 2).

Rate of Utilization – by diagnosis and surgical procedure

In this cohort, “excision of primary wrist ganglion” (CPT code 25111) was performed the most, comprising 19% of total number of cases. This was closely followed by “excision of lesion of tendon sheath or capsule, e.g. mucous cyst, hand or finger” (CPT code 26160) at 17% (Figure 1) (See Appendix D, Supplemental Digital Content 4, [INSERT HYPER LINK](#)). The procedure that had the highest rate of specimen submission was “excision, benign lesion, except skin tag, scalp, neck, hands, feet, genitalia: lesion diameter over 4.0cm” (CPT code 11426); 91% of the cases had surgical pathology evaluation. After sorting data by ICD codes, we found “benign neoplasm of skin of upper limb, including shoulder” (ICD-9-CM 2166) to be the most prevalent diagnosis, and also with the highest rate of specimen submission (87%). Ganglion of joint (ICD-9-CM: 72741) was the second most prevalent diagnosis, with rate of submission at 70% (Figure 2).

Risk of Malignancy

From 153,518 cases that had surgical pathology evaluation, only 879 patients had a malignant diagnosis made within 2 months from the initial excision of upper extremity lesion. Out of this subgroup, 319 patients underwent a second excision of the upper extremity within 2 months of the original surgery. In a discordant case, pathology evaluation reveals new information and alters the treatment plan. In a discrepant case, the new information is revealed, but does not change the treatment plan. The rate of discrepancy and discordance is calculated with the total number of cases undergoing pathology evaluation as the denominator.^{6,13} Therefore, there were 319 discordant cases (0.2%) and 560 discrepant cases (0.4%) in our sample. The odds of malignant diagnosis were statistically significant for age groups 55–64 (OR 1.41) and 65 and older (OR 2.37), and higher comorbidity scores (OR 2.20 – 6.83). The odds ratios increased as the score increased (Table 3). This indicates that a patient's high comorbidity score should alert the surgeon to a high likelihood of a malignant diagnosis.

Rate of Utilization and Cost – pathology evaluation

A total of 182,962 pathologic examinations were captured in the analysis because pathology service is billed per specimen. The total cost of routine pathologic evaluation of non-malignant lesions of the upper extremity during the observed 5 years was over \$24 million nationally (Table 4). On average, each specimen submitted underwent pathology evaluation

at the expense of \$133 per specimen, for both technical and professional component of service. Level III gross and microscopic analysis (CPT 88304) was the most frequently performed pathology procedure, comprising 52% of all pathology procedures performed at the cost of \$9.4 million (Figure 2). The second most utilized analysis was Level IV gross and microscopic evaluation (CPT 88305, 36%); although this exam had lower case count, the average cost was higher and thus cost more in total, at \$11 million (Table 4). Advanced histopathologic tests were rarely used (Figure 2). Despite the low unit cost, basic level pathology evaluation (Level I – VI Gross and microscopic analysis) has a high collective cost because it was performed frequently. Level III and IV evaluations together comprised 88% of the pathology services performed on the upper extremity lesions.

Discussion

There has not been a study demonstrating the nationwide pattern of practice regarding routine submission of surgical pathology specimen for lesions of the upper extremity. Our study assessing at a national database found that the routine pathology evaluation of benign-appearing hand specimens has been frequently utilized at the rate of 69%. A diagnostic test is only worthwhile if the result is meaningful and provides information to guide patient care.² Although patients often request a definitive diagnosis of benign appearing lesions with pathology, routine pathology evaluation is only truly beneficial if the results change the course of treatment. A few studies have examined benign hand lesions but all of them failed to find a single discordant case.^{2,6,13} The three studies together evaluated 714 benign hand lesions. Even if, hypothetically, the 715th lesion was malignant, the cost of finding that rare case is \$95,095 (715 specimens × our result of \$133 per specimen). These studies concluded that the chance of diagnosing occult malignancy in these lesions was low enough to warrant a change to the practice of the routine pathology specimen submission. Our analysis showed similar risk of discordance at 0.2%, and the cost to find one discordant case at \$75,236. The total cost for this practice was over \$24 million in 5 years. Marketscan database reported average of 52.5 million patients per year since 2010. The U.S. adult population is 240 million. Extrapolating our results to include patients without job-provided insurance, the estimated cost of routine pathology evaluation of non-malignant upper extremity lesions is \$23 million per year (population ratio (240/52.5) × our result of \$5 million per year). Raab noted the clinical responsibility of a physician to catch every rare case in his discussion of routine diagnostic tests;⁶ however, in light of the nationwide initiative to contain healthcare costs, the value of such defensive practice must be assessed through economic analyses. Many experts have concluded that routine testing is not worthwhile.^{11,20,21} Physicians should judiciously select the cases that warrant pathology evaluation. We found that older age and higher comorbidity scores had higher odds of malignancy by pathology diagnosis. This does not necessarily imply that benign-appearing lesions must be sent for pathology evaluation if the patient is older or has many comorbidities. Rather, surgeons should be hyper-vigilant about the likelihood of malignancy and assess the lesion for suspicious qualities and submit for pathology evaluation if concerned. The future of healthcare payment model moves towards value-based care system and bundled payments.³⁰ To protect adequate reimbursement and compensation for the services clinically indicated and absolutely essential, we need to reduce unnecessary components such as routine testing.^{1,30,31}

In our study, the Northeast region was associated with highest rate of specimen submission when compared to other regions. This difference possibly owes to the higher number of medical malpractice lawsuits in the Northeast.³² In fact, experts suggest that more than 70% of the physicians across the country are influenced by the fear of medical liability.³³ There are many reasons behind repetitive and unnecessary testing, such as patient expectations, diagnostic completeness, and peer and commercial pressure. Medical malpractice management is a powerful driving force in financing healthcare, and fear of litigation cannot be taken lightly.^{6–8,34} The relatively low cost of individual specimen submission (\$133) likely contributes to the frequent utilization despite the low clinical value. As individual unit cost is low, medical providers have a low decision threshold each time they order a test.³⁵ Thus, the simple, relatively cheap test is ordered often, with a large collective cost as a consequence.³⁶ In fact, a large-scale systematic review found 25–40% of all laboratory tests redundant.³⁷ Healthcare in the U.S. is notoriously expensive and is growing at an unsustainable rate.^{30,38} The National Academy of Medicine report estimated in 2012 that \$690 billion was wasted in U.S. health care annually, not including fraud.³⁹ According to McKinsey Global Institute, the U.S. spent nearly \$650 billion more than did other developed countries in 2006 after controlling for its relative wealth.⁴⁰ An analysis of the increases in healthcare costs over the last 30 years has revealed that two-thirds of the excess increase is caused by inefficient, repetitive testing.^{7,38,41} The practice of defensive medicine is estimated to cost \$46 billion annually in the U.S., which is more than 80% of total expenditure for medical liability of \$55.6 billion.⁵

This study has several limitations. First, owing to the nature of retrospective cohort analysis using diagnosis and procedure codes from a national level database, our study is biased from the inherent uncertainty and variation in coding practice and record keeping. There is a well-known motive in the medical field to “up code” for services; in other words, providers will preferentially select the code that will bring in higher reimbursement. In surgical fields, excision of suspicious lesions pays more than excision of benign lesions. Our result of \$24 million in cost may be considered an overestimate because of the coding practice; however, our estimate still stands valid because we selected our study cohort very conservatively. The uncertain extent of up-coding is balanced by the lower number of specimens included in the analysis. Another limitation resulted from the way healthcare reimbursement works for health insurances, as the charges claimed to the insurance company does not precisely correlate to the actual costs incurred by the hospital or the physician. For instance, two pathologists may evaluate one surgical specimen; one physician would bill for both technical and professional component of the service, whereas the other physician may not bill at all because his professional service is paid by the hospital. Therefore, it is difficult to accurately determine the total cost of pathology examination per specimen. Furthermore, the real cost of a service includes the financial expenses and other invested resources such as time, energy, and efforts of the professionals. In our study, we were only able to capture the monetary cost claimed to the insurance companies for routine pathology evaluations. We can estimate that the real cost would be much higher. Lastly, economic analysis is constrained by the cost that society’s willing to spend for a rare diagnosis has yet to be determined. Defining this price is essential for an accurate analysis of the economic value of a diagnostic test.¹¹ Still, considering the substantial cost of finding such a rare save, the social consensus

is unlikely to deem routine testing financially justified. The concept of decreasing redundancy to improve quality is general and widely applicable to the field of plastic surgery. What we have found in our study can be extrapolated to procedures such as breast augmentation and skin grafting, that also produce similar type of specimens that are likely benign unless preoperatively suspected otherwise. Experts from other surgical fields such as orthopedic surgery and otolaryngology have arrived at conclusions similar to ours.^{1–4,6,7,13,21–27,42,43} We anticipate this demonstration of the “low-yield” of routine pathology evaluation of benign hand lesions on a national level should promote a change in policy towards improving quality and efficiency of healthcare by institute guidelines to protect surgeons from practicing value-based care.

Pathology evaluation of non-malignant lesions of the upper extremity provides little clinical benefit, yet it is regularly utilized. Such practice costs the U.S. \$23 million a year for solely upper extremity lesions. In efforts to contain healthcare costs and promote improvement in quality along the national agenda for value based care, the policy regarding the routine specimen submission should be changed to decrease redundancy and increase efficiency.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Chesley PM, Black GE, Martin MJ, Johnson EK, Maykel JA, Steele SR. The utility of pathologic evaluation of adult hernia specimens. *Am J Surg.* 2015; 209:783–786. discussion 786. [PubMed: 25725504]
2. McKeon K, Boyer MI, Goldfarb CA. Use of routine histologic evaluation of carpal ganglions. *J Hand Surg.* 2006; 31:284–288.
3. Culp JA, Hartigan BJ, Stern PJ. A brief note. Ask yourself, why? A cost effective look at routine pathologic examination of specimens using the trapezium. *J Bone Joint Surg.* 2001; 83-a:722–724. [PubMed: 11379742]
4. Matthyssens LE, Ziol M, Barrat C, Champault GG. Routine surgical pathology in general surgery. *Br J Surg.* 2006; 93:362–368. [PubMed: 16470713]
5. Mello MM, Chandra A, Gawande AA, Studdert DM. National Costs Of The Medical Liability System. *Health Aff.* 2010; 29:1569–1577.
6. Guitton TG, van Leerdam RH, Ring D. Necessity of routine pathological examination after surgical excision of wrist ganglions. *J Hand Surg.* 2010; 35:905–908.
7. Kassin MA, Munoz E, Laughlin A, Margolis IB, Wise L. Value of routine pathology in herniorrhaphy performed upon adults. *Surg Gynecol Obstet.* 1986; 163:518–522. [PubMed: 3787425]
8. Rao GG, Crook M, Tillyer ML. Pathology tests: is the time for demand management ripe at last? *J Clin Pathol.* 2003; 56:243–248. [PubMed: 12663633]

9. Rothberg MB, Class J, Bishop TF, Friderici J, Kleppel R, Lindenauer PK. The Cost of Defensive Medicine on Three Hospital Medicine Services. *JAMA Intern Med.* 2014; 174:1867–1868. [PubMed: 25222939]
10. Fitzgibbons P, Cleary K. CAP offers recommendations on selecting surgical specimens for examination. *CAP today.* 1996; 10:40.
11. Raab SS. The cost-effectiveness of routine histologic examination. *Am J Clin Pathol.* 1998; 110:391–396. [PubMed: 9728616]
12. Zarbo RJ, Nakhleh RE. Surgical pathology specimens for gross examination only and exempt from submission: a College of American Pathologists Q-Probes study of current policies in 413 institutions. *Arch Pathol Lab Med.* 1999; 123:133–139. [PubMed: 10050786]
13. Sluijmer HCE, Becker SJE, Bossen JKJ, Ring D. Excisional biopsy of suspected benign soft tissue tumors of the upper extremity: correlation between preoperative diagnosis and actual pathology. *Hand.* 2014; 9:351–355. [PubMed: 25191167]
14. Hsu CS, Hentz VR, Yao J. Tumours of the hand. *The Lancet Oncology.* 2007; 8(2):157–166. [PubMed: 17267330]
15. Bogumill GP, Sullivan DJ, Baker GI. Tumors of the hand. *Clin Orthop Relat Res.* 1975:214–222. [PubMed: 1095276]
16. Johnson J, Kilgore E, Newmeyer W. Tumorous lesions of the hand. *J Hand Surg.* 1985; 10:284–286.
17. Sobanko JF, Dagum AB, Davis IC, Kriegel DA. Soft Tissue Tumors of the Hand. 2. Malignant. *Dermatol Surg.* 2007; 33:771–785. [PubMed: 17598842]
18. Leung PC. Tumours of hand. *The Hand.* 1981; 13:169–172. [PubMed: 7286803]
19. Henderson M, Neumeister MW, Bueno RA Jr. Hand tumors: II. Benign and malignant bone tumors of the hand. *Plast Reconstr Surg.* 2014; 133:814e–821e.
20. Raab SS, Slagel DD, Robinson RA. The utility of histological examination of tissue removed during elective joint replacement. A preliminary assessment. *J Bone Joint Surg.* 1998; 80:331–335. [PubMed: 9531199]
21. Netser JC, Robinson RA, Smith RJ, Raab SS. Value-based pathology: a cost-benefit analysis of the examination of routine and nonroutine tonsil and adenoid specimens. *Am J Clin Pathol.* 1997; 108:158–165. [PubMed: 9260756]
22. Bondeson L, Linell F, Ringberg A. Breast reductions: what to do with all the tissue specimens? *Histopathology.* 1985; 9:281–285. [PubMed: 3997085]
23. Kocher MS, Erens G, Thornhill TS, Ready JE. Cost and effectiveness of routine pathological examination of operative specimens obtained during primary total hip and knee replacement in patients with osteoarthritis. *J Bone Joint Surg.* 2000; 82-a:1531–1535. [PubMed: 11097439]
24. Boutin P, Hogshead H. Surgical pathology of the intervertebral disc. Is routine examination necessary? *Spine.* 1992; 17:1236–1238. [PubMed: 1440015]
25. Lin MM, Goldsmith JD, Resch SC, DeAngelis JP, Ramappa AJ. Histologic examinations of arthroplasty specimens are not cost-effective: a retrospective cohort study. *Clin Orthop Relat Res.* 2012; 470:1452–1460. [PubMed: 22057818]
26. Kim B, Leonard MP, Bass J, Ruzhynsky V, de Nanassy J, Guerra L. Analysis of the Clinical Significance and Cost Associated With the Routine Pathological Analysis of Pediatric Inguinal Hernia Sacs. *J Urol.* 2011; 186:1620–1624. [PubMed: 21855930]
27. Wolkowicz AF, Barone JE, Moser RL. Selective microscopic examination of gallbladders, hernia sacs, and appendices. *The American surgeon.* 1991; 57:289–292. [PubMed: 2039125]
28. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med care.* 1998; 36:8–27. [PubMed: 9431328]
29. van Walraven C, Austin PC, Jennings A, Quan H, Forster AJ. A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data. *Med care.* 2009; 47:626–633. [PubMed: 19433995]
30. Emanuel E, Tanden N, Altman S, et al. A systemic approach to containing health care spending. *N Eng J Med.* 2012; 367:949–954.

31. Fechner RE. Value-based surgical pathology: a valuable concept. *Am J Clin Pathol*. 1997; 108:123–126. [PubMed: 9260751]
32. [Accessed September 23rd, 2017] Medical Malpractice Payment Reports and Adverse Action Reports in National Practitioner Data Bank Statistics 2016 <https://www.npdb.hrsa.gov>
33. Tancredi LR, Barondess JA. The problem of defensive medicine. *Science*. 1978; 200:879–882. [PubMed: 644329]
34. Winkens R, Dinant GJ. Evidence base of clinical diagnosis: Rational, cost effective use of investigations in clinical practice. *BMJ*. 2002; 324:783–785. [PubMed: 11924663]
35. Bulusu S. Rational, cost effective use of investigations. Rising workload and costs in diagnostic departments must be contained. *BMJ*. 2002; 325:222.
36. van Walraven C, Naylor CD. Do we know what inappropriate laboratory utilization is? A systematic review of laboratory clinical audits. *JAMA*. 1998; 280:550–558. [PubMed: 9707147]
37. Zhi M, Ding EL, Theisen-Toupal J, Whelan J, Arnaout R. The landscape of inappropriate laboratory testing: a 15-year meta-analysis. *PloS one*. 2013; 8:e78962. [PubMed: 24260139]
38. Berwick DM, Hackbarth AD. Eliminating waste in US health care. *JAMA*. 2012; 307:1513–1516. [PubMed: 22419800]
39. NCL. [Accessed August 27th, 2017] Health Policy Brief: Reducing Waste in Health Care 2012 www.healthaffairs.org
40. Farrell DJE, Kocher B. Why Americans pay more for health care. *Health International*. 2009; 8:79–87.
41. Eddy DM. Clinical decision making: from theory to practice. *Anatomy of a decision*. *JAMA*. 1990; 263:441–443. [PubMed: 2294311]
42. Woerdeman LA, Kortmann JBJ, Hage JJ. Routine histologic examination of 728 mastectomy scars: did it benefit our patients? *Plast Reconstr Surg*. 2006; 118:1288–1292. [PubMed: 17051097]
43. Alam M, Kiely C, Shah SH, Lawlor C, O'Donnell M. Mastectomy scar histopathology of limited clinical value. *Ann Plast Surg*. 2006; 57:374–375. [PubMed: 16998326]

Figure 1. Rate of Specimen Submission per Surgical Procedure

11426: Excision, benign lesion, except skin tag, scalp, neck, hands, feet, genitalia, lesion >4.0cm

25111: Excision of ganglion, wrist, primary

26160: Excision of lesion of tendon sheath or capsule e.g., cyst, mucous cyst, ganglion, hand or finger

26520: Capsulectomy or capsulotomy for contracture; metacarpophalangeal joint, single, each

*The primary Y-axis for Cases (N) is in logarithmic scale for clear visual presentation in conjunction with the secondary Y-axis for rate of specimen submission (%).

Figure 2. Commonly Utilized Types of Pathology Evaluation

88304: Level III Gross and microscopic analysis

88305: Level IV Gross and microscopic analysis

88307: Level V Gross and microscopic analysis

88311: Decalcification

88342: Immunohistochemistry – tissue study, each antibody

88312: Special Stains Group I

Table 1

Patient Characteristics

Variables	No pathology (N (%))	Pathology (N (%))	Total Case Count (N)	Rate of Submission (%) [†]
Age				
18–34	11,487 (17)	30,201 (20)	41,688	72
35–44	10,519 (15)	28,496 (19)	39,015	73
45–54	18,506 (27)	41,183 (27)	59,689	69
55–64	20,425 (29)	38,890 (25)	59,315	66
65 and older	8,492 (12)	14,748 (10)	23,240	63
Sex				
Male	27,576 (40)	59,552 (39)	87,128	68
Female	41,583 (60)	93,966 (61)	135,819	69
Quartile of median house income				
Quartile 1 (< \$46,910)	12,339 (18)	28,331 (18)	40,670	70
Quartile 2 (\$46,910 – \$51,920)	13,207 (19)	30,271 (20)	43,478	70
Quartile 3 (\$51,921 – \$58,900)	16,995 (24)	32,213 (21)	49,208	65
Quartile 4 (> \$58,900)	13,848 (20)	32,549 (21)	46,397	70
Missing	13,040 (19)	30,154 (20)	43,194	70
Insurance type [‡]				
PPO	40,545 (58)	93,250 (61)	133,795	70
Comprehensive	4,175 (6)	8,205 (5)	12,380	66
HMO	8,757 (13)	15,336 (10)	24,093	64
POS	5,038 (7)	10,991 (7)	16,029	69
Other	6,199 (9)	13,404 (9)	19,603	68
Missing	4,715 (7)	12,332 (8)	17,047	72
Region				
Northeast	11,123 (16)	32,859 (21)	43,982	75
North Central	17,044 (25)	42,827 (28)	59,871	72
South	24,778 (36)	52,794 (34)	77,572	68
West	14,665 (21)	21,451 (14)	36,116	59
Missing	1,819 (3)	3,587 (2)	5,406	66
Comorbidity score				
Quartile 1 (0)	42,859 (62)	94,371 (61)	137,230	69
Quartile 2 (1–3)	5,366 (8)	11,506 (7)	16,872	68
Quartile 3 (4–8)	13,683 (20)	30,561 (20)	44,244	69
Quartile 4 (>8)	7,521 (11)	17,080 (11)	24,601	69

[†]Rate of specimen submission was calculated by dividing total case count by the number of cases with pathology submission for each demographic variable subgroup. For example, for age group 18–34, rate of submission = 30201/41688 = 0.724 = 72%, rounded to the nearest whole number.

[‡]PPO = Preferred Provider Organization, HMO = Health Maintenance Organization, POS = Preferred Provider Organization

Table 2

The Odds of Specimen Submission Based on Patient Characteristics

Variables	Odds Ratios (95% CI)	P values
Age		
18–34	1	-
35–44	1.05 (1.01, 1.08)	0.016
45–54	0.85 (0.82, 0.87)	<0.001
55–64	0.72 (0.70, 0.74)	<0.001
65 and older	0.64 (0.61, 0.67)	<0.001
Sex		
Male	1	-
Female	1.05 (1.03, 1.08)	<0.001
Quartile of Median House Income		
Quartile 1 (< \$46,910)	1	-
Quartile 2 (\$46,910 to \$51,920)	0.93 (0.90, 0.96)	<0.001
Quartile 3 (\$51,921 to \$58,900)	0.89 (0.86, 0.92)	<0.001
Quartile 4 (> \$58,900)	0.94 (0.90, 0.97)	<0.001
Insurance Type		
PPO	1	-
Comprehensive	0.96 (0.91, 1.01)	0.086
HMO	0.82 (0.79, 0.84)	<0.001
POS	0.90 (0.87, 0.94)	<0.001
Other	0.90 (0.87, 0.93)	<0.001
Region		
Northeast	1	-
North Central	0.83 (0.80, 0.86)	<0.001
South	0.67 (0.65, 0.70)	<0.001
West	0.50 (0.49, 0.52)	<0.001
Comorbidity Score		
Quartile 1 (0)	1	-
Quartile 2 (1–3)	1.03 (0.99, 1.07)	0.124
Quartile 3 (4–8)	1.05 (1.03, 1.08)	<0.001
Quartile 4 (>8)	1.11 (1.07, 1.15)	<0.001

Table 3

The Odds of Malignancy by Patient Characteristics

Variables	Odds Ratios (95% CI)	P values
Age		
18–34	1	-
35–44	0.96 (0.69, 1.34)	0.825
45–54	1.18 (0.89, 1.58)	0.253
55–64	1.41 (1.07, 1.87)	0.015
65 and older	2.37 (1.74, 3.23)	<0.001
Sex		
Male	1	-
Female	0.57 (0.48, 0.66)	<0.001
Quartile of Median House Income		
Quartile 1 (< \$46,910)	1	-
Quartile 2 (\$46,910 to \$51,920)	0.96 (0.76, 1.21)	0.701
Quartile 3 (\$51,921 to \$58,900)	0.89 (0.71, 1.13)	0.338
Quartile 4 (> \$58,900)	0.93 (0.72, 1.20)	0.578
Insurance Type		
PPO	1	-
Comprehensive	1.21 (0.92, 1.60)	0.177
HMO	0.71 (0.53, 0.95)	0.020
POS	1.05 (0.78, 1.43)	0.736
Other	0.87 (0.63, 1.19)	0.382
Region		
Northeast	1	-
North Central	1.12 (0.86, 1.45)	0.405
South	0.99 (0.76, 1.28)	0.911
West	1.32 (0.99, 1.74)	0.055
Comorbidity Score		
Quartile 1 (0)	1	-
Quartile 2 (1–3)	2.20 (1.53, 3.16)	<0.001
Quartile 3 (4–8)	5.75 (4.65, 7.11)	<0.001
Quartile 4 (>8)	6.83 (5.44, 8.59)	<0.001

Table 4

Cost of Surgical Pathology Evaluation

Pathology Procedure (CPT)	Total Cost (\$)	Total Case Count (N)	Mean Cost (\$)
88300	32,406	760	43
88302	61,506	874	70
88304	9,355,490	95,329	98
88305	10,961,253	65,834	166
88307	1,293,173	5,036	257
88311	218,553	5,747	38
88312	286,140	1,705	168
88313	87,055	1,086	80
88331	109,090	562	194
88342	1,777,809	4,941	360
Other **	192,191	1,088	177
All	24,374,666	182,962	133

** CPT codes included: 88104, 88108, 88172, 88173, 88309, 88314, 88318, 88319, 88321, 88323, 88325, 88329, 88332, 88346, 88347, 88348, 88349, 88355, 88356, 88358, 88362, 88365, 88399. Please refer to Appendix C, Supplemental Digital Content 3, for Pathology procedure CPT codes and descriptions, [INSERT HYPER LINK](#).