Cost Analysis: Mohs Micrographic Surgery

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BACKGROUND With the continuing increase in the incidence of skin cancer, delivery of cost-efficient skin cancer treatment is a top priority.

OBJECTIVE To compare costs associated with removal of skin cancers using Mohs micrographic surgery (MMS) with that using standard surgical excision (SSE) with frozen or permanent margin control in the office or an ambulatory surgery center (ASC).

METHODS AND MATERIALS Costs for actual MMS and calculated costs for all SSE were recorded. The expense of treatment of incomplete excisions with subsequent reexcision and reconstruction and MMS on recurrent tumors were added to the final estimate.

RESULTS Four hundred six tumors were included in the study. An average tumor was cleared in 1.6 stages. MMS was the least expensive surgical procedure evaluated, at $805 per tumor. SSE with permanent margins ($1,026) was more expensive than MMS but less expensive than SSE with frozen margins ($1,200) and ASC-SSE with frozen margins ($2,507). Adjusted for inflation, the cost of MMS, inclusive of initial examination, biopsy, and 5-year follow-up, in 2009 ($1,376) was lower than in 1998 ($1,635).

CONCLUSIONS This study confirms MMS as the cornerstone of cost-effective treatment, regardless of place of service or type of margin control pathology.

The authors have indicated no significant interest with commercial supporters.

Incidence of melanoma and epithelial malignancies of the skin have been steadily increasing. In 1994, at least 900,000 nonmelanoma skin cancers (NMSC) were diagnosed in the United States.[1] In less than 10 years, this number climbed 30% to a minimum of 1.3 million cases of basal cell carcinoma (BCC) and squamous cell carcinoma (SCC).[2] With NMSC remaining the most-frequent oncologic diagnosis over the last decade and its incidence continuing to increase, following the trend of an aging population, delivery of cost-efficient skin cancer treatment is a top priority. A variety of methods have been applied in treatment of NMSC, including topical agents such as 5-fluorouracil and imiquimod; destruction with electrodesiccation and curettage (ED&C), cryotherapy, or laser ablation; standard surgical excision (SSE); Mohs micrographic surgery (MMS); radiation therapy; and photodynamic therapy. Because a significant proportion of NMSC occurs on functionally and cosmetically important areas, functional and cosmetic outcomes are of crucial significance.[3] As with any therapeutic intervention, the intent is to achieve high cure rates, with minimal morbidity and controlled costs.

The cost of MMS is often misunderstood because of its unique reimbursement, which bundles surgery and surgical pathology together into a single fee. In contrast, SSE does not include the cost of surgical pathology (permanent or frozen sections) for margin examination. In 1998, a study was published showing there was little difference in cost between MMS ($1,243) and SSE with margin

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ISSN: 1076-0512 • Dermatol Surg 2012;38:585–594 • DOI: 10.1111/j.1524-4725.2012.02341.x

control using paraffin sections ($1,167). Furthermore, the cost of excision with frozen section margin control was significantly higher than MMS in the office setting ($1,400) and in an ambulatory surgical center (ASC) ($1,973). Thus, MMS potentially offered more than 10% and nearly 40% in savings than SSE with frozen section control in an office setting and ASC, respectively, when all of the costs were included. These findings were substantiated in a second independent study.[4]

Additional studies addressing costs of NMSC followed. In 2006, Essers and colleagues published a study of cost-effectiveness of MMS and surgical excision for BCC of the face.[3] The results of the study were based on a large randomized trial in a public health system.[5] Although the authors concluded that MMS is significantly more expensive than excision, the results of the study are difficult to interpret because the surgical procedures studied did not qualify as MMS; a pathologist and not a Mohs surgeon evaluated the Mohs specimens. A surgeon and a pathologist charged separately for the services, adding significant expense to the costs of the operation, in effect, making the procedure described in this study excision with horizontal frozen section margin control rather than MMS. In addition, larger margins that Essers and colleagues used for "Mohs" excisions (3 mm, vs the 1 mm that most Mohs surgeons use for the majority of primary BCCs of the face) may have also contributed to the complexity of repairs, further inflating associated costs. Also, because of flawed study design, the randomization schedule was violated on a number of occasions. Otley succinctly outlines these and other deficiencies in his critique of the study.[6]

Given the recent explosion in skin cancer incidence and its attendant treatment costs, there is further pressure to rein in health care expenditures on procedures with rapidly increasing usage, such as MMS and the cost efficacy of MMS continues to be debated.[3] Multiple surgery reduction rule (MSRR) imposes a 50% decrease in reimbursement of the least expensive of two or more procedures performed by the same surgeon on the same patient on the same day, that is, only the most expensive procedure is paid at 100% of the Centers for Medicare and Medicaid Services (CMS) fee and all others are paid at 50%. The original exemption of Mohs surgery from the MSRR was based on the fact that MMS performed on an individual tumor is a separate procedure, without overlap in evaluation and management (E&M) of each surgical site. Thus, for every tumor, a Mohs surgeon must consider tumor histology, location, and underlying anatomy; potential interference with organ function; and options for reconstruction. A decision whether to bisect or otherwise section a Mohs stage into blocks for appropriate processing must be made. Each successive MMS stage entails return to a procedure room, with additional surgical site preparation, local anesthesia, surgical implements, hemostasis, and wound management. A subsequent decision to reconstruct a Mohs defect involves a separate E&M and an independent return to the operating suite. In 2006, the CMS reviewed, and subsequently deleted, the original MMS codes (17304–17310) and beginning in 2007 instituted the current codes (17311–17315), effectively reducing reimbursement for MMS performed on the trunk and extremities. After repeated reexamination of MMS codes, the CMS final rule for the 2008 Medicare Fee Schedule withdrew the MMS exemption from the MSRR that had been in place since 1992.[7,8]. Reimbursement for add-on codes for second and subsequent MMS stages (17312 and 17314) and additional MMS blocks over the initial 5 (17315) was reduced at the inception of these codes in 1991 to account for abbreviated physician work, when compared to the first stage and/or the first set of 5 or fewer blocks. These codes have MSRR factored into the reimbursement cost and are not subject to additional reductions.

We set out to examine the effect of these recent changes, comparing costs associated with MMS and SSEE with permanent or frozen sections in an office or ASC.

Methods

We compared the costs associated with removal of skin cancers using each of four methods: MMS, office-based SSE with permanent margin control (SSE-OP), office-based SSE with frozen margin control followed by permanent margin examination (SSE-OF), and ASC-based SSE with frozen margin control followed by permanent margin examination (SSE-AF). Consecutive patients referred for MMS for biopsy-confirmed primary and recurrent skin cancer were included in the study from March through June 2008. Patients who were subsequently referred elsewhere for repairs were excluded. First a plan for traditional excision and reconstruction was made. The clinically apparent tumor was delineated, and then appropriate surgical excision margins were drawn (4 mm for BCC, 4–6 mm for SCC, 5–20 mm for melanoma, and 0.6 cm for all other tumor types). SSE margins were based on current National Comprehensive Cancer Network recommendations.[9] The simplest and most functionally and cosmetically pleasing putative reconstruction of the resulting SSE defect was subsequently designed. An assumption was made that all SSE defects would be reconstructed. The plan was recorded and coded. Then MMS was performed on all tumors, and codes for MMS and reconstruction, if performed, were recorded. The tumor was then excised using fresh–frozen MMS technique and, if required, the resulting defect reconstructed (Figure 1) and actual costs tabulated.

Actual costs for MMS and calculated costs for SSE-OP, SSE-OF, and SSE-AF were calculated based on Current Procedural Terminology (CPT) 2009 and CMS ASC fees for non-Philadelphia, Pennsylvania. For patients with multiple tumors, the MSRR was applied. Because the initial evaluation (new patient visit 99203, skin biopsy 11100, pathology for diagnosis 88305) and yearly follow-up to monitor recurrences (99213) for 5 years would be the same for all patients regardless of treatment modality, these costs were omitted from analysis. The infrequent expense of immunopathology and general anesthesia were excluded from all calculations.

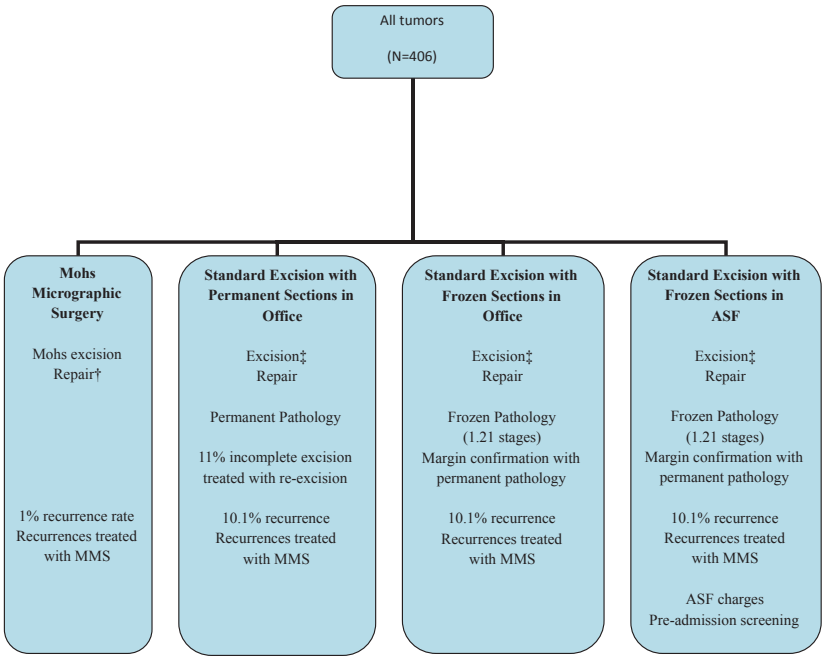

Figure 1. Comparison layout of costs included in calculations.
† - Secondary intention wound healing was calculated as $0 repair.
‡ -Excision costs were added whenever not bundled with repairs.

The following assumptions were made to predict costs of surgical excision. Of tumors treated with SSE-OP (88305), 11% would be expected to have positive margins.[10] Tumors requiring flap repairs were excluded from this calculation because it was assumed that a complicated repair would be deferred until pathology results confirming tumor clearance were available. The cost of subsequent standard surgical reexcision with permanent section control and reconstruction for tumors with positive margins was added to the total cost of treatment.

Of tumors treated with SSE-OF (88331 and 88332), 21% would require additional limited re-excision during the same operative session, translating into 1.21 stages to clear.[10] It was presumed that the final margin would be evaluated with permanent sections to confirm tumor clearance (88305).

Tumor recurrence was accounted for in the calculations as well. Based on a study by Rowe and colleagues, 10.1% of tumors treated with SSE and 1.0% of those treated with MMS would recur.[11] The cost of treating recurrences with MMS (equal to the average cost of MMS calculated herein) was added to the final estimate.

The expense of SSE-AF included a lower relative value unit for the physician work component, separate facility fees, and added costs of preadmission testing (chest X-ray, electrocardiography, prothrombin time and partial thromboplastin time, complete blood cell counts, sequential multiple analysis-8). Readmission to the ASC for subsequent stages and reconstruction would not require additional testing. The cost of reconstruction was assumed to be subject to MSRR even if performed on a different day than the surgical excision(s).

The cost of treating a tumor based on location was calculated for patients with single tumors. Nose, ear, eye, face, scalp and neck, trunk and extremity, hands and feet, and genitalia were used as discrete locations in calculations.

TABLE 1. Tumor Characteristics and Anatomic Locations

Characteristic and Location	*Value*
Histology, *n* (%)	
Basal cell carcinoma	296 (72.6)
Squamous cell carcinoma	70 (17.2)
Melanoma	31 (7.6)
Other (sebaceous carcinoma, desmoplastic trichoepithelioma, infiltrative carcinoma, atypical fibroxanthoma, adnexal carcinoma)	9 (2.2)
Recurrence, *n* (%)	
Primary	341 (90)
Recurrent	98 (10)
Anatomic location	
Nose	87 (21.4)
Ear	35 (8.6)
Eye	13 (3.2)
Face	140 (34.5)
Scalp and neck	42 (10.3)
Trunk and extremities	79 (19.5)
Hands and feet	9 (2.2)
Genitals	1 (0.2)
Tumor size, cm	
Average	1.1
Median	1.0
Maximum	4.7
Minimum	0.2
Number of tumors per patient, *n* (%)	
1	301 (87.5)
2	29 (8.4)
3	10 (2.9)
4	3 (0.9)
5	1 (0.3)

Results

Three hundred forty-four patients with 406 tumors were included in the study (Table 1). Five with eyelid tumors requiring reconstruction by outside surgeons were excluded. There were 208 men (60.5%) and 136 women (39.4%). Most tumors were located on the nose and elsewhere on the face. Of the patients, 12.5% had multiple tumors. Data on previous treatment were available on 379 tumors; 341 (90%) were primary, and 38 (10%) were recurrent. As expected, BCC outnumbered SCC by 4 to 1. An average tumor was cleared in 1.6 stages (median 1.0; range 1–8), with nearly 60% of patients cleared in one stage

TABLE 2. Required Number of Mohs Micrographic Surgery Stages for Tumor Clearance (*N*=400)

Stage	*Tumors,* n *(%)*
1	243 (59.9)
2	119 (29.3)
3	30 (7.4)
4	5 (1.5)
5+	9 (2.2)

(Table 2). Of tumors treated with MMS, 37.9% were allowed to heal by secondary intention, and another 37.5% were closed primarily (complex or intermediate linear closures). Only 13.8% and 8.9% of MMS defects required a flap or graft, respectively (Table 3). Conversely, because of larger expected size of defects, tumors treated with SSE necessitated nearly three times as many flaps and grafts. Complicated repairs, such as two- and more staged procedures and compound and cartilage grafts, were twice as likely to occur in the SSE group.

Of the four surgical procedures evaluated, MMS was the least expensive at $804.72 per tumor (Table 4). SSE performed in an office setting with permanent section margin control (SSE-OP) was more expensive than MMS but less than SSE-OF and SSE-AF.

In the comparison of regional costs, MMS remained the most cost-efficient surgical treatment across all sites studied (Table 5). SSE-OP was 5% to 67% more expensive than MMS, and the cost of SSE-OF was up to 80% higher than MMS. SSE-AF was up to five times as expensive as MMS and three times as expensive as excisions in an office setting. Tumors on the nose and eyes were more expensive regardless of treatment modality, with tumors on the ears and face close behind. The nose and eyelid also had the most-disparate difference in cost when comparing treatments. Thus, on average it is 77% more expensive to treat a tumor on the nose with SSE-AF than with MMS in an office setting and nearly 20% more costly for SSE-OP in an office setting than for MMS. Even for tumors on the trunk and extremities, areas where most tumors are traditionally treated with excision, MMS remains the least-expensive option.

TABLE 3. Repairs After Mohs Micrographic Surgery (MMS) (Actual) and Standard Surgical Excision (Proposed)

	N *(%)*	
Repair	*MMS*	*Excision*
Second intention	154 (37.9)	0 (0)
Primary closure	152 (37.4)	140 (34.5)
Local flap	56 (13.8)	158 (38.9)
Grafts (full and split thickness)	36 (8.9)	80 (19.7)
Other*	6 (1.5)	12 (3.0)

Repairs encompassing more than one surgical defect were counted once.
*Staged procedures and complicated single-stage reconstructions, such as compound and cartilage grafts and multiple flaps.

TABLE 4. Costs of Treatment per Tumor: Mohs Micrographic Surgery (MMS) (Actual) Traditional Excision (Calculated)

Procedure	*Cost, $, Mean (Range)*
MMS	804.72 (544.67–8,397.67)
Office excision, permanent	1,025.83 (438.22–13,459.09)
Office excision, frozen	1,199.82 (693.49–13,702.18)
ASC excision, frozen	2,507.10 (1,141.99–16,761.27)

Discussion

In the realm of cutaneous oncology, surgical and medical, the debate on the cost efficacy of existing strategies is acutely pertinent in the current climate, which favors cost containment. This study is a 10-year follow-up on the seminal study of MMS cost analysis by Cook and Zitelli[12] that compared actual costs of MMS with calculated costs for SSE-OP, SSE-OF, and SSE-AF. At the time of publication in 1998, MMS was still exempted from the MSRR. As a result, the least-expensive option for treatment of a skin cancer was SSE-OP, which was

TABLE 5. Regional Cost for Treatment per Tumor: Mohs Micrographic Surgery (MMS) (Actual) and Traditional Excision (Calculated)

	$							
Procedure	*Nose*	*Ear*	*Eyelid*	*Face*	*Scalp or Neck*	*Trunk or Extremity*	*Hands or Feet*	*Genitalia*
MMS	996.50	803.38	1,042.70	876.17	783.02	827.88	651.72	596.22
Office excision, permanent	1,219.13	1,347.50	1,330.45	1,142.88	921.88	863.31	1,036.38	886.25
Office excision, frozen	1,322.88	1,451.25	1,434.20	1,246.63	1,025.63	967.06	1,140.13	989.99
ASC excision, frozen	3,853.19	4,004.12	4,059.90	2,982.65	2,685.58	2,309.81	3,178.54	2,640.81

7% less expensive than MMS ($1,167 vs $1,243). Conversely, MMS was less expensive than SSE-OF ($1,400) and sSE-AF ($1,973).

Current reimbursement has changed significantly during the last 10 years. Notably, MMS is no longer exempt from MSRR and, because of new CPT codes, MMS on the trunk and extremities is reimbursed at a lower rate. How did these changes affect the costs of surgical treatment of cutaneous tumors? If we include the cost of evaluation of a patient (99203), skin biopsy (11100), pathology reading (88305), and 5 annual follow-up visits (99213), the cost of MMS is $1,376, which is a moderate increase from $1,243 in 1998, but when adjusted for inflation, the cost of MMS in 2009 ($1,376) is 16% lower than in 1998 ($1,635). Similarly, the cost of SSE-OP increased by 4%, from $1,167 (or $1,534 when adjusted for inflation) to $1,598. The most impressive increase in cost occurred in SSE-AF, with an increase of 56%—from $1,973 in 1998 ($2,595 or 19% when adjusted for inflation) to $3,079. The only standard surgical intervention that experienced a minimal decline of 4% in cost was SSE-OF, which decreased from $1,841 adjusted (or $1,400 in 1998) to $1,772.

The fiscal advantage of MMS is in the bundling of component costs into a single reimbursement: Mohs excision, pathology preparation, and interpretation. Because 100% margin control with horizontal frozen sections allows same-day determination of margin clearance in the overwhelming majority of cases, even the more-complicated repairs are commonly performed on the same day, with an inherent 50% reduction of reimbursement because of loss of exemption from MSRR.

Perhaps the most important, yet underappreciated, value intrinsic in the use of MMS is the significant tissue sparing accomplished by taking margins that are smaller peripherally and in depth, resulting in smaller, shallower wounds. This in turn routinely results in smaller, simpler repairs or an option to allow the wound to heal by secondary intention.[13,14] Our results confirm that tumors treated with SSE require flap and graft repairs three times more often than the same tumors treated with MMS. Two-stage flaps and other complicated repairs are necessary twice as often in the SSE group than with MMS. Tissue conservation is not only an advantage of MMS to people with skin cancer, but also ultimately results in cost savings in the management of surgical wounds. MMS result in smaller, simpler reconstructions, which tend to have fewer complications and better cosmetic outcomes. Furthermore, 37.9% of MMS defects were allowed to heal by secondary intention, obviating the need for the additional expense of a repair. This number is comparable with previously published data.[10]

Based on experience, the authors assumed that all recurrences would be treated using MMS, whereas incomplete excisions would be reexcised using SSE. The effect of additional surgery with appropriate margins, including the likely need for more-complex reconstruction and additional pathology, would be to increase the total cost of treatment proportionally, but because such effect is difficult to calculate, data presented herein underestimate the full cost of SSE.

Another conjecture that may have led to underestimation of SSE cost was frozen and permanent section billing by a pathologist. Whereas small first-stage tumors may be examined with frozen sections by bisecting the specimen into two blocks (88331 for the first block and 88332 for the second block), larger tumors would require one or more additional blocks (88332) for complete margin evaluation. We further assumed that only the final frozen margin would be evaluated with permanent sections, but in other institutions, permanent sections and reports are generated for each frozen stage.[4,15]

A recent publication by Rogers and Coldiron[16] examined the effect of the loss of exemption from the MSRR on the cost MMS. This rigorous theoretical examination centered on the calculated costs of treating different sized BCC of the central cheek and SCC on the forearm. When similar sites are compared, the average cost for treatment of a facial tumor (nose, ear, eye locations excluded) was $876 for our study, versus $1,263 for theirs and for an extremity tumor was $828 versus $1,131, respectively, although they stated that only 18% of MMS wounds would heal by secondary intention, which is 50% less than our actual data. In addition, 60% of our patients were cleared in a single stage, whereas they assumed that 24% would be cleared on the first pass.

It is important to address nonsurgical modalities, such as ED&C, imiquimod, and radiation, in our discussion. The former two treatments are often touted as efficacious and inexpensive; the calculated cost of ED&C is $471 on the face and $392 on an extremity.[16] Others have estimated the cost of ED&C for a 1.5-cm tumor to be higher ($652)—only 20% less than the cost of MMS.[12] These cost calculations include recurrences, which may range from 5.7% to as high as 13.2%, and treatment of such recurrences, which is likely to be with MMS.[17–21] When the cost of initial visit, biopsy, and 5-year follow-up are included (a total of $571.98), the cost of ED&C increases dramatically. Furthermore, because of poor cosmesis and the inability to treat more than superficial tumors or recurrent disease, ED&C of facial tumors is limited.

Although attractive as a nonsurgical intervention, imiquimod is a more-expensive option. The cost of an off-label treatment course of a facial lesion, inclusive of cost of care for recurrences is $959. As such, imiquimod is more expensive than MMS and approaches the cost of SSE-OP and SSE-OF while having a much higher recurrence rate (20% at 1–2 years) than any surgical procedure presented herein.[16,22,23] According to Food and Drug Administration (FDA), imiquimod is indicated for "biopsy-confirmed, primary superficial basal cell carcinoma in immunocompetent adults; maximum tumor diameter of 2.0 cm on trunk, neck, or extremities (excluding hands and feet), only when surgical methods are medically less appropriate and patient follow-up can be reasonably assured."[24] When only sites where imiquimod has gained FDA approval are included in analysis, the cost of treatment with Aldara is as or more expensive than all excisions except SSE-AF.

Lastly, radiation has always been a preferred therapy for inoperable tumors or in patients who may not be able to tolerate surgery.[25–27] Treatment of a facial tumor may range from $2,559 to $4,558, depending on the radiation schedule.[12,16] The cost estimate accounts for a 7% failure rate and 10% recurrence, both of which would be treated using MMS.[26] There is also an additional burden of multiple visits on patients and their families

(20–30 sessions, based on radiation schedule) to a radiation center and delayed cutaneous and, depending on location, mucocutaneous complications.

Overall value of a treatment extends far beyond its cost. The morbidity of tumor recurrence treatment is as onerous as are the additional costs associated with consequent treatment. Further in-depth studies would be necessary to determine lost productivity for patients younger than the retirement age and for those in retirement with part-time jobs. The burden on caretakers can also be significant and may result in productivity loss. Compared to SSE of primary BCC with 11% incomplete excision and 10.1% recurrence rates according to conservative estimates, MMS has the lowest recurrence rate of all surgical modalities (1–3.3%).[11,19] The recurrence rate of previously treated tumors subsequently excised using MMS remains significantly lower than the numbers cited for SSE.[11]

A similar study comparing MMS with SSE confirmed that MMS is comparably priced when recurrences and subsequent treatment are accounted for in the final calculations.[4] The authors found that an extraordinary 32% of SSE specimens had a positive margin, necessitating further treatment. A wide range of incomplete excision rates can be found in the literature (4–16.7%).[28–38] The fact that only a handful of articles mention surgical margins and sites treated complicates interpretation of these figures. Su and colleagues[39] found that tumors larger than 2 cm (20.4%), recurrent tumors (26.8%), and those located on the head and neck (14.5%) tend to have incomplete rates. Conversely, tumors smaller than 1 cm (11.0%), primary tumors (11.2%), and non-head and neck location (7.0–8.5%) were less frequently incompletely excised. A similarly wide range is cited for postexcision recurrences (0.7–67%)[1,35,40,41]

There are limitations to this study. When analyzing MMS, our calculations were based solely on data from a single practice with two Mohs surgeons. This single-practice experience also includes additional variables such as laboratory expertise and particulars of the decision-making process, such as the use of secondary intention healing, complexity of repairs, and histology of tumors treated, and the type of reconstructive work chosen for a particular defect. The cost calculation of SSE was based on several assumptions. Tumor margins were assumed to be 4 mm for BCC and 4 to 6 mm for SCC, depending on whether they were high risk or not.[42] It is possible that certain more-aggressive tumors would require greater margins under real-life circumstances. We assumed that the resulting defects would be reconstructed in the simplest way and that more-complicated repairs would be delayed until clear margin confirmation. We also assumed that all defects would be repaired on the same day so that the MSRR would apply. Altogether, these conjectures would result in lower overall costs associated with excision. Furthermore, five tumors that required reconstruction by an outside provider were excluded from the study. The costs of immunopathology and general anesthesia were not included in this study. The exclusion of these expenses would probably affect the cost of SSE disproportionately by artificially lowering the cost of SSE-OF, SSE-OP, and SSE-AF excisions.

Cutaneous tumors traditionally have been treated using a variety of approaches, based on tumor location and other characteristics. The cost and efficacy of MMS and other surgical and nonsurgical modalities had been debated for longer than 20 years. The common misperception of MMS as an expensive option has its roots in the poorly understood bundled reimbursement of the procedure, which includes costs of surgical excision, histology preparation, and pathology. Increased use of MMS follows the growing incidence of skin cancer in our aging population. Ongoing increase in use resulted in tighter controls that have limited reimbursement for and may seek to restrict access to MMS. In the current economic

climate of cost awareness and health care, often driven by an educated consumer, medical providers must be well versed in the pros and cons of treatment options. Low recurrence rates; smaller defects resulting in simpler, less-costly repairs or secondary intention healing; and demonstrated cost effectiveness confirm MMS as the cornerstone of efficacious and cost-effective treatment, regardless of place of service (office or ASC) or type of margin control pathology. Once the effect of MMS on economic savings and cure rates is recognized, restrictions on the use of MMS will be lifted. The cost and value inherent in MMS rightfully prioritize it as the treatment of choice for cutaneous malignancies.

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