

# Outcomes of Mohs Micrographic Surgery at the American Society for Dermatologic Surgery International Traveling Mentorship Program International Mohs Fellowship Recognition Units: A Retrospective Survey of 5889 Cases From South Africa, Romania, and the Netherlands

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**BACKGROUND** The American Society for Dermatologic Surgery (ASDS) International Traveling Mentorship Program (ITMP) has initiated an International Mohs Fellowship Recognition Program, with 3 centers accredited to date.

**OBJECTIVE** To describe and compare the outcomes of Mohs micrographic surgery (MMS) at the three units.

**METHODS** From patient files, we extracted demographic information, as well as tumor type, location of tumor, tumor histology, stages of MMS, and outcomes.

**RESULTS** At the 3 units, 3,899 patients were treated with MMS over a 5-year period in the South African unit, and 1,141 cases in the Romanian unit. Over a 3-year period, 849 cases were treated in the Netherlands unit. Basal cell carcinomas (BCCs) constituted 78.9% (South African unit), 79% (Romanian unit), and 97.2% (Netherlands unit), and squamous cell carcinomas (SCCs) 17.7% (South African unit), 19% (Romanian unit), and 0.7% (Netherlands unit) of the tumors treated. The recurrence rate following MMS was low, at 0.1% (South African Unit) and 0.17% (Romanian Unit) of cases at the end of the study period, with a median follow-up time of 2 years.

**CONCLUSION** Mohs micrographic surgery is an effective treatment modality for removing BCC and SCC at ASDS ITMP-recognized International Mohs Fellowship units.

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Many countries experience a large burden of skin cancer, especially basal cell carcinoma (BCC) and squamous cell carcinoma (SCC),<sup>1</sup> which translates into substantial health care costs.<sup>2</sup> The surgical method for the most effective removal of skin cancer is Mohs micrographic surgery (MMS).<sup>3–6</sup> Although ensuring the most precise removal of tumors, with the least amount of damage to surrounding tissues, MMS also results in smaller defects that are potentially simpler to close. Mohs micrographic surgery is also deemed more cost

effective than standard excision,<sup>7,8</sup> especially where the costs of the procedure are bundled.<sup>5</sup>

Mohs surgery has become the standard of care for removal of nonmelanoma skin cancer (NMSC) in the United States, Canada, Australia, New Zealand, Great Britain, and Israel,<sup>9</sup> where more than 1,500 fellowship-trained American College of Mohs Surgery (ACMS) surgeons practice MMS, plus many others trained via other training programs. In other countries with a high skin cancer burden, such as South Africa

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and Romania, MMS is not as widely available. Some countries in Europe and Asia, including Germany, Russia, and many eastern European countries have advanced health care systems, but dermatologic surgery, MMS units, and training programs in these disciplines are absent or rudimentary.

In Europe, the European Society for Micrographic Surgery (ESMS) established criteria for recognition as a Mohs or Micrographic surgeon. Accreditation as a micrographic surgeon is intended to accommodate countries where mostly “slow Mohs” surgery with paraffin sections is performed. By mid 2019, there were altogether 117 ESMS-certified Mohs and micrographic surgeons, unevenly distributed throughout Europe with the largest number of certified members in the Netherlands, Switzerland, and Belgium.

Internationally, there is generally strong interest by dermatologists for accessible training programs in dermatologic surgery and MMS. Although the United States has many ACMS-recognized fellowship training programs, such structured programs are scarce in the rest of the world. To meet this demand, the American Society of Dermatologic Surgery (ASDS) established the International Travelling Mentorship Program (ITMP), which has more than 130 accredited mentors willing to accept trainees in the various aspects of procedural dermatology or willing to travel to teach. The ASDS extended the ITMP to an ASDS ITMP International Fellowship Recognition Program, recognizing International Fellowships in MMS, dermatologic surgery, or cosmetic dermatology, complying with guidelines developed by the ASDS Fellowship Recognition Committee. American Society of Dermatologic Surgery ITMP International Fellowships in MMS have been recognized and accredited since 2017 in South Africa, Romania, and the Netherlands.

ASDS ITMP Guidelines for a Fellow in MMS require the fellow to observe a minimum of 250 cases and personally perform 50 cases of MMS and reconstruction under the guidance and supervision of the program faculty. In addition, the fellow must complete an academic syllabus and undertake a research project. To maintain accreditation, the unit must be visited annually for at least 3 years by an ASDS ITMP Fellowship Committee member.

The aim of this article is to describe and compare data and practices regarding MMS and reconstruction at 3 MMS units from 3 different countries on 2 continents, South Africa, Romania, and the Netherlands, accredited by the ASDS ITMP International Fellowship Recognition Program.

## Methods

We conducted a retrospective review of patient records admitted for MMS to the 3 units, from the start of MMS at each unit, until July 2019. The starting year for the Skinmatters Mohs and Reconstruction Unit, Pretoria, in South Africa was 2014, the Dr Leventer Centre in Romania from 2014, and the MohsA Huidcentrum in the Netherlands from 2017. Data were extracted from a comprehensive photographic, histologic, and clinical database maintained by each unit. Only cases treated with MMS, as opposed to micrographic surgery using formalin-fixed paraffin sections, were included.

From the records, we summarized the tumors treated according to a number of parameters, including patient gender, tumor type, preoperative tumor and postoperative defect size, and tumor site. Regarding the MMS performed, we summarized the average number of stages required for the different histological tumor types, when more than one stage was required. Descriptive statistics were used for analysis.

Finally, we described the type of reconstructions performed, who completed the reconstruction, and the anesthetic protocol used. We also report on the frequency of tumor recurrences following MMS and any complications. Recurrences were assessed and classified according to the guidelines in the literature.<sup>10</sup>

No personal patient information was included in this research. The directors of the various units approved the review of patient records.

## Results

In total, during the study period, the Skinmatters Mohs and Reconstruction Unit in South Africa (SA) treated 3,899 cases. In Romania (R), 1,141 cases were

treated at the Dr Leventer Fellowship Unit, and in the Netherlands (N), 849 MMS were performed at the MohsA Huidcentrum.

Most of the tumors treated were BCC (SA, 3,077 cases, 78.9%; R, 901 cases, 79%; and N, 825 cases, 97.2%). The second most common tumor type was SCC (SA, 691 cases 17.7%; R, 217 cases, 19%; N, 6 cases, 0.7%) (Table 1). Rarer tumors included sebaceous carcinoma (SA, 1 case), malignant adnexal tumors (SA, 3 cases), atypical fibroxanthoma (SA, 6 cases), and Merkel cell carcinoma (SA, 1 case). The number of cases treated with MMS at the units increased steadily (Table 1).

Mohs micrographic surgery was successfully completed in most cases, with the process aborted in a small number of patients (SA, 7 cases, 0.18%). Mohs surgery was aborted if a final Mohs layer could not be obtained to confirm a clear tumor margin because the patient was either judged too frail to tolerate the taking of further layers or because of bone or deeper structure invasion (including tympanic membrane [SA, 1 case]).

The average number of stages required to achieve 100% margin clearance were SA, 1.61; R, 1.60; and N, 1.49. When more than 1 stage was required for margin clearance, the average number of stages then required for clearance for each tumor type are presented in Table 2.

The MMS were performed by the dermatologists working at the units. In the South African unit, reconstructions were mostly performed by the team of plastic and reconstructive specialists (3,512 cases, 90.1%) with the remaining cases reconstructed by the dermatologists performing the MMS (387 cases, 9.9%). In the Romanian and Netherlands units, reconstructions were performed by the dermatologists performing the MMS, with only a few (4, 0.4%) cases in the Dutch unit closed by a plastic and reconstructive surgeon.

All procedures (MMS and reconstructions) performed by the ASDS ITMP Mohs Fellows were performed under the guidance, supervision, and assistance (as required) of the fellowship directors.

Reconstructive options used by the 3 units are summarized in Table 3.

Mohs micrographic surgery was performed almost exclusively under local anesthesia, with intravenous sedation used in the SA unit in rare selected instances. In the Romanian and Dutch units, reconstructions were all performed under local anesthesia, whereas in the SA unit, reconstructions were performed under local anesthesia in 1774 cases (45.5%) and intravenous conscious sedation in 2,125 cases (54.50%). All recurrences were carefully documented, and all slides of any potential recurrence reviewed.

In the South African unit, with a median follow-up of 2 years to date, there have been 3 definite tumor recurrences, all BCC, satisfying all 3 criteria for recurrence.<sup>10</sup> In addition, there was 1 SCC case of possible recurrence, 2 BCC cases of unlikely recurrence, and 2 SCC cases of satellitosis. Regrowth of tumor was confirmed in 4 BCC cases where a final clear layer was not obtained and therefore considered as incompletely excised.

For the Romanian unit, during the 5 years studied and with a median follow-up period of 2 years, 2 definite tumor recurrences were documented (0.17%), 1 BCC and 1 SCC. In the Dutch unit, there was no data for recurrence on the current series.

Regarding complications, for all 3 units, no serious or life-threatening complications were reported during the study period, in particular, no myocardial infarction, stroke, septicemia, deep venous thromboses, pulmonary or air embolism, severe allergic reactions (anaphylaxis), or deaths.

## Discussion

Surgery should be considered as first choice of treatment for any potentially curable NMSC tumor with a high risk of recurrence.<sup>11,12</sup> This includes NMSC situated on the H-zone of the face, genitalia, hands, feet, or nipples, when a tumor is recurrent, incompletely removed, demonstrates an aggressive growth pattern, perineural invasion is present, exceeds 1 cm in size on the face and neck, and is more than 2 cm in size on the

**TABLE 1. Patient Gender, Tumor Type, Site of Occurrence, and Annual Number of Tumors Treated With MMS in Patients Attending the 3 ASDS ITMP International Mohs Fellowship Units From 2014 to 2019**

	<i>South African Unit</i>		<i>Romanian Unit</i>		<i>Dutch Unit</i>	
	N	%	N	%	N	%
<b>Patient characteristics</b>						
Female	1,470	38	606	53.1	416	49
Male	2,429	62	535	46.9	433	51
<b>No. of tumors treated per year</b>						
2014	176		116		N/A	
2015	464		148		N/A	
2016	719		175		N/A	
2017	778		195		103	
2018	1,387		278		440	
2019*	375		229		306	
<b>Tumors treated</b>						
Total (N, %)	3,899		1,141		849	
BCC	3,077	78.9	901	79.0	825	97.2
SCC	691	17.7	217	19	6	0.7
Other	131	3.4	23	2	18	2.1
<b>Tumor size</b>						
<b>Preoperative</b>						
<1 cm	290	7.4	332	47	362	43
1–2 cm	1827	46.9	182	26	340	40
2–4 cm	1,471	37.7	122	17	64	8
4–6 cm	229	5.9	24	3	5	1
>6 cm	52	1.3	11	2	0	0
Unknown	30	0.8	31	4	78	9
<b>Postoperative defects</b>						
<1 cm	196	5	146	20.8	143	16.8
1–2 cm	1,669	42.8	286	40.7	465	54.8%
2–4 cm	1,605	41	202	28.8	139	16.4
4–6 cm	313	8	37	5.3	21	2.5
>6 cm	87	2.2	22	3.1	1	0.1
Unknown	30	0.8	9	1.3	80	9.4
<b>Site of tumor</b>						
Facial H-zone (nose, lips, eyelids, temples, ears)	1890	48.5	810	71	559	65.8
Face (non-H-zone)	784	20.1	214	18.8	136	16
Scalp and neck	408	10.5	66	5.8	144	17
Trunk (excluding special areas)	506	13.0	22	1.9	9	1.1
Special truncal areas (genitalia, perianal, nipples, hands, and feet)	101	2.6	15	1.3	N/A	N/A
Anterior lower legs	195	5	14	1.2	N/A	N/A
Unknown	15	0.4	0	0.0	1	0.1

\*MMS cases completed to March 2019 (SA unit) and July 2019 (Romanian and Netherlands units).

BCC, basal cell carcinoma; ITMP, International Travelling Mentorship Program; MMS, Mohs micrographic surgery; N/A, not available; SCC, squamous cell carcinoma.

trunk or limbs, or if the patient is immunosuppressed.<sup>3</sup> The surgical method of choice for these patients would be MMS. In this article, we show that the outcomes

following MMS are excellent, especially when performed at an accredited facility with appropriately trained Mohs surgeons.

**TABLE 2. The Average Number of Stages and Tissue Sections Processed for All Tumors Treated Using MMS, and the Average Number of Stages and Sections Processed Till Clearance If Not Clear After First Stage, by Combined BCC and SCC and by Histologic Subtype**

	South African Unit			Romanian Unit			Dutch Unit		
	Total	Stages (Mean)	Sections (Mean)	Total	Stages (Mean)	Sections (Mean)	Total	Stages (Mean)	Sections (Mean)
All tumors	3,899	1.61	3.01	1,141	1.60	2.49	837	1.49	3.50
Tumors requiring >1 stage to clearance (45%)	1742	2.33	4.11	470	2.43	3.87	323	2.26	4.82
For BCC	1,466	2.4	4.24	389	2.41	3.75	322	2.27	4.90
For SCC	276	2.26	4.03	81	2.48	4.42	1	2	4
<b>BCC subtype</b>									
Nodular	722	2.32	4.05	297	2.27	3.36	N/A	N/A	N/A
Superficial	248	2.55	4.24	7	2.00	2.14	N/A	N/A	N/A
Micronodular	92	2.7	5.93	8	3.25	4.63	N/A	N/A	N/A
Infiltrative	226	2.34	4.62	29	2.69	4.41	N/A	N/A	N/A
Morphoeic	68	2.57	5.28	46	3.00	5.89	N/A	N/A	N/A
Basosquamous	29	2.24	3.55	1	2.00	3.00	N/A	N/A	N/A
Unclassified	81	2.38	2.38	1	6.00	6.00	N/A	N/A	N/A
<b>SCC subtype</b>									
Well differentiated	108	2.28	3.74	26	2.42	3.23	N/A	N/A	N/A
Moderate	92	2.33	4.66	9	2.78	6.45	N/A	N/A	N/A
Poorly differentiated	2	3	11.5	5	2.40	12.8	N/A	N/A	N/A
In situ	N/A	N/A	N/A	30	2.50	3.93	N/A	N/A	N/A
Unclassified	70	2.15	3.47	11	2.36	3.09	N/A	N/A	N/A
Recurrent BCC/SCC, >1 stage to clear (151/251 = 60%)	151	2.46	4.93	109	2.77	5.01	N/A	N/A	N/A

BCC, basal cell carcinoma; MMS, Mohs micrographic surgery; N/A, not available; SCC, squamous cell carcinoma.

For a dermatologist to perform MMS on a NMSC, he or she requires training in the procedure. To ensure that the training is adequate and of the desired quality, it is ideal for such training to occur in a setting of a fellowship or another well-organized training program. Fellowships for training in MMS are established in many countries. Even in countries without Mohs fellowships, there is a demand for such training. The ASDS ITMP Program established an ASDS ITMP International Fellowship Recognition Program in 2016, with well-defined guidelines for recognition, including requiring that the fellowship director, and cofaculty, should be approved ASDS ITMP Mentors, and 3 ASDS ITMP Mohs Fellowship Units have been established since 2017. The first was in Pretoria, South Africa, the second in Bucharest, Romania, and the third in Eindhoven in the Netherlands.

Mohs micrographic surgery has been demonstrated as the surgical technique achieving the highest cure rates, especially over the long term.<sup>13</sup> Mosterd et al<sup>14</sup> compared the outcomes of standard excision with MMS and reported significantly lower recurrences for recurrent BCCs treated with MMS compared with standard surgical excision and similar recurrences for primary BCCs, over a 5-year follow-up period. Continuing the study over a 10-year follow-up period, van Loo et al<sup>13</sup> reported a 3 times higher probability of recurrence for primary BCC if treated using standard excision rather than MMS. In the South African unit, we report low recurrence (0.1%) rates. The Romanian unit reports a similarly low recurrence rate of 0.17%. Median follow-up time for both units are at 2 years, and more recurrences may manifest over time, but the current low rate of recurrence is encouraging.

**TABLE 3. Techniques Used to Reconstruct Defects Following MMS at the 3 ASDS ITMP International Mohs Fellowship Units From 2014 to 2019**

	<i>South African Unit</i>		<i>Romanian Unit</i>		<i>Dutch Unit</i>	
	N	%	N	%	N	%
Linear repairs	840	21.5	390	55.6	520	61.3
Skin grafts	132	3.4	21	3	75	8.8
Healing by second intent	5	0.13	12	1.7	157	18.5
Flaps	2,628	67.4	265	37.7	45	5.2
Type of flaps						
Advancement flaps	2,131	54.7	119	17	30	3.5
Rotation flaps	105	2.7	77	11	N/A	N/A
Transposition flaps	244 (includes bilobed flaps)	6.3	19	2.7	14	1.6
Island pedicle/V-Y flaps	87	2.2	30	4.3	0	N/A
Bilobed flaps	N/A	N/A	4	0.6	1	0.1
Paramedian/median forehead flaps	61	1.6	2	0.3	0	N/A
Keystone flaps	N/A	N/A	2	0.3	0	N/A
Vermilionectomy	N/A	N/A	12	1.7	0	N/A
Combined	N/A	N/A	13	1.9	34	4.0
Amputation	0	0	1	0.1	N/A	N/A
Other (includes unclassified flaps and combined reconstructions)	294	7.5	N/A	N/A	15	1.8
Plastic surgeon	N/A	N/A	N/A	N/A	3	0.4

ASDS, American Society of Dermatologic Surgery; ITMP, International Travelling Mentorship Program; MMS, Mohs micrographic surgery; N/A, not available.

In the United States, Krishnan et al<sup>15</sup> reported an average of 1.74 stages to clearance, with a low outlier cutoff of 1.28 stages per case, and the high cutoff of 2.41 stages per case. In this study, the 3 units report mean stages of 1.61 (SA), 1.60 (R), and 1.49 (N), respectively, which all fit within the low and high outlier values reported from the United States. The fewer stages reported by the Netherlands unit may be due to the better availability of skin cancer care in the Netherlands with the Dutch population presenting at an earlier stage to the Mohs surgeon. This is also supported by the observation that 72% of Dutch patients had postoperative defects equal to or smaller than 2 cm, whereas only 62% and 48% of patients from Romania and South Africa, respectively, had defects equal to or smaller than 2 cm.

The 3 units had similar numbers of tumors requiring more than 1 stage to achieve margin clearance, with 45% for the South African unit, 41% for the Romanian unit, and 39% for the Netherlands unit. Upon

closer inspection, the 3 units reported similar experiences with the clearance of complicated, multistage BCCs and SCCs (Table 2), reporting similar numbers of stages required to clear these tumors. Although the histologic BCC subset data were not available from the Netherlands, data from the South Africa and Romanian units indicated that BCCs with micronodular and morphoeic growth types required the most stages to clearance, resulting in larger postoperative defects for these 2 BCC subtypes.

Aside from effective tumor clearance, MMS has significant tissue sparing benefits.<sup>16</sup> For BCCs, the first section usually comprises the tumor and a margin of 1 to 3 mm, depending on where the tumor is situated. Subsequent excisions are only performed on the positive margins of the defect, leading to smaller defects and sparing of healthy tissue.<sup>16</sup> Smaller defects should ultimately be easier to reconstruct with lower morbidity than larger defects caused by wider excisions.<sup>5</sup>

The efficacy of MMS has been linked to effective margin control.<sup>6</sup> Studies have demonstrated that “blind” simple excisions leave behind malignant cells in the peripheral excision margins in a significant percentage of cases,<sup>17</sup> compared with MMS, which achieves 100% control of tumor-free margins. Alternatives to “blind” simple excisions include performing random vertical frozen sections on the excision block in theatre, but even then, typically only 1% to 3% of the peripheral margin is evaluated.<sup>18–20</sup> In contrast, the tissue block excised during MMS is evaluated with 100% peripheral margin control, effectively eliminating the risk of leaving any tumor behind, providing the whole tumor is continuous. Successful MMS is followed by reconstruction of the defect, or the defect may be left to heal by second intent. Defects can be reconstructed by the dermatologist performing the MMS or by a reconstructive specialist.

In the South African Unit, the unit has been conceived as a partnership between the dermatologists performing MMS, and plastic and reconstructive specialists, which allowed a multidisciplinary multispecialist unit to be established. The team approach allows the unit to manage the volume of cases, as well as the majority of complex cases. The reconstructive specialist team at the South African Skinmatters Mohs and Reconstructive Unit comprises 4 specialist reconstructive surgeons, and as required, oculoplastic, faciofacial, head and neck, and general surgeons, or neurosurgeons.

The reconstructive comparison between the units is interesting. As discussed above, the South African Unit comprises a multidisciplinary team with the plastic and reconstructive surgeons performing reconstructions on a daily basis and takes part as cofaculty in the training of the Mohs fellow. This is in contrast with the Romanian and Netherlands units where the dermatologist performing the MMS also performs most of the reconstructions. In the South African unit, only 24% of closures comprised linear closures, healing by second intent and skin grafts, whereas these techniques made up 60% of closures in the Romanian unit and 88.5% in the Dutch unit.

The 3 units also differed in terms of the preferred method of anesthesia during reconstructions. In the

South African unit, local anesthesia and intravenous conscious sedation were used with equal frequency, whereas the Romanian and Netherlands units almost exclusively used local anesthetic. Performing MMS under local anesthetic allows the patient to undergo multiple stages of excision of positive margins if required, while returning to the ward or waiting room in between stages. In contrast, reconstructions are performed as a single procedure, allowing the option for the reconstructive procedure to be performed under intravenous conscious sedation. In the South African unit, intravenous conscious anesthetic is preferred for patients requiring larger and more complicated reconstructions or reconstructions on sensitive areas such as eyelids, nose, and lips.

In all 3 units, the MMS and reconstructions were performed in a specifically equipped facility, with some differences between the facilities. In the South African unit, the facility comprises a day hospital facility with the theatre and operating room complex having a specially designed Mohs frozen section laboratory and microscope room. Once a MMS patient’s tumor margins are confirmed to be clear of tumor, the patient is transferred from the MMS list to the reconstruction list in the adjacent theatre. Having an MMS team and a reconstruction team in adjacent theatres allows more patients to be treated during a working day, more challenging and complicated cases to be managed on a routine basis, and allows most of the patients to have their MMS and reconstruction completed on the same day. The Romanian unit is similar to the South African unit, with dedicated operating rooms, an adjacent Mohs frozen section laboratory, and a ward where patients are admitted and returned to between MMS stages. Mohs micrographic surgery can also be performed in an outpatient, consulting room setting provided the facility is appropriately equipped, maintained, cleaned, sterilized, and staffed. The MMS unit in the Netherlands functions from such a well-equipped outpatient facility.

Most of the cases treated at the units were referred by other physicians. The steady increase in the annual number of cases referred, likely reflects an increased awareness of, and satisfaction with, the technique and outcomes among physicians managing skin cancer patients.

In summary, MMS is the gold standard treatment for NMSC, offering 100% margin control of the tumor, translating into the highest cure rates.<sup>4,6</sup> The results from the first 3 units to establish ASDS ITMP International Mohs Fellowship Recognition training programs shows, with a combined 5,889 cases, a less than 1% recurrence rate to date and no serious complications. The patient records from these 3 units reflect an increasing demand for MMS of NMSC in South Africa, Romania, and the Netherlands. The results confirm that the 3 units offer the procedure within the accepted international parameters of measured results, assuring ASDS ITMP Mohs fellows of a good training experience and serve as benchmarks for future ASDS ITMP International Mohs Fellowship Units.

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