

ORIGINAL ARTICLE

Mohs Appropriate Use Criteria Scores and Treatment of Keratinocyte Carcinoma: Review of 11,145 Tumors

Richard H. Hope, MD¹, Travis S. Dowdle, MD², Landon Hope, MD³, Corley Pruneda, MD⁴

¹ Lubbock Dermatology and Skin Cancer Center/Texas Tech University Health Sciences Center, Department of Dermatology, Lubbock, TX

² University of South Dakota, Sanford School of Medicine, Sioux Falls, SD

³ University of Arkansas for Medical Sciences, Department of Surgery, Little Rock, AR

⁴ Texas Tech University Health Sciences Center, Department of Dermatology, Lubbock, TX

ABSTRACT

Background: Various methods are available for treatment of keratinocyte carcinomas (KCs). The Mohs appropriate use criteria (AUC) score was developed to quantify the appropriateness of Mohs micrographic surgery (MMS) based on multiple tumor and patient characteristics.

Objectives: Stratify KCs by treatment modality used and compare to Mohs AUC score.

Methods: Conducted a retrospective review of 11,145 consecutive KCs between 01/2017 and 12/2021, comparing associated Mohs AUC score with modality selected.

Results: The average Mohs AUC score for all KCs combined was 7.1 with 8714 (78.2%) qualifying for MMS via AUC score. However, MMS was only done on 2813 (32.3%) of KCs. Excisional surgery was used to treat 4580 (41.1%) of KCs, 2777 (24.9%) were treated with electrodesiccation and curettage (ED&C), and 732 (6.6%) were treated with biopsy only. Of those KCs treated with excision, ED&C, or a biopsy, 70.7%, 70.7%, and 72.4% reached an “appropriate” Mohs AUC score for MMS respectively.

Limitations: This is a single private practice, with two board certified dermatologists

Conclusions: Mohs AUC score can help determine if a KC warrants MMS; however, in our practice, MMS was necessary for only 32.3% of the KCs that qualified based on the Mohs AUC score.

INTRODUCTION

Treatment of KCs, which includes BCCs and SCCs, is influenced by many factors, including the type and aggressiveness of the skin cancer, resources available and the experience and training of the practitioner.¹⁻³ One of the methodologies that continues to grow in use by dermatologists is Mohs micrographic surgery (MMS). MMS is a surgical treatment for skin cancer that

combines maximal tissue conservation with immediate microscopic evaluation of tumor margins. This combination allows for a smaller surgical defect and superior cure rates.⁴⁻⁸ The implementation of MMS to treat SCCs and BCCs of the skin has continued to increase, with over 800,000 cases being performed yearly, and that number is on the rise.⁵ With the increased use it became apparent for a need of standardization when deciding to perform MMS. This is where the

Mohs appropriate use criteria (AUC) becomes a useful tool for the clinician.⁹⁻¹⁴

The Mohs AUC score considers patient and tumor characteristics, giving a numerical 1-9 result on the appropriateness of MMS and can assist the physician in determining whether a NMSC warrants MMS. If a score of 7, 8, or 9 is reached then MMS can be considered “appropriate.”⁹

The purpose of our review of 11,145 KCs is to stratify this large database by Mohs AUC score and the various treatments as selected by the dermatologist. Although tumors can reach a Mohs AUC that is “appropriate” for MMS, this is not always implemented based on a variety of factors.^{1,2,15,16} We looked at our data to analyze the use of MMS, and other treatments, in relation to the Mohs AUC.

METHODS

The data on tumor features and patient characteristics were searched and retrieved from a proprietary electronic health records system. The timeframe for diagnoses was a five-year period from January 1, 2017 through December 31, 2021. A Mohs AUC score was calculated for each KC based on features of the tumor as well as patient characteristics as previously described.

RESULTS

A total of 11,145 consecutive KCs were diagnosed between January 1, 2017, and December 31, 2021. The average Mohs AUC score was 7.1 for all tumors. 1502 (13.5%) were considered “inappropriate” for MMS. 929 (8.3%) were considered “uncertain” for MMS. 8714 (78.2%) were considered “appropriate” for MMS. This is

shown in more detail in **Table I**. **Table II** shows the tumors that were treated with MMS. Six (0.2%) KCs were treated with MMS although the Mohs AUC score was considered “inappropriate”. Also, seven tumors (0.3%) were considered “uncertain” but treated with MMS. Of the rest of the KCs treated with MMS, 2800 (99.5%) were considered “appropriate” for MMS. Excisional surgery was used to treat 4580 (41.1%) of all KCs. These results are shown in the **table III**. The Mohs AUC score for these tumors shows that 3244 (70.7%) would have been considered “appropriate” for treatment with MMS. ED&C was used to treat 2777 (24.9%) of all KCs. Of these, 1963 (70.7%) were considered “appropriate” for MMS. These results are seen in **Table IV**. **Table V** shows that 732 (6.6%) of all KCs were treated with biopsy only. Upon return visit, the site of the original biopsy had no evidence of tumor and no further procedure was performed on that site. Of these tumors, 530 (72.4%) were considered “appropriate” for MMS. Finally, 153 (1.4%) KCs were lost to follow up and 90 (0.8%) KCs were either treated by topical therapy or referred to other physicians for treatment.

DISCUSSION

Dermatologists have many options for treatment of KCs. Our practice has two board certified dermatologist with combined 49 years of clinical experience and multiple modalities for treatment of KCs are available, including MMS and outside referral. The choice of treatment for KC is multifactorial, including the tumor features, the patient’s current comorbidities, the ability of the patient to tolerate a procedure, the patient’s social situation, the provider’s experience and training, the available of outside referrals, treatment costs, and other considerations. All of these factors come into play in the decision

Table I. The total number of NMSCs in data set was 11,145 and all data was collected between 01/01/2017 - 12/31/2021. Total number patients with NMSC were 5877, however every patient in the data set has had NMSC. 153 (1.4%) KCs lost to follow-up. 90 (0.8%) KCs either treated by topical or systemic therapy or referred to other physicians.

ALL KC TUMORS – 11145
Avg Mohs AUC score 7.1
Mohs AUC 1 - 11 (0.1%)
Mohs AUC 2 - 32 (0.3%)
Mohs AUC 3 - 1459 (13.1%)
1502 (13.5%) inappropriate for MMS
Mohs AUC 4 - 11 (0.1%)
Mohs AUC 5 – 47 (0.4%)
Mohs AUC 6 - 871 (7.8%)
929 (8.3%) uncertain for MMS
Mohs AUC 7 - 2195 (19.7%)
Mohs AUC 8 - 4677 (42.0%)
Mohs AUC 9 - 1842 (16.5%)
8714 (78.2%) appropriate for MMS

Table II. Treated with Mohs surgery.

Treated with Mohs Surgery
- 2813 (25.2%) of all KCs
- 2813 (32.3%) of 8714 KCs appropriate for MMS
Avg Mohs AUC score 8.3
Mohs AUC 1 - 0 (0.0%)
Mohs AUC 2 - 0 (0.0%)
Mohs AUC 3 - 6 (0.2%)
6 (0.2%) inappropriate for MMS
Mohs AUC 4 - 1 (0.1%)
Mohs AUC 5 - 0 (0.0%)
Mohs AUC 6 - 6 (0.2%)
7 (0.3%) uncertain for MMS
Mohs AUC 7 - 256 (9.1%)
Mohs AUC 8 - 1306 (46.6%)
Mohs AUC 9 - 1238 (44.0%)
2800 (99.5%) appropriate for MMS

Table III. Treated with excisional surgery.

Treated with Excisional Surgery
- 4580 (41.1%) of all KCs
Avg Mohs AUC score 6.8
Mohs AUC 1 - 3 (0.1%)
Mohs AUC 2 - 9 (0.2%)
Mohs AUC 3 - 704 (15.4%)
716 (15.7%) inappropriate for MMS
Mohs AUC 4 - 6 (0.1%)
Mohs AUC 5 - 17 (0.4%)
Mohs AUC 6 - 605 (13.2%)
628 (13.7%) uncertain for MMS
Mohs AUC 7 - 1082 (23.6%)
Mohs AUC 8 - 1891 (41.3%)
Mohs AUC 9 - 263 (5.8%)
3236 (70.7%) appropriate for MMS

Table IV. Treated with electrodesiccation and curettage.

Treated with Electrodesiccation and Curettage
- 2777 (24.9%) of all KCs
Avg Mohs AUC score 6.6
Mohs AUC 1 - 3 (0.1%)
Mohs AUC 2 - 17 (0.6%)
Mohs AUC 3 - 578 (20.8%)
598 (21.5%) inappropriate for MMS
Mohs AUC 4 - 2 (0.1%)
Mohs AUC 5 - 23 (0.8%)
Mohs AUC 6 – 191 (6.9%)
216 (7.8%) uncertain for MMS
Mohs AUC 7 - 620 (22.3%)
Mohs AUC 8 - 1129 (40.7%)
Mohs AUC 9 - 214 (7.7%)
1963 (70.7%) appropriate for Mohs

Table V. Treated with biopsy only.

Treated with Biopsy Only
-732 (6.6%) of all KCs (Lesion not present on subsequent visits)
Avg Mohs AUC score 6.7
Mohs AUC 1 - 4 (0.5%)
Mohs AUC 2 - 4 (0.5%)
Mohs AUC 3 - 133 (18.2%)
141 (19.2%) inappropriate for MMS
Mohs AUC 4 - 2 (0.3%)
Mohs AUC 5 - 6 (0.8%)
Mohs AUC 6 - 53 (7.2%)
61 (8.3%) uncertain for MMS
Mohs AUC 7 - 176 (24.0%)
Mohs AUC 8 - 272 (37.2%)
Mohs AUC 9 - 82 (11.2%)
530 (72.4%) appropriate for MMS

to implement MMS or pursue an alternative treatment.^{1-3,10,12,17}

A collaborative effort between the American Academy of Dermatology, the American College of Mohs surgery, the American Society for Dermatologic Surgery and the American Society for Mohs surgery created the Mohs AUC scoring system in 2012 based 270 clinical scenarios. The various features considered in developing Mohs AUC score include tumor features and patient characteristics. Tumor features include location and size, aggressiveness of the tumor, and positive margins on recent excision. Patient characteristics, include healthy patient, immunocompromised (by medications or diseases) patients, genetic syndromes, and prior irradiated skin.⁹ Of these cases, they showed that 74.07% were “appropriate”, 8.89% were “uncertain”, and 17.04% were “inappropriate” for MMS.

Of interest, of our 11,145 tumors, we showed that 78.2% were “appropriate”, 8.3% were “uncertain”, and 13.5% were “inappropriate” for MMS. These are quite similar percentages as the original paper.⁹ Another retrospective review by Blechman et. al was performed similar to ours at a single academic center to examine the utilization of MMS in comparison to AUC criteria. In that study, 1059 KCs were examined with 72.0% deemed “appropriate”, 7.6% “uncertain”, and 20.4% “inappropriate”. Ultimately only 29.7% of those tumors appropriate for MMS ultimately received it, very similar to the 32.3% utilization in our data set.^{18,19} Chong et al. also determined at the University of Utah in 2012 that there is a large percentage of non-melanoma skin cancers that meet AUC criteria for MMS but are ultimately treated by different modalities, only 34.1% of the 1026 NMSC’s were treated with MMS, again very similar to our data set.² Recently in 2022, Stancut et. al also evaluated the adherence

to the AUC at the University of Alabama at Birmingham, and reviewed reasons for nonadherence, with hopes of informing future versions of the AUC. They reported 93.9% of tumors treated as “appropriate”, 4.5% as uncertain, and 1.7% as inappropriate from a total data set of 1318.¹⁶

In 2020, our proprietary medical records software included a feature to automatically calculate the Mohs AUC each time a NMSC case was diagnosed and/or treated. This helped the dermatologists be more accurate on whether KC would meet the Mohs AUC score for MMS. Of the 2813 KCs that were treated with MMS this represented 25.2% of all KCs and 32.3% of KCs considered “appropriate” for MMS. For these tumors treated with MMS, 2800 (99.5%) were considered “appropriate” and 7 (0.3%) were considered “uncertain” and 6 (0.2%) were considered “inappropriate.” Of course, there can be many clinical scenarios where MMS may be chosen outside of the “appropriate” Mohs AUC score.

Excisional surgery is the most common treatment modality for KCs and was the chosen treatment modality for 4580 (41.1%) of all KCs in our data set. Of these, 3236 (70.7%) would have been considered “appropriate” cases for MMS. Multiple reasons exist in which a dermatologist may chose excision over MMS, including less utilization of resources, quicker and faster for the patient, patient preference and others. A common scenario encountered would be a less aggressive skin cancer and the dermatologist determines that appropriate margins can be achieved with little chance of recurrence and a relatively straightforward closure can be accomplished. With both of these criteria met, an appropriate margin and simple defect for closure it is appropriate to not utilize MMS, even though MMS

“appropriateness” was determined by the Mohs AUC score.

In our data set, 2777 (24.9%) of KCs were treated with ED&C. Of these, 1963 (70.7%) would have been considered appropriate for MMS as per the Mohs AUC score. ED&C treatment is generally considered the quickest and easiest method to remove a KC. This treatment is often chosen by the dermatologists and other practitioners when the lesion is relatively small, in a non-sensitive cosmetic area, and the risk of recurrence would be low or potentially easily treated. ED&C is often implemented for treatment of superficial BCCs and SCCs of the trunk and extremities. When patients have significant comorbidities and cannot tolerate a more involved procedure, ED&C will often be the method of treatment.

Some lesions could not be found clinically upon return to the clinic after a biopsy was done that confirmed a KC. These were considered “treated with biopsy”. There are situations when a patient is referred to the clinic, or returns after biopsy, to have a tumor removed but it cannot be appreciated clinically. This can happen despite having the other clinician’s notes as well as a pathology report reporting a cancerous lesion. This seems to occur more commonly when there is a significant amount of time between the biopsy and planned procedure. The cancerous site may have healed from the biopsy and the subsequent inflammation leaving no tumor present clinically. In our data set, we had 732 (6.6%) of these situations and 530 (72.4%) of these KCs would have qualified for MMS as per the Mohs AUC score.

Finally, 90 (0.8%) KCs were either treated by topical or systemic therapy or referred to other physicians for treatment. Systemic therapy would have been hedgehog

inhibitors. Topical treatment generally included imiquimod or 5-fluorouracil. Most of our outside physician referrals would include to radiation oncologists or otolaryngologists. A small proportion of patients with KCs never received treatment, that we are aware of, and that included 153 (1.4%) that were “lost to follow up.” Some of these patients may have become deceased between biopsy and scheduled surgical resection, or simply never returned to the clinic despite multiple contact attempts.

CONCLUSION

From our review, the Mohs AUC score, can certainly help determine what KCs are appropriate for MMS. We can determine that just because a KC reaches the Mohs AUC score for MMS does not necessarily mean that MMS is the best treatment option for that particular patient and tumor based on the patient’s clinical status and the clinician’s evaluation the lesion.^{1,19} However, our paper did not evaluate complication or recurrence rates for these KC treated with MMS or other modalities. As outlined above there are a multitude of situations in which MMS AUC can be met, but for one reason or another it is not the best option for a particular patient.² The main limitation of this study is its reliance on data from a single private practice with only two Mohs surgeons, which raises concerns about the generalizability of the findings beyond this specific setting, however, these data align with previous studies performed at single academic institutions.^{2,16,18,19} It is imperative that dermatologists understand the Mohs AUC is a good tool to use but has its own limitations. The ultimate decision for MMS versus other treatment of NMSC lies in the hands of well-trained clinicians and should take into account the multitude of patient factors present.^{1,12,18-20}

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Corresponding Author:

Lubbock Dermatology and Skin Cancer Center
 3601 22nd Street
 Lubbock, TX 79410
 (806) 441-4242
 Email: rhope@suddenlink.net

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