Effect of Dermoscopy Education on the Ability of Medical Students to Detect Skin Cancer

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Objectives: To determine students’ ability to discriminate benign vs malignant lesions and to assess attitudes regarding skin cancer examination (SCE).

Design: Second-year medical students at 1 institution participated in an SCE intervention for 2 consecutive years.

Intervention: Cohort 1 received intervention A, consisting of SCE teaching without a dermoscopy tutorial. Cohort 2 received intervention B, consisting of SCE teaching with a dermoscopy tutorial, access to online dermoscopy resources, and a dermoscope.

Main Outcome Measure: Surveys before and after the lecture included an image-based test of 10 lesions to assess ability to differentiate benign from malignant lesions.

Results: There were 130 participants from cohort 1 and 131 participants from cohort 2 at the postintervention survey. At baseline, students in both groups reported similar attitudes regarding the value of SCE ($P = .05$) and intention to perform SCE on patients ($P = .55$). Overall, cohort 2 exhibited improvement ($P < .001$) from preintervention (52.0% correct) to postintervention assessments (63.0% correct), whereas cohort 1 did not (47.0% and 46.0% correct, respectively; $P = .50$). Although both groups improved ($P < .001$) in the diagnosis of the superficial spreading melanoma, cohort 2 improved in the diagnosis of the basal cell carcinoma ($P < .001$) and cohort 1 displayed deterioration in identifying the malignant nature of this lesion ($P < .001$). For the nodular melanoma, correct diagnosis decreased significantly in cohort 1 ($P < .001$) and negligibly in cohort 2 ($P = .90$).

Conclusions: Students receiving the dermoscopy tutorial improve in diagnosis of cutaneous lesions compared with those not receiving the dermoscopy intervention. Teaching SCE with inclusion of dermoscopy may be an effective means of enhancing skin cancer knowledge.

Arch Dermatol. 2012;148(9):1016-1022

**Melanoma is the deadliest form of skin cancer, and despite significant recent advances in systemic therapies, the prognosis for advanced disease remains poor. Furthermore, the incidence of and mortality from this disease continue to rise; from 1990 to 2006, although mortality due to all cancers decreased, the mortality continued to increase for melanoma.** The greatest potential to lessen the burden of melanoma is through detection during the early stages of tumorigenesis, while the cancer is thin and confined to the upper layer of the skin. Educating the medical community regarding the warning signs of melanoma may help in the detection of a higher proportion of thinner tumors. Toward this end, supporting and equipping medical students with the clinical skills necessary to evaluate the skin and differentiate benign from malignant lesions may greatly improve their ability to detect early melanomas. Nonetheless, previous studies have shown that current medical school curricula do not provide adequate training to facilitate the detection of skin cancer.

Dermoscopy is a noninvasive imaging technique designed to provide information not readily appreciable to the naked eye, specifically, visual cues within the epidermis and papillary dermis. Studies have documented that dermoscopy can assist experienced users in identifying melanoma and other malignant lesions when compared with naked-eye examination. Reports indicate that dermoscopy is used in 84% of US dermatology residency pro-
grams and has been shown to increase the diagnostic accuracy of melanoma and to reduce the number of unnecessary excisions. Introducing medical students to dermoscopy in their second year of medical school, along with teaching more standard skin cancer examinations (SCEs), may increase their familiarity with skin and help improve their accuracy when performing SCEs.

The effect of 2 educational interventions on medical students’ ability to identify benign vs malignant lesions was assessed using a 2-arm study design. Intervention A was an SCE lecture; intervention B, an SCE lecture with the addition of a dermoscopy tutorial. This study reports on the immediate differences observed for each intervention group and compares the effectiveness of the 2 interventions.

STUDY DESIGN

During year 1 of the study, second-year medical students (class of 2012) received intervention A; during year 2, second-year medical students (class of 2013) received intervention B. Intervention A consisted of a 45-minute SCE lecture without the dermoscopy tutorial (eFigure 1 lecture slides; http://www.archdermatol.com); intervention B, a 45-minute SCE lecture and a 15-minute dermoscopy tutorial (eFigure 2 dermoscopy tutorial). Students were required to attend the lecture but were permitted to opt out of the protocol-related assessments. The interventions were given in lecture format and included formal instruction on SCE consistent with other components of the clinical skills curriculum. The teaching intervention stressed the identification of benign vs malignant lesions with the use of an image set. The lecture incorporated different cognitive methods and algorithms used in identifying melanoma, including the ABCD rule (A, asymmetry; B, border irregularity; C, color variegation; and D, diameter >6 mm) and ugly duckling sign, to serve as the basis for creating appropriate, effective, and improved teaching strategies for melanoma detection. The objectives of the lecture were to provide instruction on how to obtain a focused skin cancer history with assessment of risk factors and perform a formal total body visual inspection with a special emphasis on how to recognize lesions that could be melanoma.

Students in intervention A attended the lecture and received no additional materials. Students in intervention B received additional dermoscopy training incorporated into the lecture. This image-based dermoscopy tutorial was developed with the following criteria: (1) the inclusion of dermoscopic features demonstrating high interobserver agreement after limited training and (2) maximization of specificity for detection of melanoma. Therefore, the 3-point checklist, centered on the detection of pigmented cutaneous malignant neoplasms, was the focus of this dermoscopy tutorial. In addition, students in intervention B were provided with optional online resources for learning dermoscopy after the lecture and a dermoscope (Dermlite DL100; 3Gen).

PREINTERVENTION AND POSTINTERVENTION ASSESSMENTS

Outcome assessment and evaluation were accomplished using surveys and image-based tests (1) at baseline, immediately before the lecture, and (2) immediately after the delivery of the lecture.

Students in both arms of the study were given a preintervention survey collecting minimal background information and beliefs and attitudes about the SCE. Students in both cohorts completed the same image-based pretest of 10 lesions for evaluation of the students’ baseline ability to identify whether a lesion is benign or malignant (eFigure 3 clinical images test). The image-based test for cohort 2 also included dermoscopic images for each study lesion (eFigure 4 clinical dermoscopic test).

Immediately after the teaching intervention, students in both study arms were then given a 10-item image-based assessment using a collection of benign and malignant lesion images. The purpose of this evaluation was to determine whether the students improved as the result of the lecture and also whether the addition of dermoscopy made a difference. Survey questions were also directed at (1) intentions to perform SCE during the third-year clinical rotations and (2) the acceptability of and satisfaction with the intervention. Additional demographic data were also obtained.

DATA AND STATISTICAL ANALYSIS

The study hypothesis was that the addition of dermoscopy to the SCE lecture (intervention B) would lead to better outcomes (ie, knowledge, attitudes, and beliefs) compared with the SCE lecture alone (intervention A). The proportion of correct responses by lesion category was assessed for each intervention group using the McNemar $\chi^2$ test for paired proportions. The Pearson $\chi^2$ test was used to explore (1) differences in medical students’ ability to identify malignant lesions between interventions A and B and (2) differences in behavioral factors related to attitudes, beliefs, and practices. Linear regression models using the general estimating equations framework were used to assess differences between the intervention groups across the study points. In addition, acceptability of the interventions and feasibility of the design were also considered primary outcomes, given that these results may serve as a model for teaching the SCE in medical school clinical skills curriculum. All analyses were performed using commercially available software (STATA, version 10.1 SE; StataCorp).

RESULTS

One hundred forty-five students were enrolled in the medical student class in cohort 1; 129 (89.0%) completed the preintervention survey, and 130 (89.7%) completed the postintervention survey. One hundred forty-three students were enrolled in the medical student class in cohort 2; 134 (93.7%) completed the preintervention survey, and 131 (91.6%) completed the postintervention survey.

Results from the preintervention survey are illustrated in Table 1. The 2 groups were similar with regard to mean (SD) age (cohort 1, 24.8 [2.2] years; cohort 2, 24.3 [1.7] years), sex (cohort 1, 51.2% male and 48.8% female; cohort 2, 48.9% male and 51.1% female).
family or personal history of skin cancer (cohort 1, 22.4%; cohort 2, 20.6% \( P = .74 \)), and intended choice of dermatology as a career (cohort 1, 0.8%; cohort 2, 2.2% \( P = .73 \)). At baseline, students in both groups reported similar attitudes regarding the value of the SCE (\( P = .05 \)) and their intention to perform the SCE on their patients in the future (\( P = .55 \)).

Results from the postintervention survey are illustrated in Table 2. Most of the students in both cohorts reported that the lecture was “somewhat or very” helpful in teaching them to perform the SCE (Table 2). The postintervention survey also showed no differences between the cohorts with regard to the students’ attitudes concerning the value of learning the SCE (\( P = .15 \)), intent to perform the SCE on patients in the future (\( P = .20 \)), confidence in distinguishing between benign and malignant lesions (\( P = .12 \)), and helpfulness of the lecture in teaching the SCE (\( P = .63 \)).

The results from the image-based tests are shown in Table 3. When tested with the 10 lesions, students...
cohort 1 did not improve from the preintervention (47.0%) to postintervention (46.0%) assessment overall ($P = .50$) owing to their inability to improve significantly in the correct identification of benign lesions (P = .13), basal cell carcinoma (BCC), and nodular melanoma (NM) in the postintervention test. The benign lesions in the tests included seborrheic keratoses and melanocytic nevi. Students in cohort 1 improved significantly in the classification of superficial spreading melanoma (SSM) from the preintervention (59.7%) to postintervention (93.1%) assessment overall ($P < .001$), likely because of the ABCD features displayed in these lesions. The students did not improve in their assessments of dysplastic nevi (DN) and tended to label 2 of the 3 DN as malignant in the postintervention test. Overall, cohort 1 worsened from the preintervention to postintervention assessment in the classification of malignant lesions ($P < .001$); in particular, lesions that lacked any ABCD features, including the BCCs and NM, were not correctly identified as lesions of concern in the postintervention test.

Students in cohort 2 exhibited significant improvement from the preintervention (52.0% correct) to postintervention (63.0%) assessment in cohort 2 ($P < .001$). Cohort 2 significantly improved from the preintervention to postintervention assessment in the correct classification of malignant lesions, from 65.0% correct to 83.5% correct ($P < .001$), including lesions with and without ABCD features. Malignant lesions that lack ABCD features may be difficult for even experienced dermatologists to identify; thus, results in cohort 2 regarding improved postintervention diagnosis of these lesions are notable. No detriment to learning dermoscopy was observed; rather, ability improved with the use of dermoscopy to identify cancer, including BCC (from 67.2% to 92.4% correct [$P < .001$]) and SSM (from 57.5% to 88.6% correct [$P < .001$]), and to remain concerned about NM despite its lack of ABCD features (from 70.2% to 69.5% correct [$P = .90$]). The addition of dermoscopy improved the participants’ ability to identify DN as benign, with the percentage of correct classifications increasing from 41.7% at the preintervention to 53.9% at the postintervention assessment ($P < .001$). In all, after exposure to the lecture, including clinical and dermoscopy education, students in cohort 2 improved their ability to differentiate benign from malignant lesions.

No significant difference was observed between the cohorts in the baseline image test results (cohort 1, 47% correct; cohort 2, 52% correct). However, students in cohort 2 exhibited a significant improvement in the proportion of correctly identified lesions overall ($P < .001$) from the preintervention to postintervention assessment, whereas students in cohort 1 did not improve ($P = .50$) (Table 3). For most of the individual lesions (7 of 10 [70%]), students in cohort 2 exhibited greater improvement or a lesser degree of decline in correct diagnosis from the preintervention to postintervention assessment when compared with cohort 1. Specifically, when evaluating benign lesions, students in cohort 2 showed greater positive change or less negative change from the preintervention to postintervention assessment than cohort 1 in most (5 of 7 [71%]) of the lesions. In other words, cohort 2 exhibited a lesser degree of decline in the correct diagnosis than did cohort 1. For other individual lesion types, cohort 2 improved in diagnosis, whereas cohort 1 worsened or improved to a lesser degree. With regard to the 3 malignant lesions in the test, the results are as follows. Both groups significantly improved after their respective lectures in the correct diagnosis of the SSM (cohort 1, +33.4%; cohort 2, +31.1% [$P < .001$ for both cohorts]). Cohort 2 significantly improved in the correct diagnosis of the BCC (+25.2% [$P < .001$]), whereas cohort 1 displayed a significant deterioration in identifying the correct diagnosis (~23.6% [$P < .001$]). For the NM, a significant decrease was observed in the correct diagnosis in cohort 1 (~41.2% [$P < .001$]), whereas the decrease was not significant in cohort 2 (~0.7% [$P = .90$]).

### Table 3. Results of Image-Based Tests

<table>
<thead>
<tr>
<th>Lesions</th>
<th>Answers Correct, %</th>
<th>Pre</th>
<th>Post</th>
<th>Δ</th>
<th>P Value</th>
<th>Δ</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>47.0</td>
<td>46.0</td>
<td>-1.0</td>
<td>.50</td>
<td></td>
<td>+11.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>All benign</td>
<td>42.9</td>
<td>45.7</td>
<td>+2.9</td>
<td>.13</td>
<td></td>
<td>+7.0</td>
<td>.001</td>
</tr>
<tr>
<td>DN</td>
<td>43.4</td>
<td>43.6</td>
<td>+0.2</td>
<td>.96</td>
<td></td>
<td>+12.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>All malignant</td>
<td>57.9</td>
<td>47.4</td>
<td>-10.5</td>
<td>&lt;.001</td>
<td></td>
<td>+18.5</td>
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<td>BCC</td>
<td>63.6</td>
<td>40.0</td>
<td>-23.6</td>
<td>&lt;.001</td>
<td></td>
<td>+25.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SSM</td>
<td>59.7</td>
<td>92.1</td>
<td>+32.4</td>
<td>&lt;.001</td>
<td></td>
<td>+51.1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>NM</td>
<td>58.4</td>
<td>92.2</td>
<td>-41.2</td>
<td>&lt;.001</td>
<td></td>
<td>-7.2</td>
<td>.43</td>
</tr>
</tbody>
</table>

Comparison Between Cohorts

<table>
<thead>
<tr>
<th>Lesions</th>
<th>Answers Correct, %</th>
<th>Pre</th>
<th>Post</th>
<th>Δ</th>
<th>P Value</th>
<th>Δ</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>52.0</td>
<td>63.0</td>
<td>+11.0</td>
<td>&lt;.001</td>
<td></td>
<td>+12.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>All benign</td>
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<td>+7.0</td>
<td>.001</td>
<td></td>
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<td>.03</td>
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<tr>
<td>DN</td>
<td>41.7</td>
<td>53.9</td>
<td>+12.2</td>
<td>&lt;.001</td>
<td></td>
<td>+12.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>All malignant</td>
<td>65.0</td>
<td>63.5</td>
<td>-1.5</td>
<td>&lt;.001</td>
<td></td>
<td>+29.0</td>
<td>&lt;.001</td>
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<tr>
<td>BCC</td>
<td>67.2</td>
<td>92.4</td>
<td>+25.2</td>
<td>&lt;.001</td>
<td></td>
<td>+48.8</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SSM</td>
<td>57.5</td>
<td>88.6</td>
<td>+31.1</td>
<td>&lt;.001</td>
<td></td>
<td>+23.2</td>
<td>.43</td>
</tr>
<tr>
<td>NM</td>
<td>70.2</td>
<td>69.5</td>
<td>-0.7</td>
<td>.90</td>
<td></td>
<td>+40.5</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviations: BCC, basal cell carcinoma; Δ, difference; DN, dysplastic nevi; NM, nodular melanoma; Pre, preintervention; Post, postintervention; SSM, superficial spreading melanoma.

### COMMENT

Education in medical schools regarding the diagnosis of cutaneous lesions is minimal, and students are exposed to little training and practice in dermatology. In a survey regarding medical student curricula in dermatology...
at 75 academic institutions, students were only required to complete a median of 10 total hours of dermatology education. In 8% of the programs, no required dermatology instruction was provided; clinical dermatology rotations were offered in 93% of the schools as electives but were required in only 10%. Prior studies also reflect that typically fewer than 20 hours of dermatology education are required throughout medical school. The reported rates of SCE education and clinical experience are particularly low, with 1 study showing that SCE was represented in only 0.03% of the total medical school curriculum. As noted in a study of fourth-year medical students at 1 academic institution, many students (35%) never had the opportunity to perform an SCE, and most (52%) considered themselves unskilled in the technique. Furthermore, in a larger study of students at 7 medical schools, 23% had never seen an SCE performed, and 43% had never performed one themselves. Many medical students have minimal experience with examining patients for skin cancers, which may lead them to continually overlook the skin.

Diagnosing skin cancer is an essential clinical skill that can be useful in all fields of medicine, especially primary care fields. Primary care physicians (PCPs) are expected to have at least basic skills in dermatology. However, PCPs perform skin cancer prevention or screening activities rarely and less frequently than many other screening and prevention activities. Regrettably, PCPs consistently report low confidence in their skin cancer diagnostic skills. Considering that PCPs are expected to accurately diagnose or triage cutaneous malignant neoplasms, education regarding dermatology and examination of the skin is currently inadequate in many medical schools. Unfortunately, these skills may be unlikely to improve during residency, as shown in a survey of 342 residents in primary care–related residency programs at 4 institutions in which most residents (75.8%) did not receive any SCE training during residency. Moreover, only 15% had performed an SCE 4 or more times during residency. Furthermore, in a survey of community PCPs and primary care residents, only 28% of the residents believed that they were adequately prepared by their respective medical schools to treat common dermatologic conditions. Within the confines of limited preclinical dermatology training, an opportunity was identified to improve skin cancer training by providing students with the tools needed to be successful, such as using lectures on diagnosing skin cancers with high-yield teaching points, providing interactive websites with image sets for self-directed learning, and, finally, instructing students on the use of dermoscopy for skin cancer detection.

Although dermoscopy is optimally used by experts in the technique, nonexperts can be taught to use basic tenets of dermoscopy with beneficial effects. For example, PCPs trained in dermoscopy through a 1-day course and subsequently randomized to receive a dermoscope and perform dermoscopy regularly were shown to more accurately diagnose cutaneous malignant neoplasms compared with PCPs randomized to continue using only conventional, naked-eye clinical examination. The PCPs using dermoscopy attained higher sensitivity without a reduction in specificity when triaging these malignant skin lesions. Likewise, in another study in which PCPs were provided with a 1-hour dermoscopy education lecture along with an atlas for studying, the PCPs significantly enhanced their sensitivity in identifying dermoscopic and clinical images of melanoma vs baseline and controls.

Other studies have also focused on innovative ways of educating medical students about clinical dermatology, such as using temporary tattoos, 3-dimensional prosthetic mimics of skin lesions, and online tutorials. Students, however, tend to focus on learning what they will be tested on and therefore may tend to disregard the skin unless they can be encouraged to become engaged in looking at the skin during everyday patient interactions. Our study demonstrates that a focused, high-yield session can be executed effectively even when constrained by limited curriculum time. With a brief dermoscopy education intervention in this study, the students became more engaged in learning about skin cancers, which may help to empower students to consciously look at the skin of their patients, remember what they have been taught, and be more inclined to learn more on the subject independently in the future.

This study includes several limitations. Differences seen in interventions A vs B may result from a difference in the academic environment (eg, course content, professors, and interest groups) that the students are exposed to from one year to the next. However, no major, relevant curricular changes were implemented. By conducting the study for 2 consecutive years at the same institution, the “school effect” encountered when conducting a study at multiple institutions was minimized. To account for differences in students’ personal interests, the preintervention test incorporated background questions to collect data about student baseline characteristics. The first cohort underwent testing with clinical images of the lesions only, whereas the second cohort underwent testing with clinical and dermoscopic images. However, the first cohort did not receive dermoscopy education, whereas the second cohort was provided with the brief dermoscopy intervention; in the clinical setting, a physician with training and access to a dermoscope will use the combination of clinical and dermoscopic features to arrive at a diagnosis, and a physician not previously exposed to dermoscopy will rely on clinical features only. Therefore, our findings speak to the value of dermoscopy when diagnosing cutaneous lesions. It is unknown whether these interventions will translate to improved diagnosis of skin cancers in the clinical setting. Longer-term follow-up is needed to determine whether students retain the knowledge, interest, and ability to perform SCES. The students will continue to be followed up as part of an ongoing study.

Medical students can benefit from a brief dermoscopy tutorial in conjunction with a single lecture focused on SCE. This study may provide insight into future large-scale educational endeavors to further engage the medical community in diagnosing skin cancers. Both cohorts showed some benefit from intervention, but the cohort that received the dermoscopy intervention improved more significantly. This finding can be attributed to the limitations of the ABCD criteria for all mela-
nomas and the improved ability to differentiate between benign and malignant based on dermoscopic morphology. The ABCD rule allows the observer to detect SSM and become excessively concerned about DN, but the rule is not particularly effective at identifying BCC or NM. In contrast, with the use of dermoscopic images, the students were more effective at identifying the malignant nature of BCC and NM. Furthermore, the addition of dermoscopy in cohort 2 modestly improved the ability of the students to accurately categorize DN as benign lesions. Although this improvement is not tremendous, even minor progress in the correct classification of the lesions could have a considerable effect on the absolute number of biopsies performed owing to the high prevalence of DN encountered during skin cancer examinations. Thus, this study underscores the added benefit of dermoscopy; the 3-point checklist is designed to help the observer diagnose pigmented malignant neoplasms irrespective of the particular type. With the use of dermoscopy and 1 simple algorithm, the observer can more effectively identify the malignant nature of BCC, SSM, and NM than when using the clinical characteristics and ABCD rule alone.

Despite a concerted effort to continually improve the early diagnosis of melanoma, NMs in particular are often not identified until they reach a thicker depth, probably because NMs often lack the characteristic ABCD features. Various strategies have been proposed to promote the recognition of thinner and more curable NM, such as the addition of evolution as the E in ABCDE and the EFG criteria of elevated, firm, and growing, but the op-.

Accepted for Publication: January 30, 2012.

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Author Contributions: Drs Dusza and Marghoo had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Soriano, Dusza, Halpern, Lee, and Marghoo. Acquisition of data: Liebman, Goulart, Soriano, and Marghoo. Analysis and interpretation of data: Liebman, Soriano, Dusza, Halpern, and Marghoo. Drafting of the manuscript: Liebman, Goulart, Soriano, and Dusza. Critical revision of the manuscript for important intellectual content: Liebman, Soriano, Dusza, Halpern, Lee, and Marghoo. Statistical analysis: Dusza. Obtained funding: Marghoo. Administrative, technical, or material support: Soriano, Halpern, and Marghoo. Study supervision: Soriano and Marghoo.

Financial Disclosure: None reported.

Funding/Support: This study was supported by the Lloyd Charitable Trust.


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Strange but True Moments in Dermatology

From the panorama of life and from history’s dramatic events, this article presents the following strange but true moments in dermatology:

1. The tattoo scar that helped capture a Nazi war criminal.

On May 11, 1960, an undercover team of Israeli intelligence agents captured Ricardo Klement in Argentina; he was suspected of being the notorious Nazi war criminal Adolf Eichmann. Eichmann’s identity was confirmed, in part, by the discovery of a small scar under his left arm where his SS tattoo had been erased (SS officers had their blood type tattooed in that location).\(^1\) Eichmann was transported to Israel, where he was tried, convicted, and hanged on May 31, 1962, for his crimes against humanity.

2. The abscess that derailed a home run race.

During the 1961 baseball season, New York Yankee teammates Roger Maris and Mickey Mantle were engaged in a great home run race, with each player vying to break Babe Ruth’s single season record of 60 home runs. On September 23, 1961, Mantle hit his 54th homer, while Maris had already amassed 59. Feeling “peaked,” Mantle saw a physician who administered an injection into his right hip area.\(^2\) The injection site became infected, requiring incision and drainage of an abscess, which sidelined Mantle for the final games of the season. Roger Maris went on to hit 61 home runs, a new major league record. Mickey Mantle returned to the Yankee lineup, in a limited role, for the 1961 World Series, in which the Yankees defeated the Cincinnati Reds.

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