Cutaneous Appendageal Carcinoma Incidence and Survival Patterns in the United States

A Population-Based Study

Patrick W. Blake, BS; Porcia T. Bradford, MD; Susan S. Devesa, PhD; Jorge R. Toro, MD

Objective: To examine incidence patterns of patients diagnosed as having cutaneous appendageal carcinoma (CAC).

Design: Population-based study using the Surveillance, Epidemiology, and End Results (SEER) Program of the National Cancer Institute data from 1978 through 2005.


Main Outcome Measure: Incidence rates (IRs) per 1 million person-years according to anatomic site, race, sex, age, and histologic type.

Results: Cutaneous appendageal carcinomas are uncommon (age-adjusted IR, 5.1 per 1 million person-years), with the IR among men statistically significantly higher than women (6.3 vs 4.2, respectively; male to female IR ratio 1.51; \( P < .001 \)). Hispanic whites (IR, 3.7), blacks (IR, 3.5), and Asian/Pacific Islanders (IR, 2.5) all had significantly lower IRs than non-Hispanic whites (IR, 5.7) \( ( P < .001 ) \). Apocrine-eccrine carcinoma overall was the most common category (IR, 2.6), and the IR was highest among non-Hispanic white (IR, 2.8) compared with other ethnic/racial groups \( ( P < .001 ) \). Cutaneous appendageal carcinomas IRs rose 100-fold with age, from 0.37 among those aged 20 to 29 years to 37.3 among those 80 years or older. From 1978-1982 to 2002-2005, the CAC IRs increased 150%, from 2.0 to 5.0; the apocrine-eccrine carcinoma and the sebaceous carcinoma IRs rose 170%, from 1.0 to 2.7, and 217%, from 0.6 to 1.9, respectively. Five-year relative survival rates overall were 99% for localized and 43% for distant disease.

Conclusions: Cutaneous appendageal carcinomas are rare tumors with IRs that vary by sex and racial/ethnic group. Cutaneous appendageal carcinoma IRs are increasing in the United States, especially for sebaceous carcinoma, perhaps related to improved recognition and classification, but factors such as UV exposure and immunosuppression may also play a role.

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Cutaneous appendageal carcinomas (CACs) are a rare and diverse group of complex neoplasms with diverse differentiation that frequently represent a diagnostic challenge. Cutaneous appendageal carcinomas were recently categorized according to the 2005 World Health Organization (WHO) classification of skin carcinomas.¹ This consensus classification takes into account the distinct clinical, histological, and molecular genetic features and includes 3 main types of differentiation: apocrine-eccrine, follicular, and sebaceous.² Most of these cutaneous carcinomas present de novo, although they can arise in precursor lesions such as nevus sebaceous or in a pre-existing benign counterpart.³ They can also occur in the context of inherited cancer syndromes such as sebaceous carcinoma in Muir-Torre syndrome³ and spiradenocarcinoma in Brooke-Spiegler syndrome.⁶ Although the epidemiological patterns of sebaceous carcinoma have been reported,⁷ the epidemiological patterns of other CACs are mostly unknown.³

Studies of CACs have been limited because of their rarity and thus the inability to study large numbers of patients. To date, only 62 cases of spiradenocarcinoma⁸ and adenoid cystic carcinoma⁹ and less than 100 cases of most other apocrine-eccrine carcinomas (hidradenocarcinoma, apocrine carcinoma, digital papillary carcinoma, and malignant mixed tumor) have been reported in the English language literature.⁹,¹⁰ Approximately 200 mucinous carcinoma, 300 porocarcinoma, and micro-
Table 1. Cutaneous Appendageal Carcinomas Diagnosed During 2001 Through 2005 in the SEER 16 Program Registries18 by Histologic Type and Sex

<table>
<thead>
<tr>
<th>Histologic Type</th>
<th>ICD-O-3 Codes</th>
<th>Median Age at Diagnosis, y</th>
<th>Total</th>
<th>By Type</th>
<th>Cases, No.</th>
<th>Freq, %</th>
<th>Rate (95% CI)b</th>
<th>Cases, No.</th>
<th>Freq, %</th>
<th>Rate (95% CI)b</th>
<th>Cases, No.</th>
<th>Freq, %</th>
<th>Rate (95% CI)b</th>
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<td>Total</td>
<td>70</td>
<td>1801</td>
<td>100</td>
<td>5.1 (4.8-5.3)</td>
<td>966</td>
<td>6.3 (5.9-6.7)</td>
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<td>4.2 (3.9-4.5)</td>
<td>1.51 (1.38-1.66)</td>
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<tr>
<td>Apocrine-ecrine carcinomas</td>
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<td>51.4</td>
<td>100</td>
<td>2.6 (2.4-2.8)</td>
<td>456</td>
<td>2.9 (2.7-3.2)</td>
<td>470</td>
<td>2.4 (2.2-2.6)</td>
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<td>Adenoid cystic carcinoma</td>
<td>8200</td>
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<td>8.2 (8.0-8.3)</td>
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<td>0.2 (0.1-0.3)</td>
<td>41</td>
<td>0.2 (0.1-0.3)</td>
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<td>Porocarcinoma</td>
<td>8409</td>
<td>75</td>
<td>126</td>
<td>7.0</td>
<td>13.6 (13.4-13.8)</td>
<td>79</td>
<td>0.5 (0.4-0.7)</td>
<td>79</td>
<td>0.5 (0.4-0.7)</td>
<td>1.37 (1.00-1.92)</td>
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<td>Eccrine carcinoma</td>
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<td>139</td>
<td>7.7</td>
<td>15.0 (14.8-15.2)</td>
<td>67</td>
<td>0.4 (0.3-0.5)</td>
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<td>0.4 (0.3-0.5)</td>
<td>1.19 (0.84-1.69)</td>
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<tr>
<td>Porocarcinoma</td>
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<td>75</td>
<td>126</td>
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<td>0.5 (0.4-0.7)</td>
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<td>Mucinous carcinoma</td>
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<td>Other apocrine-ecrine carcino-</td>
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<td>65</td>
<td>81</td>
<td>5.4</td>
<td>9.6 (9.4-9.8)</td>
<td>68</td>
<td>0.4 (0.3-0.5)</td>
<td>55</td>
<td>0.3 (0.2-0.4)</td>
<td>1.51 (1.04-2.02)</td>
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<td>Malignant mixed tumor</td>
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<td>17</td>
<td>0.9</td>
<td>1.8 (1.7-1.9)</td>
<td>5</td>
<td>NR</td>
<td>12 (0.1-0.2)</td>
<td>12 (0.1-0.2)</td>
<td>1.02 (0.63-1.65)</td>
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<td>54.9</td>
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<td>1.8 (1.6-1.9)</td>
<td>358</td>
<td>2.4 (2.1-2.6)</td>
<td>271</td>
<td>1.3 (1.2-1.5)</td>
<td>1.76 (1.59-2.07)</td>
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<td>Skin appendage</td>
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<td>72.5</td>
<td>246</td>
<td>13.7</td>
<td>100</td>
<td>0.7 (0.6-0.8)</td>
<td>152</td>
<td>1.0 (0.9-1.2)</td>
<td>94</td>
<td>0.5 (0.4-0.6)</td>
<td>2.21 (1.69-2.90)</td>
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</table>

Abbreviations: CI, confidence interval; Freq, frequency; ICD-O-3, International Classification of Diseases for Oncology, Third Edition; IRR, incidence rate ratio; NOS, not otherwise specified; NR, not reported (statistic not presented owing to less than 10 cases); SEER, Surveillance, Epidemiology, and End Results.

Sex

<table>
<thead>
<tr>
<th>Cases, No.</th>
<th>M</th>
<th>F</th>
<th>M:F IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>966</td>
<td>6.3</td>
<td>6.3</td>
<td>1.00</td>
</tr>
<tr>
<td>835</td>
<td>4.2</td>
<td>4.2</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Methods

Population-based cancer frequency, incidence, and survival data were evaluated for cutaneous appendageal cases diagnosed among residents of SEER 16 program registries.18 The 16 registries include 8 states (Connecticut, Hawaii, Iowa, Kentucky, Louisiana, New Jersey, New Mexico, and Utah), greater California, rural Georgia, and 6 metropolitan areas (Atlanta, Georgia; Detroit, Michigan; Los Angeles, San Francisco-Oakland, and San Jose-Monterey, California; and Seattle-Puget Sound, Washington). During 2000, the populations in the SEER 16 registries represented approximately 26% of the US population, including 25% of US whites, 23% of US African Americans, 54% of US Asians/Pacific Islanders, and 44% of US Hispanics. Case counts, population estimates, and IRs for Louisiana for only the first 6 months of 2005 were used, so that no further adjustments for the effects of Hurricanes Katrina and Rita were necessary. Data for American Indians/Alaska Natives, the Alaska registry, and cases with race coded as “unknown” were excluded. Quality control efforts include review of case finding, reabstracting, and recoding. The SEER registries record the primary site of the carcinoma and do not collect data regarding metastatic sites. Cases were identified using the World Health Organization’s International Classification of Diseases for Oncology, Third Edition (ICD-O-3) codes for cutaneous appendageal tumors.19 The main analyses focused on cases diagnosed during 2001 through 2005 (Table 1), when ICD-O-3 codes were used, reflecting the most current and relevant codes. Codes with less than 10 total carcinoma cases (8110, pilomatrix carcinoma; 8211, tubular adenocarcinoma; 8406, papillary syringoadenocarcinoma; 8481, adenocarcinoma; and 8941, carcinoma in pleomorphic adenoma) and codes representing Paget disease (code 8540) and extramammary Paget (code 8542) disease were excluded. The remaining cases with ICD-O-3 morphology codes (8390, 8200, 8400-8403, 8407-8410, 8413, 8480, and 8940) that included a primary skin site code (C440-C449) were included in this study. We grouped individual 4-digit histology codes into 3 major histologic types.

Age-adjusted (2000 US standard) IRs were calculated using the SEER*Stat software public use program version 6.5.11; IRs were expressed as new cases per 1 million person-years and were analyzed by age, sex, race, ethnicity, and year of diagnosis. Temporal trend analyses were conducted for those categories that have been recognized long-term, using data from 1978 through 2005 from the original SEER 9 registries (2228 subjects). Temporal trends and age-specific rates were plotted using a semilog scale, with a y- to x-axis ratio of 1 log cycle = 10 years, such that an angle of 10° portrayed a change of 1% per year.22 We aggregated data over years to derive more stable rate estimates. Differences in rates and ratios of rates and confidence intervals (CIs) were calculated using SEER*Stat version 6.5.1. Following SEER conventions, 5-year relative SRs for cases diagnosed during 1992 through 1999 in the SEER 12 registries and during 2000 through 2004 in the SEER 16 registries were calculated using the actu-
RESULTS

The number of cases, percentage distribution, and IR of CACs are given according to histologic type in Table 1. In total, 1801 cases (IR, 5.1 [95% CI, 4.8-5.3] per 1 million person-years) of CACs were diagnosed among residents of the SEER 16 registries during 2001 through 2005. The most common histologic category was apocrine-eccrine carcinomas (51% of cases; IR, 2.6 [95% CI, 2.4-2.8]), followed by sebaceous carcinoma (35% of cases; IR, 1.8 [95% CI, 1.6-1.9]). Of the apocrine-eccrine carcinomas, microcystic adnexal carcinoma was the most common subtype, accounting for 25% of cases (IR, 0.6), followed by hidradenocarcinoma (17%; IR, 0.4). Less common carcinomas included adenoid cystic carcinoma (8%) and spiradenocarcinoma (3%).

SEX

Overall, men had a statistically significant higher IR of CAC than women (6.3 [95% CI, 5.9-6.7] vs 4.2 [95% CI, 3.9-4.5]), respectively; with a male to female incidence rate ratio [M:F IRR] of 1.51, P < .001 (Table 1). Similarly, men had a statistically significant higher IR for most subtypes of apocrine-eccrine carcinomas than women (2.9 [95% CI, 2.7-3.2] vs 2.4 [95% CI, 2.2-2.6], respectively; M:F IRR, 1.24; P = .002) (Table 1) with few exceptions. The M:F IRRs ranged between 0.63 and 2.34 for the various apocrine-eccrine carcinomas subtypes and were significantly raised for porocarcinoma (M:F IRR, 2.34; P < .001) and hidradenocarcinoma (M:F IRR, 1.53; P = .01). In contrast to other apocrine-eccrine carcinomas subtypes, we found that women had higher IRs for microcystic adnexal carcinoma and mucinous adenocarcinoma compared with men (M:F IRR, 0.93 and 0.63, respectively), although the differences were not significant. Men had a significantly higher IR of sebaceous carcinoma than women (2.4 [95% CI, 2.1-2.6] vs 1.3 [95% CI, 1.2-1.5], respectively).

RACE

Age-adjusted IRs for CACs overall were highest among non-Hispanic whites (NHWs) (5.7 [95% CI, 5.4-6.0] per 1 million person-years), followed by significantly lower rates among Hispanic whites (HWS) (3.7 [95% CI, 3.1-4.4]; IRR, 0.65), blacks (3.5 [95% CI, 2.9-4.3]; IRR 0.62), and Asian/Pacific Islanders (A/PIs) (2.5 [95% CI, 1.9-3.1]; IRR, 0.43) (all P < .001) (Table 2). Similarly, age-adjusted IRs of apocrine-eccrine carcinomas overall were highest among NHWs (2.8 [95% CI, 2.6-3.1]), followed by blacks (2.4 [95% CI, 1.9-3.0]), HWS (2.0 [95% CI, 1.5-2.5]), and A/PIs (1.1 [95% CI, 0.8-1.6]). Compared with NHWs, HWS (IRR, 0.70; P = .003), and A/PIs (IRR, 0.40; P < .001) had statistically significant lower IRs of apocrine-eccrine carcinomas overall. However, blacks had a similar IR to NHWs (IRR, 0.85; P = .21). Although analysis by race/ethnicity was hampered for many of the subtypes because of the low number of cases, we identified some important findings...
among apocrine-eccrine carcinomas (Table 2). Hispanic whites had a lower IR of microcystic adnexal carcinoma (0.4) than NHWs (0.8) (IRR, 0.46; *P* = .003). Blacks had a higher IR of mucinous adenocarcinoma (0.5) than non-Hispanic whites (0.2) (IRR, 2.20; *P* = .03).

The sebaceous carcinoma IR was highest among NHWs (2.0 [95% CI, 1.8-2.2]), followed by HWs (1.3 [95% CI, 0.9-1.7]), A/PIs (1.3 [95% CI, 0.9-1.8]), and blacks (0.6 [95% CI, 0.3-0.9]) (Table 2). Compared with NHWs, HWs (IRR, 0.63; *P* = .03), blacks (IRR, 0.28; *P* < .001), and A/PIs (IRR, 0.64; *P* < .001) had statistically significantly lower IRs of sebaceous carcinoma.

**AGE-SPECIFIC INCIDENCE**

The CAC IRs increased exponentially with age, with peak frequencies in the eighth decade of life (Figure 1A). Incidence rates of CAC overall increased 100-fold from those aged 20 to 29 years (0.37) to those 80 years or older (37.3). This pattern was generally apparent also for apocrine-eccrine carcinoma overall and sebaceous carcinoma. There were no cases of sebaceous carcinoma diagnosed at an age younger than 30 years, and age-specific rates subsequently increased exponentially.

The CAC rates were similar among men and women younger than 50 years but were greatly increased among men compared with women at older ages (data not shown). The M:F IRR for CACs overall, stratified by age group, ranged from 0.91 (age 40-49 years) to 1.82 (age ≥80 years) (data not shown).

Apocrine-eccrine subtype IRs all rose rapidly with age (Figure 1B and C). The most rapid and consistent increases were for porocarcinoma and eccrine carcinoma. Incidence rates increased rapidly with age but were relatively stable after age 65 years for adenoid cystic carcinoma and peaked around age 75 years for mucinous adenocarcinoma.

The median ages of diagnosis are given for the various CACs in Table 1. Cutaneous appendageal carcinomas have a median age of occurrence in the late seventh or early eighth decade of life, with the exception of digital papillary carcinoma (age 48.5 years), malignant mixed tumor (age 57 years), and adenoid cystic carcinoma (age 61 years).

**TEMPORAL TRENDS**

During 1978 through 2005 in the original 9 SEER areas, 2228 cases of CACs were diagnosed. From 1978-1982 to 2002-2005, the CAC IRs increased 150%, from 2.0 (95% CI, 1.74-2.36) to 5.0 (95% CI, 4.63-5.49) (Figure 2). Similarly, there was a 170% rise for apocrine-eccrine carcinoma from 1.0 [95% CI, 0.81-1.25] to 2.7 [95% CI, 2.36-2.98]) and a 217% increase for sebaceous carcinoma (0.6 [95% CI, 0.48-0.83] to 1.9 [95% CI, 1.63-2.17]). The IR increased for all carcinoma subtypes analyzed except for adenoid cystic carcinoma, hidradenocarcinoma, and skin appendage carcinoma, not otherwise specified (NOS) (data not shown). The IR of skin appendage carcinoma, NOS declined notably after 1995. Rates of sebaceous carcinoma increased exponentially over the entire period. The IRs of CACs overall rose for all stages of disease (localized and regional/distant) (data not shown).

**ANATOMIC LOCATION**

Cutaneous appendageal carcinomas overall and sebaceous carcinomas occurred disproportionately on the face, scalp, and neck (>63% of cases each) (Table 3). Less
common sites for CACs overall were the upper and lower extremities (19%), trunk (17%), and multisite/NOS (1%). Similarly, apocrine-eccrine carcinomas overall occurred most commonly on the face and scalp and neck (55%), though there are variations in site-specific frequency by subtype. Mucinous carcinoma, microcystic adenocarcinoma, and adenoid cystic carcinoma occurred most commonly on the face (69%, 68%, and 43%, respectively) and digital papillary carcinoma, malignant mixed tumor, and porocarcinoma occurred most frequently on the extremities (92%, 59%, and 48%, respectively), while apocrine carcinoma and spiradenocarcinoma occurred most frequently on the trunk (41% and 31%, respectively) (Table 3).

SURVIVAL

The 5-year relative SR for patients with CACs and apocrine-eccrine carcinomas overall was excellent (96%-97%) (Table 4) and mostly unchanged when stratified by sex or race. The 5-year relative SRs for apocrine-eccrine carcinoma subtypes were higher than 90%, except for malignant mixed tumor (84%). There was a lower SR for men with apocrine carcinoma (77% [male] vs 97% [female]) and blacks with sebaceous carcinoma (85% [blacks] vs 96% [whites], respectively). Five-year relative SRs for CACs overall were much higher for cancers diagnosed with localized (99%) or regional (93%) involvement than those with distant involvement (43%).

COMMENT

To our knowledge, this is the first and largest population-based study and assessment of racial/ethnic patterns in CACs overall, based on cases diagnosed among residents of SEER registries in the US population. Previous reports have been case reports or hospital series9,10,24 with a limited number of cases, except for a few population-based studies7,15 restricted to 1 histologic subtype.

Between 1978-1982 and 2001-2005, age-adjusted IRs increased 150% for CACs overall and 217% for sebaceous carcinoma (Figure 2). The age-adjusted IRs for apocrine-eccrine carcinomas, sebaceous carcinoma, and skin appendage carcinoma, not otherwise specified (NOS), are shown in Table 3.
It is noteworthy that the decreased IR of skin appendage carcinomas, NOS after 1995 might have contributed to the rises in apocrine-eccrine carcinoma and sebaceous carcinoma IRs during that same period but cannot account for all the increases. The classification of CACs is challenging owing to the complex, overlapping, or poor differentiation of these neoplasms. However, recent molecular techniques are advancing our understanding of these tumors. Analysis by tumor stage to assess the potential effect of improved detection on temporal trends in incidence showed that both localized and regional/distant stages had significantly increased annual percentage changes over time (1978-2005). The increase in IR for CACs overall for all stages of disease supports the hypothesis that there is a true increase in incidence of CACs, not just improved detection. Age-specific IRs for CACs overall, sebaceous carcinomas, and most apocrine-eccrine carcinomas increased exponentially with age. This finding is consistent with reports that these carcinomas occur predominantly in middle-aged or older individuals.1,15 Our study shows that elderly persons bear a disproportionate burden of CACs. The explanation for the rising IRs is unknown, but UV radiation may be a contributing factor. Cutaneous appendageal carcinomas share some of the following similarities with nonmelanoma skin cancer: (1) rates are higher among men than women, (2) the rates for exposed body sites are higher than those for nonexposed sites, (3) rates are lower among those with more skin pigmentation, and (4) the temporal trends show that IRs are increasing. The observed ethnic differences showing significantly higher IRs of CACS and head and neck anatomic predilection among NHWs compared with other racial/ethnic groups are consistent with the hypothesis that UV radiation may be a risk factor for CACs.

Epidemiological studies have demonstrated that individual exposure to UV radiation is related to the risk of skin cancer.26 UV radiation–type mutations in p53 have been reported in spiradenocarcinoma and hidradenocarcinoma.27 Microcystic adnexal carcinoma was reported to occur more often on the left than the right side of the face, and the left side is expected to receive more UV radiation through the driver’s side window.28 Ionizing radiation exposure may explain in part the observed trend because case series of cutaneous microcystic adnexal carcinoma and malignant clear-cell acrospiroma (hidradenocarcinoma) have been reported at previously irradiated sites,29,30 which could be due to direct DNA damage and/or local immunosuppression. Individuals treated with ionizing radiation as children or adolescents may be particularly at high risk. From the early 1920s to the late 1950s, ionizing radiation was commonly used to treat acne or other inflammatory and benign conditions of the head and neck.31 This is consistent with the anatomic location and predilection for elderly persons that we observed. Furthermore, from 1980 to 2006, the number of annual computed tomographic scans performed increased from approximately 3 million to 67 million in the United States.32,33

Another possible explanation may be the increasing population of immunosuppressed individuals due to infection (ie, human immunodeficiency virus),34,35 immunosuppressant drugs for organ transplant,24 and/or rheumatologic or other inflammatory diseases. Cutaneous appendageal carcinomas have been reported more frequently in organ transplant recipients than immune competent individuals. Organ transplant recipients who are immunosuppressed have a greatly increased risk of cutaneous appendageal tumors compared with apparently immuno-competent individuals. In addition, their tumors are more...
likely to be malignant and of sebaceous origin.\textsuperscript{36} The role of environmental exposures including polychlorinated biphenyls in the development of CACs need to be explored.

To our knowledge, this study is the first comprehensive investigation of apocrine-eccrine carcinoma IR according to histologic subtypes. In our study, apocrine-eccrine carcinomas were the most common carcinoma category, accounting for 51% of cases (IR, 2.6 per 1 million person-years). In contrast to previous studies, we found a male predominance for CACs overall and for most of the major categories and subtypes except for microcystic adnexal carcinoma and mucinous carcinoma. Previous case series studies using proportion of cases reported a female predominance for adenoid cystic carcinoma, hidradenocarcinoma, and microcystic adnexal carcinoma.\textsuperscript{1,12} and no sex predilection for spiradenocarcinoma, apocrine carcinoma, and porocarcinoma.\textsuperscript{1,9} A possible explanation for the discrepancy is that previous studies were small clinical or hospital-based case series and did not report age-adjusted IRs. Because most patients with CACs described in previous clinical series\textsuperscript{1,15,19} had advanced age at diagnosis, the female predominance reported may be due to women living longer than men.

Our findings on the anatomic distribution contrast with some of the scant reports in the literature.\textsuperscript{1,10,11,13,37,39} Apocrine-eccrine carcinoma subtypes occurred with unique site distributions. Adenoid cystic carcinoma occurred most commonly on the face (43%), though it has been previously reported most frequently on the scalp (33%) or the trunk (24%).\textsuperscript{1,10} Porocarcinoma occurred more on the head and neck (33%) and less on the lower extremities (32%) compared with previous reports (20% and 60%, respectively).\textsuperscript{1} Hidradenocarcinoma occurred equally on both the extremities and head and neck (27%), in contrast to other reports of a predilection for the head and neck.\textsuperscript{1,11} Apocrine carcinoma occurred commonly on the head and neck in contrast to a previous reports showing predilection for the axillae.\textsuperscript{3} Microcystic adnexal carcinoma and mucinous carcinoma occurred most commonly on the face similar to previous reports.\textsuperscript{1,15} The anatomic distribution of digital papillary carcinoma, porocarcinoma, and spiradenocarcinoma are similar to past reports.\textsuperscript{1,13,37,40}

Our survival analysis was based on relative SRs, which were adjusted for mortality in the general population and represents survival in the absence of other causes of death. Previous case series of CACs have offered crude survival proportions or disease-free survival intervals\textsuperscript{17,41} rather than 5-year relative survival. These differences in methodology may explain the differences in survival between our study and previous reports. Furthermore, in our study most CACs were diagnosed at a localized stage, which may explain in part the overall high SRs. Importantly, CACs may have an indolent nature and long tumor-free intervals.\textsuperscript{10,46} We found excellent survival among patients with sebaceous carcinoma, which is in agreement with a previous study using SEER data from 1973 through 2004.\textsuperscript{8} The slightly better SRs in our study (96%) may be because our analysis was restricted to data from 1992 through 2004. Other possibilities include changes in diagnostic practice and improved treatment over time.

We conducted a population-based study, which avoids the biases associated with hospital and clinical series and provided us with enough statistical power to calculate IRs and SRs. The strengths of this study were the large sample size of rare CACs and unbiased ascertainment and assessment of cases. However, even though we had a large sample size, in some instances it was not large enough to allow for sufficient power to calculate stable rates by stratification (especially by race). Other limitations included the lack of centralized pathologic review of cases, error introduced through missing or incomplete data in the registry, and potential underestimation of IRs owing to reporting delays and incomplete inclusion of all patients diagnosed at dermatologist’s offices into SEER. However, pathologic specimens sent from a dermatologist’s office to a hospital for diagnosis would be identified by SEER staff and included if a resident of the SEER catchment area. Recently, SEER has mounted considerable effort to identify those cases diagnosed at a dermatologist’s office not ascertained otherwise.

In conclusion, this study has shown variation in incidence patterns by race, sex, age, and histologic type, supporting the notion that CACs represent distinct disease entities. Since 1978, there was a 150% increase in CAC IR. Further increases in CAC incidence over time should prompt new strategies for cancer screening and early intervention of this cancer. Our study showed previously unrecognized epidemiological features that may ultimately be characteristic findings of the various subtypes. An NHW, male, and head and neck predominance was evident for most CAC subtypes. We also found that male predominance of CAC increased with age. Further investigations using large populations and molecular tools are warranted to elucidate the etiology of individual types of CAC.
Additional Contributions: Jere Stern, MD, contributed to the pathological classification of the cutaneous appendageal carcinomas.

REFERENCES


