SKIN CANCER SCREENING IN OCCUPATIONAL MEDICINE

by

Heather P. Lampel

B.A. in Biochemistry, Rice University, 1998

M.D., The Ohio State University College of Medicine and Public Health, 2002

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This thesis was presented
by

Heather P. Lampel

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and approved by

Thesis Advisor:
Joseph Schwerha, MD, MPH
Professor
Department of Environmental and Occupational Health
Graduate School of Public Health
University of Pittsburgh

Committee Member:
Matthew Zirwas, MD
Assistant Professor
Department of Dermatology
University of Pittsburgh Medical Center

Committee Member:
Lawrence Keller, CIH, CSP
Assistant Professor
Department of Environmental and Occupational Health
Graduate School of Public Health
University of Pittsburgh

Joseph Schwerha, MD, MPH

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Heather P. Lampel, MPH

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Abstract

Background: Skin cancer is an increasing worldwide public health concern. Rates of melanoma and skin cancer continue to rise worldwide, creating a significant public health need for detection. In 2003, nearly 54,000 Americans were diagnosed with melanoma with an expected 7,700 deaths. The visual skin exam is an effective secondary prevention tool in detecting melanoma and nonmelanoma skin cancer and may be implemented in occupational medical clinics.

Methods: Applying the results of a comprehensive literature review of skin cancer screening efforts in communities and workplaces to occupational medicine.

Results: Skin cancer screening efforts have identified high-risk populations for melanoma and nonmelanoma skin cancer and may detect suspicious lesions early.

Conclusions: Occupational physicians may be the only healthcare provider with the opportunity to screen a high-risk population, particularly males over age 50. Integrating a skin examination into pre-employment or periodic examinations would expend minimal time and funds while potentially preventing worker morbidity and mortality. Screening for skin cancer at the workplace may also fulfill a public health need. The integration of skin cancer screening into occupational medicine may simultaneously improve worker health and increase the value of the occupational medicine physician.

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INTRODUCTION

Worldwide, skin cancer is an increasing public health concern (Koh, 1991). Estimates of skin cancer affecting Americans exceed 1 million per year, surpassing all other types of cancer combined (Wingo et al., 1998). About 54,000 Americans were estimated to be diagnosed with melanoma, with an expected 7,700 deaths (CDC, 2003). A child born in the year 2000 has an estimated lifetime risk of melanoma of 1 in 75 (Rigel, 1996). The estimated lifetime risk of developing skin cancer of any kind was estimated to be 1 in 5 in 1997 (Rigel et al., 1996).

A collaborative effort between the U.S. Preventive Services Task Force, supported by the Agency for Healthcare Research and Quality and the Task Force on Community Preventive Services, supported by the CDC, provides guidelines of worksite (as well as community) interventions to promote health and prevent disease (CDC, 2003). While the primary prevention of skin cancer has been attempted by both public education campaigns (ultraviolet radiation) and governmental occupational and environmental health regulations (specific substance exposures), there remains a large disparity between the public's knowledge and action, particularly with regard to sun behavior.

Although primary prevention of skin cancer is of great concern, skin cancer screening is an important modality of secondary prevention. Early detection of melanoma should increase cure rates; localized melanoma long-term survival rates of 92% contrast with less than 5% long-term survival rate for metastatic melanoma (Miller et al., 1993). Nonmelanoma skin cancer (NMSC), although infrequently fatal, can cause

local, extensive tissue destruction (Koh et al., 1989). An effective combination of primary and secondary preventative measures should decrease both the morbidity and mortality of melanoma and NMSC (Koh et al., 1996). The implementation of dermatologic screening in the workplace will be explored, with emphasis on past studies of screening endeavors and future possibilities with regards to secondary prevention of skin cancer and the proposed role of the occupational medicine physician.

SCREENING

Screening is defined in one public health book as "[t]he use of technology and procedures to differentiate those individuals with signs or symptoms of disease from those less likely to have the disease" (Turnock, 2001). The use of the dermatologic exam as a screening process to determine skin cancer is the basis for all statements forward. Therefore, the definition and application of principles of cancer screening must first be applied to dermatology.

The primary goal of screening is to reduce morbidity and mortality by detecting disease and treating earlier than in the absence of screening (Cole and Morrison, 1980; Miller, 1985; Parkin and Day, 1985; Spratt, 1982). Furthermore, the use of screening is optimal when the following four conditions are met: first, the disease causes significant morbidity and mortality and the disease is highly prevalent; second, the disease's natural history is known; third, a treatment exists and its early implementation can reduce morbidity or mortality; finally, a safe, inexpensive screening test exists (Koh et al., 1989). A review of the literature suggests that screening for skin cancer has great potential with regards to these conditions. The application of skin cancer screening to the occupational setting will also be outlined.

Melanoma and NMSC are, indeed, highly prevalent and cause significant morbidity and mortality. Skin cancer affects more than 1,000,000 Americans per year and is the most common cancer in the United States. Skin cancer accounts for approximately 2% of all cancer deaths (American Cancer Society, 2004), while non-

melanoma skin cancer accounts for half of all human malignancies annually (Jemal et al., 2002). Of the over 10,000 deaths from skin cancer per year, melanoma accounts for roughly three fourths (American Cancer Society, 2004). Mortality from melanoma has increased since the 1970s, particularly in white males (Wingo et al., 1998; Hall et al., 1999). The incidence of melanoma has increased an average of 6% per year between 1973 and 1995; incidence rates continue to rise yearly, though at a lesser rate (Ries et al., 2004). In 2004, approximately 55,100 Americans are expected to develop melanoma, of which 7,910 are expected to die (American Cancer Society, 2004).

The natural histories of both melanoma and NMSC have been determined. Extensive research on melanoma and prognostic outcome provides staging and long-term survival rate. Depth of lesion upon discovery is the greatest determinant of clinical outcome, although other factors, including ulceration, elevated serum lactate dehydrogenase, lymph node and lung metastases have been incorporated recently. The American Joint Committee on Cancer (AJCC) staging for cutaneous melanoma altered staging guidelines for clinical outcome in 2002.

Traditionally, melanomas were microscopically staged by Breslow depth and Clark classification. Breslow depth is the depth or thickness of the lesion in millimeters from top to bottom, while the Clark classification is based upon which layers of skin have been invaded by the melanoma, and are graded I- V (Table 1).

Table 1: Clark Classification System

Clark's Definition of Tumor Invasion	Clark Classification
Tumor confined to **epidermis** (not considered invasive)	**I**
Melanoma cells in **papillary dermis**	**II**
Melanoma cells filling **papillary dermis**	**III**
Melanoma cells in **reticular dermis**	**IV**
Melanoma cells in **subcutaneous fat**	**V**

However, with the new AJCC guidelines, melanoma is classified into the TNM system by many factors to predict severity of clinical course. A summary of the new correlation of Breslow depth to the T classification of the TNM system is found in Table 2.

Table 2: T Staging and Breslow Depth of Melanomas

T Classification	Breslow Depth of Invasion
T1	$\geq$ 1.0 mm
T2	1.01- 2.0 mm
T3	2.01- 4.0 mm
T4	> 4.0 mm

The dermal level of invasion, the Clark classification, is now only used in classification of thin melanomas, that is, melanomas in the T1 category. This new system of classification incorporates Clark classification system and ulceration status to determine whether a T1 melanoma is of risk category "a" or "b." Category T1a includes

non-ulcerated melanomas of less than or equal to 1 millimeter in thickness (Breslow depth) and Clark level II or III. Category T1b includes melanomas of thickness 1 millimeter or less that have ulcerated or are Clark level IV or V. In T2 stage melanomas or above, the "a" classification denotes no ulceration while the "b" classification denotes ulceration.

Superficial, early-stage lesions have excellent long-term outcomes, whereas deeper, late-stage lesions predict higher mortality. Melanoma tumor thickness is associated with 5-year survival rates. Tumors less than 1.0 mm thickness have excellent 5-year survival rates, whereas those thicker than 4.0 mm at diagnosis predict a poor survival rate at 5 years. Detailed rates can be found in Table 3, based only on thickness and assuming no nodal or lung metastases, N0M0 (Balch et al., 2001).

Table 3: Melanoma Five-Year Survival Rates

T_x N0M0 Classification	Mean Survival (%) 5 Year	10 Year
T1a	95.3	87.9
T1b	90.9	83.1
T2a	89.0	79.2
T2b	77.4	64.4
T3a	78.7	63.8
T3b	63.0	50.8
T4a	67.4	53.9
T4b	45.1	32.3

Non-melanoma skin cancer is associated with slower, local invasion. Squamous cell skin cancer is more likely to metastasize than most basal cell cancers. However, poorer prognoses are associated with certain NMSC locations including the scalp, nasolabial folds, and post-auricular areas (Marks, 1981).

Early treatment of skin cancer can, indeed, reduce morbidity and mortality. An ideal screening situation would involve disease with a long detectable preclinical phase in which detection would result in earlier, advantageous treatment. Certainly melanoma qualifies as a disease with preclinical, detectable phase, known as its radial-growth phase. In many situations, this preclinical phase can last months to years (Mihm and Fitzpatrick, 1976). Dysplastic nevi and other precursors to melanoma may further extend this preclinical phase for detection (Koh et al. JAAD, 1989). Nonmelanoma skin cancer grows slowly, also providing a preclinical phase. Actinic keratoses, easily identified and treatable potential precursors to squamous cell carcinomas, are theoretical targets for detection in preclinical screening.

The visual skin examination is the primary mode of screening for skin cancer. It is noninvasive, inexpensive, and requires no advanced technology. Visual skin examinations are safe and painless, and one study reports high patient acceptance of such screening for cancer detection (Boyce and Bernhard, 1986). However, the validity of visual skin cancer screening in detecting cancer has not been tested by randomized trials (Koh et al., JAAD, 1993).

Many obstacles face the completion of a randomized trial. Because of the long latency period of skin cancer, a prospective randomized trial, which would require large numbers of participants, would be both daunting and costly. Although some completed

studies report the endpoint as skin cancers found during screening, there exists a self-selection bias of the population screened. Many published studies are hospital-based, and certainly there is a highly-selected population being screened. On the contrary, community-based screenings have been completed, but follow-up of these patients is extremely difficult, especially with the patient privacy legislation in the United States. Pathology testing is also required for diagnosis confirmation, and this is rarely included in published studies due to cost as well as destruction/treatment of NMSC lesions. There is also underreporting of melanoma cases in national data.

The accuracy of visual screening examination in detecting cancer depends upon the test's sensitivity, specificity, and predictive value. A summary of these parameters (outlined by Koh et al., J Am Acad Dermatol 1989) from published screening examinations for melanoma is in Table 4.

Table 4: Parameters of Visual Screening Examination for Melanoma

Study	Examiner	Sensitivity	Specificity	Positive Predictive Value
Swerdlow, 1952	Physician	73% (16/22)	98% (545/556)	59% (16/27)
Becker, 1954	Physician	-	-	43%
McMullan & Hubener, 1956	Dermatologists	-	-	38% (44/115)
Lightstone et al., 1965	Skin Cancer Specialists	89% (893/1004)	92% (1840/2006)	84% (893/1059)
Kopf et al., 1975	Skin Cancer Specialists	77% (76/99)	99% (5420/5439)	80% (76/95)
Grin et al., 1990	Dermatologists	81% (214/265)	99% (10,357/10436)	73% (214/293)
Koh et al., 1990	Dermatologists	97%	-	35-40%*
Rampen et al., 1995	Dermatologists	93%	98%	54%

*Low number: True Positives/Total screened, high number: True Positives /Total followed

Table 4 illustrates various studies and screening parameters for visual dermatologic screening exam for melanoma. While visual screening exam does vary in this group of studies for sensitivity (73-97%), specificity (92-99%) and positive predictive value (35-84%), it should be compared with other screening modalities. Breast cancer screening using mammograms has a 77% to 95% sensitivity and specificity of 94% to 97% (USPSTF, Aug 2002). Colon cancer screening with fecal occult blood testing has a sensitivity of 40% and specificity of 96% to 98% for colon cancer (USPSTF, July 2002). Finally, the pap smear dry slide detection for cervical cancer has a sensitivity of 60% to 80% for high-grade lesions, and lower for low-grade lesions (USPSTF, 2003). A summary of preventative health screening parameters is found in Table 5.

Table 5: Preventative Health Screening Tests Compared to Visual Skin Examination

Test	Prevention Target	Sensitivity	Specificity
Mammogram	Breast Cancer	77% -95%	94% to 97%
Fecal Occult Blood	Colon Cancer	40%	96% to 98%
Pap Smear (Dry Slide Preparation)	Cervical Cancer	60% to 80% for high-grade lesions	-
Visual Skin Exam*	Melanoma	73-97%	92-99%

* Data from Table 4

Therefore, compared with other accepted cancer screening modalities, the visual skin exam is a reasonable screening tool in detecting melanoma, with parameters similar to other accepted modes of cancer screening.

SKIN CANCER SCREENING EFFORTS IN THE UNITED STATES

Skin cancer screening in the United States has been greatly supported by the American Academy of Dermatology. The group has spearheaded a campaign throughout the United States combining melanoma and skin cancer education with free community skin cancer examinations. This effort has been in effect since 1985, and analysis of the data collected for 15 years (through 1999) was analyzed and published. Since this is by far the largest screening effort in the United States for skin cancer, discussion of the results of this ongoing effort will be presented, and other smaller-scale screening efforts in the United States will follow.

The American Academy of Dermatology used a systematic approach to both recruit screenees and gather data to be analyzed. The AAD promoted its free screenings though community media, including public service announcements on the radio, television, newspapers and posters. The first step in the process was the completion of a standard form by the patient. This form included information on demographics including age, sex, race, and educational level. Healthcare access and services were also described, including details about medical insurance, whether the patient had a current or past dermatologist, whether the patient received a previous skin cancer screening from AAD or other physician, and the likelihood of the patient having a skin cancer screening without the AAD service. Risk factors for melanoma were also asked, including personal and family history of melanoma or skin cancer, moles changing in size, color, shape, and skin type categorized I-IV. Finally, how the patient heard about the screening was

recorded. A consent form was signed to perform the screening as well as release of medical information should a suspicious lesion be identified in the screening.

Next, the patient received a skin cancer screening by a volunteer dermatologist. Findings were recorded by presumptive diagnosis in check-box form. The diagnoses available were: actinic keratosis, dysplastic nevus, congenital nevus, basal cell carcinoma, squamous cell carcinoma, melanoma, and "other." Also recorded was whether a referral for follow-up was made. If no lesions were found, the patient was informed that no further diagnosis or treatment was needed. However, in the case of a suspect lesion (or lesions), the screenee was told to contact his or her primary care physician or dermatologist for further work-up. If the patient was without a physician of any type, a referral was made. No biopsies were performed on site.

From 1992-1994, the study tracked potential melanoma patients (those with suspected melanoma or lentigo maligna at screening) to determine final diagnostic outcome. These patients were followed by telephone or mail, and the final biopsy report was requested if performed. During this three-year period, 282,555 people were screened and 4,458 patients had one or more suspected melanomas (1.58%). Ninety-six percent (96%) of the 4458 in question were contacted, and the study obtained confirmed pathology reports on 72.6% (3237 of 4458). Of the remaining participants who did not obtain final pathology reports, most did not make follow-up appointments with a physician after screening.

In the same two year period (from 1992 to 1994), 371 melanomas were confirmed in 364 screenees. There were more men (59%, 214) than women (41%, 150) in this group with a mean age of 58 years. Sites of melanomas included upper extremities

(30%), lower extremities (18%), back (23%), head and neck (20%), chest and abdomen (9%). Of the 97% known histopathologic diagnosis of melanomas found, 47% were superficial spreading, 42% were melanoma in situ, and 4% were nodular melanoma. Table 6 outlines the stage and thickness of melanomas found during this 2-year period.

Table 6: Depth and Thickness of Melanomas Found in AAD Screening 1992-1994

Stage or Thickness (mm)	Number	Percentage (%)
In Situ	151	41.9
Invasive	209	58.0
<0.76	126	61.2
0.76-1.50	54	26.2
1.51-3.99	22	10.7
≥4.00	4	1.9
Unknown	3	
Local and Early Stage (In Situ + Invasive)	360	98.9
Late Stage (Distant and Regional)	4	1.1
All Cases	364	100

Data from: Koh HK et al., J Am Acad Dermatol 1996.

When comparing this study to the SEER database, there was a statistically significant difference between the percentages of advanced melanomas. That is, the proportion of melanomas with depth of 1.5 mm and greater was statistically smaller in the AAD screening study when compared to SEER registries in 1990. SEER registry of 1990 had 16.9% advanced melanomas (of all melanomas with known stage) and the AAD study from 1992-1994 had 8.3% advanced melanomas with a $p=0.01$ (Koh et al. JAAD, 1996). This may suggest that a grassroots community screening such as that performed by the American Academy of Dermatology could detect melanomas at an earlier stage.

Furthermore, many of the participants with melanoma may not have visited a physician for a skin examination in the absence of the free AAD screening. In the health care access questionnaire completed before the screening, 39% of screenees with histopathologically determined melanoma reported that they would not have seen a physician otherwise. Adding to this, 17% of screenees with confirmed melanomas stated that they had no health insurance (Koh et al. JAAD, 1996). These data suggest that the free skin cancer screening may fulfill a need in the public health of the community, though the AAD participants may not represent the general population cohort secondary to self-selection.

In this study, the yield of screen-confirmed melanomas was 129/100,000 people screened. However, screening of people 50 years of age or older had a higher yield of melanoma than of people below 50 years of age (161/100,000 vs. 89 of 100,000). It is important to note that men had double the yield of melanoma than women (190/100,000 vs 89/100,000). The highest yield population was men older than 50 years of age, with 240 screen-confirmed melanomas per 100,000 people screened (Koh et al. JAAD, 1996). This could certainly aid in the targeting of a high-yield population (men age greater than 50) in developing a skin cancer screening program.

The positive predictive value of skin cancer screening evaluation in this study was calculated separately for different presumptive diagnoses. For a presumptive diagnosis of melanoma, the positive predictive value was 17%. This varied from 22.0% in 1992 to a low of 9.1% in 1993. However, with a presumptive screening diagnosis of “rule-out melanoma” or “rule-out lentigo maligna,” the positive predictive value fell to 6.3% overall. This lower positive predictive value, as compared to the 35-40% in the

Massachusetts study (Koh et al., 1990), could not be explained by the authors (Koh et al. JAAD, 1996).

Several reflections can be made from this large-scale study, the only one of its kind in the United States to date. While the yield of melanoma diagnoses was 129 per 100,000 people screened, it is presumed that this number would increase had all participants had follow-up biopsy. The highest yield population for melanoma in this study was men over the age of 50; they comprised 24% of screenees. It is possible that the "rule-out melanoma" diagnosis was a deterrent to follow-up as compared to the presumptive diagnosis of melanoma. In fact, the vast majority of the 20% of screenees who did not have follow-up fell into the "rule-out melanoma" category. Perhaps there was some ambivalence transmitted from physician to screenee, and this may account for poorer follow-up within this diagnosis.

A subset of this large database of the American Academy of Dermatology screening effort was analyzed and published in 1989. This analysis consisted of screenees in Massachusetts during the years 1986 and 1987. Fourteen centers in the state pooled their data for this publication and analysis. In total, 2560 people were screened for melanoma/ skin cancer in 1986 and 1987. Of these, 459 screenees had suspected melanoma/skin cancer, dysplastic nevi, and congenital nevi. Sixty-three percent of these screenees had follow-up, 22% chose to have no follow-up, and the remaining were unable to be contacted. Of those followed, the yield of diagnoses is found in Table 7.

Table 7: Yield of AAD Screening 1986-1987 in Massachusetts

Presumptive Diagnosis	Total Number Screenees with Diagnosis	Biopsy-Proven Diagnosis	% Biopsy-Proven Diagnosis
Melanoma	9	9	100
Squamous Cell Carcinoma	9	7	78
Basal Cell Carcinoma	82	54	66
Dysplastic Nevus	39	27	69
Congenital Nevus	3	3	100
Total	**142**	**100**	**70**

Data from: Koh HK et al., Cancer 1990.

Therefore, of the 142 diagnosed lesions, 70%, or 100 lesions were pathologically confirmed by biopsy. The authors calculated the prevalence of skin cancer in the general population and determined that the screening attracted 7 to 70 times more people with skin cancer (a self-selection, most likely). Their yield range of one melanoma per 280 to 510 screenees (Koh et al. Cancer, 1989) is approximately on target with other large studies (Miller, 1985; Morrison, 1985). The authors did suggest following some of the negative screenees in future studies to be able to calculate the specificity of the visual examination to determine a false-negative rate (Koh et al. Cancer, 1989). It is likely that this subset is similar to other subsets throughout the country.

From the same skin cancer screening program performed by the American Academy of Dermatology, an analysis of the first 15 years (1985-1999) was published in 2003. Methods were as described before, however forms were counted in the AAD central office and recorded in annual summaries. These yearly summaries were amassed into a master file at Boston University. Years 1985, 1995 and 1996 (a total of 205,000 forms) were unavailable and could not be studied. The authors performed a number of analyses on the information to provide insight into the study and clinical outcome.

Demographics of this screening effort were summarized. From 1985-1999, 1,024,350 screenings were performed on approximately 800,000 individuals (accounting for repeat screenees). All states including the District of Columbia were included by 1994. The states with the greatest number of screenings per whites in the state were Iowa (1 in 89), New Jersey (1 in 93) and Kentucky (1 in 95). Screenees were 95% white non-Hispanic and 61% were women. Median age of participants was 52 years, with a range of 1 to 101. The largest age group of participants was age 51-65 years (29%) and age 36 to 50 (25%). The highest educational level for 41% of participants was high school, followed by college (37%) and then graduate school (18%).

Major risk factors for skin cancer were obtained on the questionnaire. Almost two-thirds of screenees had 1 risk factor for skin cancer, and one third had at least 2 risk factors. These included a changing mole (33%), skin type I or II (37%), personal history of melanoma (3%), family history of melanoma (8%), personal history of nonmelanoma skin cancer (11%) or family history of nonmelanoma skin cancer (20%). Interestingly, forty-seven percent of those with confirmed melanoma had 2 or more risk factors, forty-one percent of those with basal cell carcinoma, and forty-percent of those with squamous cell carcinoma. However, only 27% of those with normal screening had 2 or more risk factors.

As expected, the repeat screenees had a higher percentage of risk factors (39-40% on average) as compared to first-time screenees (29-30%, on average). They also had a higher likelihood than first-time screenees of having presumptive diagnosis of squamous cell carcinoma (1.5% vs. 1.1%, $p<0.05$), basal cell carcinoma (7.6% vs. 6.1%, $p<0.01$), and actinic keratosis (21% vs. 16%, $p<0.001$). This suggests the benefit of annual

screening of high-risk patients (Geller et al., 2003). There was no significant difference between first-time and repeat screenees in percentage of presumptive diagnosis of melanoma, although there could be multiple factors accounting for this, including higher likelihood of finding melanoma on first screening.

During these first 15 years, the screenees' access to care was analyzed. Although only 8% did not have health insurance, almost 80% did not have a dermatologist and 78% reported never having an AAD skin cancer screening and were "first-time" screenees. Sixty percent stated that they had never had their skin checked for skin cancer, and 51% reported that they would not have seen a doctor for a skin cancer screening had it not been for the free AAD skin cancer screening. Of interest, those with a confirmed diagnosis of melanoma through the AAD free skin cancer program had higher rates of not having a dermatologist (86%), being uninsured (16%), and for being first-time screenees (88%). It was estimated that 1 in 100 screenees had a presumptive diagnosis of possible melanoma.

The persons screened by the AAD in the free skin cancer project report some significant differences with that of the general population. They reported higher rates (14%) of personal history of melanoma and nonmelanoma skin cancer (Geller et al., 2003), as compared to less than 1% obtained in a household survey of 30,000 US citizens in 1992 (Hall et al., 1997). As compared to US population controls, screenees were almost twice as likely (40% vs. 22%) to report ever having a skin cancer screening (National Center for Health Statistics, 1997). While there appears to be some self-selection of people attending the AAD free skin cancer screenings, the repeated high rates

of multiple skin cancer risk factors among new screenees suggests that the screening continued to recruit new at-risk participants yearly.

Another study was performed by dermatologists in Northern California authored by Swetter et al. Veterans in the San Francisco bay area who were not registered as VA patients for the previous three years were targeted to receive free skin cancer screenings. Methods of screening were similar to that of the AAD skin cancer screening; participants completed a questionnaire, and following screening participants were encouraged to follow-up with a dermatologist depending on the presumptive diagnoses.

Between March 1997 and May 2000, twenty screenings occurred in the northern California area. Of the 374 people screened, 362 were male and mean age was 63.4 years. The majority of screenees were Caucasian (74%) and highest educational level was college (42%) followed by high school (35%). The majority of participants (79%) did not have a dermatologist, 50% reported never having a skin cancer check by a doctor, and 71% stated they had not had a prior skin cancer screening.

While Caucasians accounted for the majority of screenees (74%), they represented 65% of participants with presumptive skin cancer and non-cancer diagnoses. Age groups were stratified for presumptive diagnoses. Two participants were 90+ years of age, and both had suspicious lesions. In the 70-79 year old age group, 81% of participants had suspicious lesion, followed by 80-89 (63%), 60-69 (55%), 40-49 (34%) and 50-59 (30%).

Fifty-percent of participants with suspicious skin lesions followed-up at a Veteran's Affairs Palo Alto Health Care System. Biopsies were performed as appropriate. Positive predictive values were reported as a range, with the lower end

accounting for the participants with suspicious lesions who did not follow-up, and the higher end point excluding them. The range of positive predictive value of visual skin cancer screening was 31-62% for basal cell carcinoma, 33-43% for squamous cell carcinoma, 21-37.5% for dysplastic nevus, and 7-12.5% for melanoma.

This study had an older mean age of participants than the AAD screening, and had the men as the majority of participants. The risk factor profile of screenees was otherwise similar to that of the AAD screening. They had a higher referral rate for follow-up (50%) than the AAD screening, but this may be due to the higher prevalence of NMSC in the population screened. Other studies such as the AAD screening points to older Caucasian men as being a high-risk group for nonmelanoma and melanoma skin cancer; this study had a predominance of this high-risk group.

Swetter et al. devised the study such that follow-up with a dermatologist would be easy and convenient for the screenees with a suspicious lesion; it was still troublesome that only 50% chose to follow-up. While 17% of the remaining state that they would follow-up elsewhere, the remaining 37% were assumed to have no follow-up at all, despite the ease of follow-up and VA benefits (Swetter et al., 2003). This suggests that even when targeting a higher-risk population, screenee follow-up may be a challenge.

These studies shed light on the state of skin cancer screening in the United States. The American Academy of Dermatology has performed widespread screening. Multiple lessons have been learned, while additional questions have been raised regarding the best practices on such a large-scale effort. Smaller-scale studies, particularly the VA study targeting higher-risk populations, offer insight into detection, as well as complexities in follow-up care. While these are some of the most prominent studies of skin cancer

screening in the United States, it is important to investigate similar efforts performed internationally.

INTERNATIONAL SKIN CANCER SCREENING EFFORTS

A comprehensive literature review was performed on international skin cancer screening efforts. Some collaborative efforts exist both among and within certain nations. For the most part, developed countries have published articles regarding skin cancer screening while developing countries are poorly represented. It is surmised that developing countries have fewer public health resources, and available resources are allocated to more acute, life-threatening diseases. Infectious disease such as tuberculosis, malaria, and food-borne illness would obviously be a greater priority in these nations than skin cancer screening. Research performed internationally regarding skin cancer screening will be presented, with particular emphasis placed on any application or comparison of results with respect to the United States.

The global burden of cancer continues to grow. In the year 2000, it is estimated that 10 million new cases of cancer were diagnosed worldwide (excluding nonmelanoma skin cancer). Melanoma skin cancer continues to increase worldwide. Internationally, the incidence rate of melanoma varies 100-fold. The highest rates of melanoma are found in Queensland, Australia, where people of northern European descent settled. This area is close to the Equator, and the rate of melanoma is approaching 40 cases per 100,000 people per year.

However, incidence of melanoma is rising internationally (Boyle, 1997). Of note, migrants from a low-incidence area (such as Europe) who settle in a high-incidence area (such as Queensland) acquire a higher incidence rate than native-born people in the high-

incidence area (McCredie et al., 1990). Furthermore, even in countries with low rates of melanoma (such as Japan) there has been a drastic increase in melanoma incidence in both sexes (Muir and Nectoux, 1982). Average annual melanoma incidence rate increases are highest in the Nordic countries (6%), New Zealand (7%), and in the Jewish population of Israel (11%). Despite changes in diagnostic criteria of melanoma, it is widely accepted that the increase in melanoma in the last 60 years is a real trend (Van der Esch et al., 1991).

EUROPEAN COLLABORATION

Multiple studies have been published in Europe, some stemming from collaborative efforts and others from individual countries. Multiple papers concur that mortality from melanoma has been increasing in Europe until recently (Francesci et al., 1992; Thorn et al., 1992; Balzi et al., 1997). In the late 1990s, skin cancer mortality rates were highest in Scandinavian countries (2.5 to 3.7/100,000 in men and 1.6 to 2.2/100,000 in women), while southern Europe had the lowest mortality rates from skin cancer (1.3 to 2.1/100,000 for men and 0.8 to 1.4/100,000 for women). This statistical difference between countries is narrowing (Levi et al., 1998; Levi et al., 2004).

It appears that this mortality trend is leveling off in Europe as it is in the United States (Scotto et al., 1991; Severi et al., 2000). This slowing may be due to many factors, including increased awareness (La Vecchia and Bosetti, 2004). Early prevention campaigns and intervention programs likely have contributed to this trend as well (Williams et al., 1990; Hill et al., 1993; Koh and Geller, 1995; MacKie et al., 1997; Melia

et al., 2000). Studies in some countries have found decreases in melanoma thickness, one of the prognostic factors of melanoma, perhaps suggesting earlier detection (Thorn et al., 1994; MacKie, 1998; Carli et al, 2003). La Vecchia and Bosetti strongly urge the implementation and support of prevention, detection and surveillance programs throughout Europe to decrease mortality from melanoma (2004).

The European Society of Skin Cancer Prevention (EUROSKIN) was formed in June of 1999. It was the first collaborative effort to address increasing skin cancer incidence in Europe. The first conference occurred in May 2000, with collaboration with the World Health Organization (WHO), European Commission (EC), and the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Recommendations regarding primary and secondary preventive measures were determined and published (Greinert et al., 2001).

It was felt that the epidemiology of skin cancer needed improvement. EUROSKIN called for standardization and collaboration of information and data collection. This would improve estimates of the true incidence rates of nonmelanoma skin cancers as well as true incidence rates of malignant melanoma. One emphasis in achieving these goals was the screening for skin cancer as a "tool for control of the disease." A call was made for the complete registration and evaluation of the morbidity and mortality of skin cancer, as well as the incidence of skin cancer. Investigation into the pros and cons of screening was proposed, including the accuracy of skin cancer screening (Greinert et al., 2001).

Therefore, through EUROSKIN, the importance of skin cancer screening is being investigated with regard to multiple concerns. The call for continent-wide research and

sharing of information again confirms the importance of skin cancer awareness in public health worldwide. It is anticipated that future studies from this collaborative effort will be published and will perhaps provide further insight into the European view of skin cancer screening as definitive secondary skin cancer prevention.

THE UNITED KINGDOM

The incidence of melanoma in the United Kingdom is low, with annual incidence 10 per 100,000. Malignant melanoma accounted for 1265 deaths in the United Kingdom in 1992, and nonmelanoma skin cancer caused 400 deaths per year (Holme et al. Clin Exp Dermatol, 2001; Osborne, 2002). In 1999, the government instated new guidelines regarding the treatment of suspected skin cancer. With the exception of basal cell carcinoma, patients with suspected skin cancer in the U.K. should be seen by a specialist within 2 weeks of referral from a general practitioner (Department of Health, 1999).

There are no formal skin cancer screening programs in the United Kingdom (Osborne, 2002). However, a melanoma screening day was implemented in 1998. The Swansea area was targeted in this study, as this area has the highest reported incidence rate of melanoma in the United Kingdom. These incidence rates of melanoma are comparable to other western European countries and seemed optimal for screening.

The screening day was modeled after the American Academy of Dermatology screening, with pamphlets and announcements throughout the community to advertise the event. Upon arrival, the screenees completed a questionnaire much like that of the AAD, and the participant then received a skin examination by a dermatologist. Lesions were recorded, including site, number, diagnosis and follow-up recommendations. If a lesion

was suspicious, the participant's general practitioner was contacted by telephone for permission to schedule excision. If no contact was possible with the general practitioner, the screenee was scheduled for removal or biopsy and the general practitioner was contacted by mail. Education regarding primary and secondary skin cancer prevention was also offered at the screening.

Additionally, one year after the screening the 832 participants were contacted by mail using information on the initial questionnaire. They were asked to complete a follow-up satisfaction and general health questionnaire. Nine aspects of the screening were to be rated on a satisfaction scale, and six general health questions were to be answered. There was also the opportunity for additional comments. If participants did not respond, they were not followed-up any further.

In total, 832 people (315 males, 517 females) were screened by 7 dermatologists in 10 hours. Mean age was 54 years, with 57% aged greater than 50 years, and 24% were between 61 and 70 years. Distribution of skin types was: type I, 12%; II, 29%; III, 43%; IV, 15% (in 1% skin type was not documented). Location of lesions varied, though they were most commonly on the trunk (back 34%, front 22%), followed by the head and neck (21%), and finally the arms (10%) and legs (10%). In 832 participants, 882 lesions were diagnosed clinically, including 6 suspected melanomas and 9 basal cell carcinomas.

Of the 832 screenees, 72 were referred for follow-up. All screenees with an appointment for biopsy or excision attended. Ultimately 40 lesions were removed from 31 participants. Of these, there were three superficial spreading malignant melanomas confirmed histologically in three screenees; all had a Breslow thickness of < 0.75 mm. Therefore, this screening effort found melanoma in 1 out of 277 participants. Further, the

response to the year- later audit was quite positive, and the majority of respondents were very satisfied with the screening.

Although the screening effort did identify melanoma in a rate similar to other screenings in the United States, the authors of this study felt that such screenings were not widely applicable to the United Kingdom. Because citizens of the UK have access to comprehensive primary health coverage, it is estimated that about 80% of individuals consult their general practitioner each year. This coupled with the low background incidence of malignant melanoma supports the authors' suggestion that it may be more cost and time effective for general practitioners to perform initial screening in high-risk patients for melanoma, then refer to a dermatologist if indicated (Holme et al. Br J Dermatol, 2001).

In Scotland, there was concern that patients were not seeking timely care for suspect lesions. This stimulated a campaign initiated in 1985 consisting of leaflet and media distribution publicizing the need for early care for suspect lesions. All general practitioners in western Scotland received booklets titled, "An Illustrated Guide to Early Malignant Melanoma." It was around this time that the Cancer Research Campaign funded the pigmented lesion clinics discussed below. Through these efforts, patient demand for specialty referral increased. Public education programs may decrease mortality rates from skin cancer in women, though no decrease has been seen in men. However, thinner lesions are being reported (Doherty and MacKie, 1988; Ellman, 1991). This may translate into an increase in 5-year survival (Herd et al., 1995).

One unique characteristic of the health system in the United Kingdom is the existence of pigmented lesion clinics, or PLCs. Many centers throughout the United

Kingdom have established these specialty referral centers. The patient population at these centers should be considered high-risk, as these patients have been pre-screened at a general practitioner's office and referred for specialty care for suspicious lesions. This is one example of ideal selected population screening when determining detection rates. Indeed, melanoma incidence rates at these pigmented lesion clinics range from an impressive 1 in 20 patients to 1 in 60 patients (Holme et al. Br J Dermatol, 2001; Herd et al., 1995; Grover et al., 1996; Kirkpatrick et al., 1995). Osborne recommends further studies evaluating the PLC in terms of decreased mortality and cost-effectiveness in the United Kingdom (2002).

AUSTRIA

In 1988, Austria performed a public health campaign called the Austrian Melanoma Public Education Campaign. This was an educational campaign for both physicians and the public regarding pigmented lesions and suspicious characteristics. These pamphlets were distributed to all Austrian surgeons, dermatologists and general practitioners. A study reported a statistically significant reduction in mean Breslow depth of melanoma in the year following the campaign, but an increase in the years following (Pehamberger et al., 1993). It is surmised that such educational tools only provided a short-term benefit.

One published study in Austria performed screenings at innovative locations. A group of dermatologists devised a skin cancer screening study at large recreation centers in Styria, Austria. The thought that people would be sunbathing and in a state of undress allowing a thorough examination at such centers supports the authors' choice of

screening venue. Furthermore, this population may be of higher risk, since many sunbathe at recreation centers and pools.

In July 1998, the authors performed skin cancer screenings at three large recreation centers. Prior to screening, a questionnaire determining risk factors was completed by screenees. In total, 344 individuals participated (159 females, 185 males). The average age was 36.1 years, with a range of 7 months to 89 years. Of the 344, 45 screenees (13%) were found to have suspicious lesions and were referred for follow-up care to local dermatologists. Interestingly, eighteen of these participants (40%) were not planning to visit a physician in the coming 6 months, and 28 (62%) had never had a skin cancer screening examination prior to the study.

In all, the screening at the recreation center was well-received by the screenees. About 72% preferred the screening to a physician visit. Moreover, this study had more men than women participants, which is encouraging as older men are thought to be at higher risk for melanoma. This study was not designed with any follow-up, so biopsy-confirmed diagnoses are not reported. However, this study does raise the issue of community outreach and targeting populations open to screening (Hofmann-Wellenhof et al., 2000).

BELGIUM

A group in Belgium was inspired by educational and screening campaigns in the United States and in Scotland, and organized “Melanoma Monday.” Leaders of this campaign banded together in the Melanoma Monday Task Force, surveyed dermatologists’ interest, and received approval from an ethics committee and scientific boards. The date for

screening and education was set for Monday, April 26, 1999. Media campaigns were initiated one month prior to the screening day.

Screening took place in participating dermatologists' offices, clearly marked by participation posters and stickers. The free screenings were by appointment, 2 hours in the morning and 2 in the evening. Participants completed a screening questionnaire about risk factors for skin cancer. If suspect lesions were discovered, the screenee received a letter to take to his or her general practitioner for further referral or treatment.

Of the 521 Belgian dermatologists, 340 (65%) participated in Melanoma Monday. In total, 2767 people were screened, with mean age 35 years. There were about twice as many women as men who participated in the screening. Of the 644 suspect lesions found, 503 were though to be atypical nevi. However, 35 lesions were suspected melanoma, and 59 lesions were suspected basal cell carcinomas, and no squamous cell carcinomas were suspected. The rate of melanoma suspicion in this study was high at greater than 1 out of every 100 screenees, and suspected basal cell carcinoma in greater than 2 out of every 100 screenees.

Although no biopsies were performed on Melanoma Monday, the participating dermatologists were queried one month after the screening. Since only 70% of dermatologists answered, data is incomplete. However, they reported that 25 melanomas were found on Melanoma Monday and later histologically proven. The remaining 10 melanomas may have been over diagnosed or cared for by general practitioner, surgeon or non-participating dermatologist. Interestingly, in the month that followed Melanoma Monday, an additional 141 melanomas were found during regular dermatologist clinic hours. This amount, added to the 25 from Melanoma Monday, demonstrated that 166

melanomas were found in one month by dermatologists only; the annual incidence of melanoma in Belgium is only 850-1150. It is likely that the public educational campaign improved awareness in the community and increased diagnosis of melanoma (Vandaele et al., 2000).

SWITZERLAND

There was launch of an evaluation of epidemiologic melanoma skin cancer data in Switzerland. A public health education campaign began in 1988 with an additional program in 1989. A review of national data revealed a doubling of new melanoma diagnoses in the 2 months following the first educational campaign. Similar to educational campaigns in other countries, there was a subsequent decrease in new cases after the surge. Patients under age 60 comprised many of the new skin cancer cases (Buillard et al., 1992).

DENMARK

Olsen and Jensen analyzed cancer data from 1970-1979. They report that melanoma accounted for 2.1% of all incident cancers in Denmark, while nonmelanoma skin cancers accounted for 12% of all malignancies in Denmark (1987). The authors also provide an excellent association of skin cancer with occupation, and this will be addressed in the next chapter.

THE NETHERLANDS

A group of dermatologists in the Netherlands modeled skin cancer screening efforts after the ones completed by the American Academy of Dermatology. Two campaigns occurred, one in 1989 in Oss, a community of 110,000 inhabitants, and larger campaign in Arnhem, a community of 650,000 inhabitants. Both screening efforts were combined in a published paper. Media announcements focused on melanoma and skin cancer risk factors. Screening occurred in a hospital setting, and screenees with suspicious lesions were referred to a specialist, as well as contacted four months later for follow-up.

In total, 2564 people were screened, 603 in Oss and 1961 in Arnhem. Of these, 262 screenees had suspicious lesions (10.2%), with 103 suspicious for skin cancer (4%). At the four-month follow-up, 93 of the 103 with suspected cancer had followed up (90%) and 128 of the 159 (80%) with precancerous or precursor lesions had followed up. Of the screenees with suspected skin cancer, 52 people had 54 histologically confirmed malignancies (two screenees each had two malignancies). One participant with a suspected dysplastic nevus actually had confirmed melanoma. In effect, 53 screenees had 55 histologically confirmed malignancies. Among these, there were 9 melanomas, 1 lentigo maligna, 40 basal cell carcinomas, and 5 Bowen's disease. Of the suspected cancerous lesions, the positive predictive value ranged from 50-56%, depending on the inclusion of screenees who did not follow-up. The total cost of this screening was $6000.

The authors were encouraged by their results. They noted that distance to screening site was a factor in participation, as the majority of participants lived in nearby areas. Whether screening is a cost-effective measure in reducing mortality from melanoma is unknown and of interest in future studies (Rampen et al., 1991). It is

notable that referral may differ in the Netherlands, particularly due to the health care system. Follow-up in this study was immense, with a nearly 85% compliance rate.

An additional study was completed in 1989 by Krol et al. The authors organized a free skin cancer screening effort in the western area of the Netherlands along the beach. They used a mobile trailer as their screening venue. In total, they screened 3069 people; suspicious lesions were found in 65 participants. Of these, 6 people were confirmed histopathologically to have melanoma. All six screenees had melanomas of less than 1 mm Breslow depth. Furthermore, in the 2 months following the screening and educational campaign, there was a modest increase in the number of benign and malignant skin lesions diagnosed in screenees (Krol et al., 1991).

Although the United States differs in healthcare system, it is valuable to note the high follow-up rate in the first study. Further investigation into the reason for such high follow-up (low cost, ease of appointments, locations, characteristics of the population) could be helpful in increasing skin cancer screening follow-up elsewhere. Finally, it would have been helpful to know more about the demographics and skin cancer risk factors of the population screened.

ITALY

Cristofolini et al. began a public health campaign in Trentino, Italy to target the early detection of melanoma. The program was started in 1977 and repeated in 1981. It consisted of the distribution of a pamphlet regarding melanoma and many discussions in conferences, television programs and meetings. The local hospital in Trento offered free consultations in the dermatology department. The aim of the study was to determine the

mortality rate before and after the campaign in the population of outreach versus similar population lacking the educational campaign. While this is not a screening effort per se, it was a valuable study worthy of inclusion of worldwide discussion of skin cancer screening efforts, as the goal of any screening effort is the reduction of morbidity and mortality.

The authors used mortality rates for melanoma from the death certificates at the Central Institute of Statistics. They analyzed rates before, during, and after the educational campaign. Rates from Trentino were compared with those from three bordering regions where the educational campaign was not available. Standard mortality ratio (observed deaths/expected deaths) and the cumulative mortality rate was used in comparison data. In Trentino, the change in cumulative mortality rates for women actually was a decrease in rate (-15%) after the campaign as compared to an increase in the other three regions (+82%, +75%, +33%). Furthermore, the male cumulative mortality rate from melanoma in Trentino had a smaller increase than in surrounding regions (+35% vs +104%, +105%, +70%).

Although the authors did not postulate why this large increase occurred in the surrounding areas, they focused on the difference between regions. Cristofolini et al. believe that these changes are unlikely to have been due to chance alone. They also applied this information to estimate the approximate number of lives "saved" by the campaign. It was assumed that if the campaign had not occurred in Trentino, then the mortality rate from melanoma would be similar to that of the surrounding areas for the same time period. In applying these three rates to the population of Trentino, approximately 21 to 31 more people would have died of melanoma in the same time

period, with an average of 24 people (Cristofolini et al., 1993). Again, educational material coupled with free skin cancer screening appeared to increase melanoma awareness and screening in the population.

CANADA

Canada has offered free skin cancer screening clinics in many cities since 1991. However, the incidence of skin cancer and follow-up from these clinics has not been published. A group from the Canadian Cancer Society and the Canadian Dermatology Association developed a study to analyze demographics of screenees, the follow-up pathology of suspicious lesions, and the positive predictive value of screening. Other endpoints of evaluation included barriers to follow-up. This study encompassed free skin cancer screening clinics in Vancouver and Parksville, British Columbia during years 1994 and 1995.

Screenees completed a questionnaire similar to the one devised by the American Academy of Dermatology prior to screening. The participants chose whether they wanted a full body examination, an examination of sun-exposed areas, or examination of a specific area. A dermatologist performed the examination, and if there was a suspicious lesion, the screenee was referred to their dermatologist or family physician. In 1996, those referred for follow-up were contacted by mail to complete information regarding any follow-up for skin lesions. If no response was received, they were then contacted by telephone and a second questionnaire was sent if necessary. A separate questionnaire was sent to the screenees' dermatologist or family physician to verify the final diagnosis

of suspected lesions. A pathology report was requested if the lesion was biopsied or excised.

At the skin cancer screening clinics, 520 people were screened, consisting of 58% women and 42% men. Average age was 39 years old, 40 years for men and 37.5 years for women. In total 105 participants were referred for 177 suspicious lesions. Of those referred, 93 responded to the survey and 80 (80/93, 86%) sought medical follow-up. The authors were able to obtain diagnoses on 76 participants; melanoma was suspected in 6 people (1 was biopsy-confirmed), 10 had suspected basal cell carcinoma (3 were biopsy-confirmed) and 2 people had suspected squamous cell carcinoma. No squamous cell carcinomas were biopsied, but 2 out of 3 were clinically agreed upon. The positive predictive value for lesions varied: 17% for melanoma, 43% for basal cell carcinoma, 19% for atypical nevus and 89% for actinic keratosis.

Of the 13 people who did not follow-up, several reasons were given. Five screenees did not understand that they should follow-up, two forgot to follow-up, two claimed that they had no physician with whom to follow-up, one followed up with a nonphysician, one was still planning to follow-up. Two people gave no reason for not following up. None of these participants had a lesion suspicious for melanoma. Interestingly, there was one false-negative case of biopsy-confirmed in situ melanoma on a screenee's leg reported by a dermatologist on follow-up. This study reinforces the need for focusing on older patients as a higher-risk population. Only half of the screenees were older than 40 years of age, but they comprised 66% of participants referred for follow-up. Additionally, although only 10% of screenees were 65 years of age or older, one out of four in this age group were referred for follow-up (Engelberg et al., 1999).

BRAZIL

A study was performed by Passos da Rocha et al. in Brazil to estimate the prevalence of pre-malignant and malignant skin lesions in a population in southern Brazil. As a secondary measure, the authors aimed to determine the sensitivity and specificity of skin cancer screening. Forty-eight randomly selected census tracts were selected from an urban area in southern Brazil on which to perform a cross-sectional population-based study outlined above.

In total, 1,292 people were interviewed after the investigators visited 2,112 homes in the area. All participants were 50 years of age or older. A questionnaire was completed inquiring about any new skin lesions in the last 6 months or any lesions on sun-exposed areas. Any participants with positive answers were referred to the university's dermatology clinic for visual skin cancer screening. However, in order to determine specificity, a control sample of those who answered negatively was also examined.

In this study, the prevalence of pre-malignant and malignant skin lesions was 20.7%. The authors reported screening sensitivity was 20.1% and specificity was 86.9%. Positive predictive value was 29%, negative predictive value was 80.4% and accuracy of diagnosis 72.9%. The authors concluded that in this population in Brazil, there was a high prevalence of skin cancer and pre-skin cancer lesions. They found the parameters of the visual skin cancer screening exam to have low sensitivity and "unsatisfactory" specificity (Passos da Rocha et al., 2002).

This study may not be generalizable, as the population chosen may not represent other populations, and the visual screening skills of the dermatologists may vary from

region or university to region or university. However, such an effort in skin cancer screening is admirable, considering the number of homes visited and recruitment of many people over 50 years of age. One could postulate that Brazil, by location, may have a high prevalence of skin cancer secondary to proximity to the equator, however, skin type III or IV may be protective against harmful UV radiation.

JAPAN

Nagano et al. devised a screening study in Japan to determine the incidence and prevalence of nonmelanoma skin cancer in the southernmost tip of Japan, where annual UV radiation cumulative dose is the highest (1999). Previous studies performed in Japan demonstrated a five-fold higher number of patients with nonmelanoma skin cancer and actinic keratosis in the southernmost part of Japan as compared to the north (Suzuki et al., 1996). Another study performed at the near geographical center of Japan in Kasai City aimed to determine the incidence and prevalence of skin cancer in this population. A total of 4736 people were screened in 1993 and 36 actinic keratoses were found. Additionally, two cases of basal cell carcinoma were also diagnosed in this screening. The study determined a prevalence rate of 414 actinic keratoses per 100,000 Japanese people in this region (Naruse et al., 1997; Suzuki et al., 1997).

Nagano et al. targeted the Ie Island in the Okinawa Prefecture, as it is at the southernmost part of Japan. The island has a population of 5562 and its mainstay of economy is the cultivation of sugar cane and fishery. The skin cancer screening was part of a public health effort to screen for various cancers among persons over age 40. Using the Health Science's Law for the Aged, this population over age 40 was encouraged to

participate. In total, 1690 people (65% of residents in this age group registered as residents under the Health Law) participated (717 men and 973 women). The study took place over 1993 to 1996 and many participants were screened in consecutive years.

Skin cancer screenees completed a questionnaire regarding demographics as well as skin cancer risk factors. Dermatologists performed visual skin cancer screenings and biopsies were performed on any suspicious lesions. Among the screenees, 86 cases of actinic keratosis, 9 cases of basal cell cancer, and 2 cases of squamous cell cancer were histopathologically confirmed. No malignant melanoma was found during the study. Annual prevalence of actinic keratosis as compared to that of centrally located Kasai City is found in Table 8.

Table 8 Annual Prevalence of Actinic Keratosis in Ie Island and Kasai City

Location	Year	Number of Screenees	Number of Cases	Prevalence*	OR	95% CI
Kasai City+	1992	4736	36	414.3	1.00	---
Ie Island#	1993	1118	37	1159.4	2.79	2.03-3.78
	1994	1117	18	572.8	1.38	1.15-1.64
	1995	1014	24	1014.3	2.45	1.85-3.18
	1996	1035	31	988.9	2.39	1.84-3.09

*After standardization to the 1990 Japanese population
+Data from: Slaper et al.,1996.
#Data from: Nagano et al., 1999.

This study demonstrates the increased prevalence of actinic keratosis with increased UV radiation in Japan (Nagano et al., 1999). It was interesting that no melanomas were diagnosed in this study. There may be a protective effect in either environmental or genetic factors among the Japanese, but analyzing death certificates for malignant melanoma may be of interest. Additionally, many actinic keratoses were

diagnosed, but only two squamous cell carcinomas were found. Because very few actinic keratoses evolve into squamous cell carcinoma, the screening for actinic keratoses may not be cost-effective in reducing mortality in this population. However, the study's strong association between UV radiation and actinic keratosis prevalence is quite evident and may be helpful in targeting populations at higher-risk for solar keratoses.

NEW ZEALAND

New Zealand has not published widely regarding skin cancer screening and education (Koh et al., Cancer 1995). However, a campaign by the New Zealand Cancer Society includes "skin check" days at centers throughout New Zealand. Between 1988 and 1989, over 12,000 people were screened for skin cancer. One of these centers reported findings in the literature. In this study, three melanomas were found in a screening of 746 participants (Elwood, 1991). Another study in New Zealand reviewed the New Zealand Cancer Registry from 1995-1999, a mandatory reporting of all cancers in New Zealand.

The study included people of European descent with melanoma and found 4966 new cases of melanoma in these years; this statistic represents one of the highest rates of melanoma in the world. The authors also reported an increasing Breslow thickness over the 5-year period ($p<0.001$) as well as a statistically significant greater number of melanomas in men than women ($p<0.001$). Within the country, the highest rate of melanoma was in the north (59.1/100,000) as compared to the south (23.5/100,000) with rates age-standardized (Martin and Robinson, 2004).

AUSTRALIA

An article by Marks published in 1999 summarized the public health effort in Australia to curtail skin cancer in its population. With a national survey of nonmelanoma skin cancer in 1985, it was found that two out of every three people born in Australia would need treatment for at least one skin cancer in their lives (Giles et al., 1988). Furthermore, melanoma mortality rates had been rising through the late 1980's (Marks et al., 1993), but cohort analysis has shown a leveling off and even reduction of mortality rates from melanoma recently (Giles et al., 1996). Early detection and skin cancer prevention have been the primary public health objectives in Australia.

Starting in the 1970s, an education program was launched in Australia, initially in Queensland then more nationally. Public education campaigns about prevention and recognition of skin cancer were the primary goal, with an additional component of physician skin cancer education. This educational information was expanded in 1985, when the Australasian Cancer Society and the Australasian College of Dermatologists developed the Skin Cancer Awareness Week. The mainstay of this week was the distribution of pamphlets and media regarding the visual aspects of skin cancer, distributed to the public as well as every general practitioner in Australia.

Part of this campaign was a screening effort for skin cancer. They developed "battle stations" in public venues, including beaches. This was not considered as a national screening effort, but the focus was primarily on education. However, if a screenee had a suspicious lesion, it was recommended that they seek care from a physician. Australia has not instituted a formal skin cancer screening program, because it is not felt that the evidence of benefit would justify the cost (Marks, 1999).

Indeed, education is the primary focus of skin cancer prevention in Australia. A nationally televised program about a young man dying from melanoma was aired in three parts called "Goodbye Sunshine." Because of this program, it was estimated that an additional 750 melanomas were diagnosed in the country. Furthermore, in Victoria, there was a 140% increase in melanoma pathology reports than in the year prior to the television airing. These melanomas were also thinner, with an average Breslow depth of 0.6 mm after the program, compared to 1.6 mm the year before (Theobald et al., 1991). One could conclude that education was helpful in increasing diagnosis of melanoma, and perhaps encouraging earlier diagnosis. It may only be a "short term" increase, however, as occurred in a similar campaign in Austria.

Another study followed a population in Queensland for 10 years prospectively for nonmelanoma skin cancer. Newly diagnosed and treated lesions were recorded, and the study was supplemented with visual skin examination. The authors found that with basal cell carcinoma, incidence rates varied according to method of skin cancer surveillance. In fact, basal cell cancer incident rates nearly tripled as compared to background treatment rates. It was determined that new basal cell cancers were found on areas other than the head, neck, arms and hands, and thus were usually uncovered during full visual examinations. The visual skin examination did not seem to increase incidence on the head, neck, arms or hands, as the incidence rates of basal cell in these areas returned to baseline after visual screening campaigns. The authors concluded that there is an increased reporting of basal cell carcinomas when a full-body visual examination is completed, increasing the apparent burden of cancer on a population (Valery et al., 2004).

Finally, The Lancet published an article in its oncology section titled, "Australian charities call for government reinvestment in screening," referring to skin cancer screening. The article reviewed the latest harrowing epidemiological statistics of skin cancer gathered in 1996, the most recent data. Among Australians older than 14, 374,000 people had treatment for nonmelanoma skin cancer in 2002, compared to 270,000 in 1995 and 168,000 in 1985. Age-standardized incidences for basal cell cancer in women is 745/100,000 and in men, 1041/100,000. Squamous cell cancer incidence for women is 291/100,000 and 499/100,000 for men. These data are drastically higher than incidences in the United States. Even the author of the report, Margaret Staples of the National Cancer Control Initiative, was "surprised" that the incidence rates of squamous cell cancer had tripled in south Australia.

The article continued to call for a national effort in Australia for screening, primarily because the rise of skin cancer is mostly in Australians over age 50. Although it has been reported that these people are beyond the education and primary prevention scope of skin cancer, it is believed that nationally organized screening for this population (secondary prevention) would actually save costs from a public health perspective. In 1996, the government in Australia spent $300,000,000 Australian to treat skin cancer. A national campaign for screening would cost $2,530,000 Australian per year and save the healthcare system about $37,000,000 Australian annually (Pincock, 2004). The authors hope that the Australian government will take this into account in determining the cost-effectiveness of skin cancer screening.

While this country has higher incidence rates than the United States, the world will continue to monitor the state of skin cancer in Australia. Whether the country

institutes a national skin cancer screening program or not, lessons will be learned either way in both epidemiology and prevention. Ideally the correct pathway will become clear (to screen or not to screen), and the morbidity and mortality of melanoma and nonmelanoma skin cancer will be curtailed. Perhaps with further research there will be a global consensus on skin cancer screening.

SKIN CANCER SCREENING IN THE WORKPLACE

Both in the United States and internationally, analyses of the relation of occupation to cancer, including skin cancer, have been published. While it is well known that ultraviolet radiation is associated with increased risk of squamous cell carcinoma and basal cell carcinoma, the risk factors for melanoma are less well-defined. This chapter will review occupational relation to skin cancer risk, as well as a few published skin cancer screening efforts in occupational medicine clinics. It is with great hope that gathering this information will further the effort to target high-risk populations (particularly men over aged 50, skin types I and II, intermittent sun exposure, occupational exposures) for skin cancer screening, particularly in occupational medicine clinics.

Unna may have made the earliest notation that excessive exposure to the sun was related to skin cancer. He wrote of the changes in sailors' skin, including skin cancer (Unna, 1896). Sunlight, particularly the ultraviolet range, is carcinogenic. It is thought that UVB (290-320nm) is especially carcinogenic, though UVA (320-400nm) may play a role in carcinogenesis as well (deGruijl and Forbes, 1995). UV radiation is also an immunosuppressant in the skin, not only inducing tumors but also decreasing the normal immune response to these tumor cells, making it a potent carcinogen (Marks, 1996).

The most obvious workers exposed to UV radiation are those who work outside. A study in England and Wales from 1970-1975 demonstrated an excess number of squamous and basal cell carcinomas in outdoor workers (Beral and Robinson, 1981). A more recent study in Japan supported the association between outdoor work and

increased risk of actinic keratosis, with an odds ratio of 2.30 (Nagano et al., 1999), yet a study in England did not find such an association (Memon et al., 2000). These hyperkeratotic lesions (actinic keratoses) are thought to be precursors to squamous cell carcinoma; one study placed the risk of malignant transformation at 1 in 1000 per year (Marks et al., 1988). In any case, these lesions are visual indicators of sun damage.

Farmers tend to have an increased risk of skin cancer in several studies. Multiple papers indicate excess mortality of farmers from nonmelanoma skin cancer (Burmeister, 1981; Decoufle et al., 1977; Whitaker et al., 1979; Milham, 1983). Particularly, squamous cell cancer of the lip is elevated among farmers (Lindquist, 1979). In a study by Keller analyzing discharge diagnoses of patients from Veteran's Association hospitals in the United States, 27% of the lip cancer patients were farmers, whereas only 8% of all discharged patients were farmers (1970). In addition to farmer mortality data, morbidity data exists as well (Blair et al., 1985). In an analysis of chronic disease among farmers in the United States, there was an elevation of crude prevalence rates of skin cancer in this population (Brackbill et al., 1994). There was a strong association of farming and squamous cell carcinoma in a morbidity study performed in England (Whitaker et al., 1979) as well as an association with basal cell carcinoma in a risk factor study in Canada (Hogan et al., 1989).

Despite multiple studies implicating sunlight in nonmelanoma skin cancer, multiple studies have not found an association between nonmelanoma skin cancer and outdoor work. A study in Denmark failed to find in increased risk of nonmelanoma skin cancer and outdoor work, particularly fishing, forestry and agriculture (Olsen and Jensen, 1987). Furthermore, a study in Finland actually showed a lower incidence of basal cell

cancer in outdoor workers such as farmers, forestry workers and fisherman, whereas those in the medical field had a higher incidence (Hannuksela-Svahn et al., 1999). Authors of a case-control study in the United Kingdom similarly did not find a statistically significant association of occupation to basal cell carcinoma. Instead, they postulated that genetic determinations, such as eye color, hair color and skin color play a larger role in determining response to ultraviolet radiation (Lear et al., 1997).

Green et al. published a paper supporting self-selection in outdoor workers. Although people with type I and II skin were represented in greater than 80% of their study sample, this population was greatly underrepresented in the outdoor working population. The authors suggested that this self-selection bias with regard to long-term outdoor workers may partly explain studies failure to find a statistically significant correlation between sun exposure and skin cancer (Green et al., 1996). In addition, lack of power, study design, and uncontrolled or quantified sunlight exposure may also contribute to varying study findings.

Exposures to ultraviolet light other than sunlight occur in various occupations. For example, germicidal lamps emit light at approximately 254 nm. This potentially places microbiology laboratory workers, healthcare workers, and any barbers or service workers using such antimicrobial lamps at risk for exposure. Furthermore, welding arcs emit light below 290 nm, thus welders, foremen, maintenance workers, metal cutters and pipeline workers could be occupationally exposed to ultraviolet light. Other sources of ultraviolet light in the occupational setting include ultraviolet lasers, curing process (irradiation and wood curing), printing process, drying and curing paint, dental lights, and

metal casting testing (Emmett, 1975). A summary expanded from Emmett, 1975 can be found in Table 9.

Table 9: Occupational Exposure to Ultraviolet Radiation

Potential Source	Occupations at Risk
Outdoor Sun Exposure	Agricultural workers, gardeners, construction workers, crossing guards, window washers, sailors, fishermen, lifeguards, professional outdoor athletes, railroad track workers, marina workers, drivers, pipeline workers, oilfield workers, ranchers, roofers, postal carriers, forest rangers, police officers, automobile salespersons, active duty military in combat arms roles, Naval shipmen
Welding Arc Exposure	Welders, foremen, maintenance workers, pipeline workers, metal cutters, metal workers, shipbuilding, automobile manufacturing and repair, aerospace manufacturing, building construction, bridge construction, power plant and refinery repair and construction
Germicidal Exposure	Medical profession, nurses, hospital technicians, bacteriology laboratory workers, barbers, hairstylists, manicurists
Plasma Torch Exposure	Plasma torch operators working on steel joints, HVAC ducts, electrical enclosures, metal roofing, siding, and metal cutting jobs
Ultraviolet Laser Exposure	Circuit board repair, electronic manufacturing, laboratory workers
Curing Processes	Food irradiators, wood curers, adhesive bonding in medical and dental industry (dental hygienists, dental technicians, dentists), finishers of inks (for letterpress, lithographic, gravure and screen printing) and adhesives (for film, foil or paper substrates) in various industries
Printing Processes	Lithographers, screen transferers, printers, publishers, ceramics, packaging workers
Nondestructive Testing	Metal casting inspectors, inspectors of welding of evaluation of metal structures such as tanks, bridges, power plants, refineries, pipelines, and petrochemical processing facilities

Occupational causes of skin cancer other than ultraviolet radiation are of concern. In fact, some chemicals may augment the carcinogenesis of ultraviolet light (Emmett, 1975). Polycyclic aromatic hydrocarbons are a known occupational exposure associated with skin cancer. In 1775, Sir Percival Pott associated the scrotal cancer noted in chimney sweeps with the exposure of the scrotum to soot through pants and the lodging in the scrotal rugae (Pott, 1775). Table 10 outlines specific polycyclic aromatic hydrocarbons mentioned by Emmett (1975) and respective occupations at risk for exposure.

Table 10: Occupational Exposures Associated with Polycyclic Aromatic Hydrocarbons and Skin Cancer

Suspected Agent	Occupations at Risk
Pitch, Tar or Tar Products	Tar distilling, Coal gas manufacturing, Pitch loading, Briquette manufacturing
Oil Fractionation and Distillation Products	Shale oil workers, Cotton mule spinners, Paraffin wax workers, Mineral cutting oil users, refinery workers
Creosote	Timber picklers, Brick title or pipe pressers, treated wood product handlers, wood cutters, railroad workers, utility pole installers, shingle hangers
Anthracene	Chemical workers, particularly producers of anthraquinone, dyes, pigments, insecticides, wood preservatives and coating materials
Soot	Chimney sweeps, work involving exposure to diesel soot

Whitaker et al. found an increased incidence of squamous cell carcinoma in English textile spinners (1979); this may be due to exposure to polycyclic aromatic hydrocarbons. Additionally, a significant increase of squamous cell carcinoma of the arm

was demonstrated in chemical workers, fishermen and paper/printing workers in this same study (Whitaker et al., 1979), though it is unknown what chemicals were involved.

Inorganic arsenic is also an occupational (and environmental) carcinogen known to cause skin cancer. Routes of entry are actually not skin contact, rather, they include ingestion, inhalation and injection (Emmett, 1975). Sources today include potassium arsenite in Fowler's solution, arsenic in drinking water (Tseng et al., 1968), metals and pesticides. In 1973 it was estimated by NIOSH that 1.5 million workers were exposed to inorganic arsenic at work (US Department of Health, Education and Welfare, 1973), though skin cancers due to exposure are rare in the United States (Emmett, 1975).

Causes of melanoma are not as clear as those for nonmelanoma skin cancer. Strong associations between intermittent sun exposure and development of melanoma are becoming more evident in the literature, whereas melanoma's relationships to lifetime sun exposure as well as occupational exposure are less clear (Elwood, 1996). The focus here will be upon various studies analyzing occupational risk (or lack thereof) of melanoma, and any higher-risk occupations. However, an occupation's relation to sun exposure becomes more complicated when vague classifications of sun exposure or relation to occupation are used in studies. This also makes for a difficult comparison between studies.

Studies have analyzed multiple factors in an effort to elucidate occupational links to melanoma. Multiple studies have found no significant association between outdoor work and melanoma (Bataille et al., 2004; Pion et al., 1995; Goodman et al., 1995; Lee and Strickland, 1979; Garland et al., 1990). A few studies have found a protective effect of outdoor work on the development of melanoma (Westerdahl et al., 1994; Holman et

al., 1986; Osterlind et al., 1988), while another published an increased association (Zanetti et al., 1988). Elwood argues that the definition of outdoor work is quite subjective in these studies, and varies greatly from study to study, making comparison and conclusion difficult. He does believe, however, that a large European study performed by Autier et al. in 1994 provides a useful definition for outdoor work (1996). In this study, outdoor work was defined as having spent at least 30 years or more in an outdoor occupation. After adjusting for host factors, this large study found a significant decrease of risk for melanoma (Autier et al., 1994).

It may be that intermittent sun exposure is a more important risk factor for melanoma than outdoor work (Elwood, 1996). In fact, multiple studies have found that indoor workers are at an increased risk for melanoma as compared to outdoor workers (Beral and Robinson, 1981; Lee and Strickland, 1980; Garland et al., 1990). Beral and Robinson reported an excess of melanomas on the trunk and limbs of indoor workers (1981). Many studies have suggested that indoor work is associated with a higher level of education, and these "white collar" workers are at an increased risk for melanoma due to lifestyle or some other unseen factor (Goodman et al., 1995).

In fact, Lee and Strickland found that socioeconomic status was the primary stratifying factor in melanoma risk in their study, and there was no difference in risk for melanoma when comparing indoor versus outdoor workers of similar socioeconomic status (1980). Pion et al. agree to some extent, finding an increased risk for malignant melanoma among white collar employees as compared to blue collar employees, and higher-income employees had a higher risk of melanoma than lower-income employees (1995).

Similarly, Vagero et al. found that professionals had the highest risk of melanoma in their study, correlating these professionals by a high level of education (1990). It is unlikely that the education itself is a risk factor for melanoma, rather, some common lifestyle or environmental factor associated with a high level of education is potentially one of the (perhaps many) factors contributing to the higher risk for melanoma in this population.

Both ionizing and other non-ionizing radiation sources have been linked to melanoma. Workers exposed to artificial UV sources (dentists, physiotherapists and lithographers) had an increased risk of melanoma in a study by Perez-Gomez et al.(2004). Occupational exposure to x-rays significantly raised the risk of melanoma in one study (Pion et al., 1995). Although rare, radiation can cause malignant melanoma as well (Emmett, 1975). Interestingly, flight crews, including pilots, navigators and flight attendants, have repeatedly had an increased risk of melanoma in studies (Vagero et al., 1990; Gundestrup and Storm, 1999; Rafnsson et al., 2000; Haldorsen et al., 2000).

Ultraviolet radiation has been discounted as a risk factor, as the dose on the flight deck is negligible (Diffey and Roscoe, 1990). Although travel to sunny destinations is a possible lifestyle risk, radiation from flight is also a possibility, as dose increases with flight length (Gundestrup and Storm, 1999; Rafnsson et al., 2000). Occupational exposure to magnetic fields has also been linked to malignant melanoma, though the authors insist more research should be completed before conclusions are drawn (Tynes et al., 2003).

Finally, specific occupational exposures are associated with an increased risk of malignant melanoma. Tear gas (α-chloroacetophenone) and polychlorinated biphenyls

(PCB's) have been implicated as possible inducers in the development of malignant melanoma (Sober and Fitzpatrick, 1979). Workers exposed to vinyl chloride and polyvinyl chloride had an increased incidence of melanoma in one study (Storetvedt Heldaas et al., 1984). Chemists exposed to benzoyl peroxide, pesticides and plastics were found to have an increased risk of malignant melanoma in one study attempting to isolate specific occupational exposures increasing risk (Wright et al., 1983). Increases in melanoma have been found among employees in the paper mills and printing industry (Linet et al., 1995), but specific chemical exposures have not been elucidated.

Although there are multiple risk factors for melanoma (both known and unknown), and the working population may be at high-risk for melanoma, few efforts of screening in an occupational setting have been published (Greene, 1993). In the United States, several Occupational Safety and Health Administration published standards exist that include a visual skin exam in screening and surveillance. Special emphasis on skin exam is included in the following standards: acrylonitrile, inorganic arsenic, 1,3-butadiene, coke oven emissions, ethylene oxide, formaldehyde (for evidence of irritation, not skin cancer), methylenedianiline, methylene chloride, and vinyl chloride (2000). Specific OSHA standards and occupational exposures requiring skin examination are summarized in Table 11.

Table 11: OSHA Standards and Occupational Exposures Requiring Skin Examination

Exposure	Applicable Standard	Skin Examination Emphasis
Acrylonitrile	1910.1045 (n)/1926.1145	Cancer
Arsenic (Inorganic)	1910.1018(n)/1926.1118	Cancer
1,3-Butadiene	1910.1051(k)/1926.1151	Cancer
Coke Oven Emissions	1910.1029(j)	Cancer
Ethylene Oxide	1910.1047(i)/1926.1147	Cancer
Formaldehyde	1910.1048(l)/1926.1148/1915.1048	Irritation
Methylenedianiline	1910.1050(m)	Cancer
Methylene Chloride	1910.1052(j)/1926.1152	Cancer
Vinyl Chloride	1910.1017(k)/1926.1117	Cancer

To determine the efficacy of occupational medicine practitioners in early detection of melanoma, Guibert et al. devised a study in France. Because the population seen by dermatologists as well as general practitioners is a self-selected group to some extent, the authors devised a screening process to target a less biased population. In France, all workers aged 18 to 65 years have a screening physical examination. In 1995 this population was 25.6 million people, comprising 43.6% of the French population. This is a mandatory examination, and the physicians performing the exam are "independent in their relations with the persons examined" since there is no doctor-patient relationship.

The authors trained the occupational medicine specialists in the ABCDE criteria of melanoma (2000). These criteria were developed by the American Cancer Society and used in the educational aspect of this study (A, asymmetry; B, irregular borders; C, heterochromous coloration; D, diameter >6 mm; E, enlargement). The occupational

medicine physicians in the Nantes region of France were educated for 2 hours on the ABCDE criteria, including educational slides. They were told to refer patients if a lesion demonstrated 2 of the 5 ABCDE criteria, or just enlargement alone. This data was recorded and the following year upon annual examination, follow-up was completed.

In total, 65,000 people were screened during the study. Of these, 370 had suspect lesions and 273 (74%) were seen in follow-up the next year. For the 101 people who had not had interim specialist evaluations, the main reason was negligence (86%). Among the 353 atypical nevi suspected, 78 people had excisions. In all, there were 5 melanomas histologically confirmed. The melanomas were found in 1 woman and 4 men and had Breslow depth of 0.46 to 1.38 mm. The screenees with melanoma ranged in age from 18 to 51 years, and all but the woman had realized the lesion was present with range of 3 months to 12 years (2000).

The ratio of number of melanomas to number of suspect lesions, 1:70, is similar to studies of the pigmented lesion clinics in Britain (1:22- 1:33) and better than the United States skin screening ratios (1:250) (MacKie and Hole, 1992; Koh et al. JAAD, 1996). The emphasis in this study is that the population screened is working and tends to have a “healthy worker effect” which often precludes this population from seeing a physician altogether. This study took advantage of the fact that yearly physical examinations offer the optimal time to screen this perhaps underserved population with regard to skin cancer screening, and results were quite favorable. The cost was reasonable ($17,000), perhaps due to the use of existing infrastructure (the occupational medicine clinic) versus the temporary screening shelters used in other studies (Guibert et

al., 2000). These study results encourage skin cancer screening in the occupational medicine setting.

A discussion of the incurred cost of screening is certainly relevant. Incorporating a skin cancer screening exam into an already scheduled annual surveillance examination, pre-employment physical, or workplace injury examination would be minimal in cost. Each examination would not be separate from the chief issue for presenting to the clinic; rather, it would be incorporated into the pre-existing exam. A full skin examination should take no more than one to two minutes, whereas a partial skin examination would take even less time. There would be no actual additional cost of examination, and personal insurance or worker's compensation would not need to pay specifically for this service. Again, any suspicious lesions would be indicated and referred to an outside physician for follow-up. No actual skin cancer treatment would take place in the occupational medicine clinic. Therefore, insurance and cost would be nonexistent, as the skin cancer screening examination would be an adjunct to another already covered visit. If an in-house occupational medicine clinic had a plant-wide initiative for skin cancer screening, then the cost would be absorbed by the corporation providing the initiative. This example, however, would be very unusual, though welcome.

Other small-scale skin cancer screening efforts in the occupational medicine setting have been published. In a study by Curley et al., indoor workers in an office setting of a large British retailer were targeted for skin cancer screening. In total, they screened 2,150 employees and found four melanomas in early stages. Additionally, three other skin cancers were identified, as well as three premalignant lesions (1993). Another study used pre-screening questionnaires to determine whether pre-categorization into risk

groups (high, intermediate and low) would help identify screenees at greatest risk. Employees at a large hospital were targeted and completed a questionnaire prior to skin cancer screening. Indeed, the high-risk population had a significantly higher percentage of suspicious lesions (35%) than did the intermediate group (24%, $p<0.001$). The authors concluded that such a stratification questionnaire would help to identify the highest-risk population at work when performing skin screening exams (Yen et al., 1996).

While there are a few skin cancer screening studies published, there is little research in this area. The few studies discussed are encouraging, and more research needs to be completed in skin cancer screening in the workplace. Occupational medicine clinics are a virtually untapped resource for skin cancer screening in the United States. They provide an excellent opportunity to screen workers for skin cancer and prevent morbidity and mortality. The future of skin cancer screening has a potential role for the occupational physician, but whether this role will be embraced in the United States is uncertain.

SKIN CANCER SCREENING IN OCCUPATIONAL MEDICINE

Skin cancer screening is a mode of secondary prevention, a natural extension of primary prevention. The worksite is an "ideal setting" for both assessment of cancer risk as well as primary prevention (Cornfeld et al., 2002; Eriksen, 1987). In one assessment of worker's interest in future health programs, the highest interest surpassing other choices of nutrition counseling, exercise instruction, stress reduction, breast cancer screening, prostate cancer screening, smoking cessation and clinical research was skin cancer screening. In fact, over 82% of people surveyed ranked skin cancer screening of moderate or greater interest and this was the highest ranked of all interests available (Cornfeld et al., 2002). Thus, not only is there a desire for skin cancer screening in the workplace, but there also is a need. There is a strong argument for not only primary prevention and assessment for cancer risk in the workplace, but also secondary screening in the workplace as outlined previously.

Skin cancer screening has been proven an effective tool for secondary prevention of skin cancer. There has been some debate over the accuracy of non-dermatologists in diagnosing skin cancer, particularly melanoma (Morton and MacKie, 1998). A thorough review of the literature comparing dermatologists' and primary care physicians' accuracy in diagnosing melanoma was performed by Chen et al. Reviewed data was inadequate to support any differences in diagnostic accuracy of melanoma in a visual skin cancer screening exam (2001). Furthermore, this thesis supports occupational physicians screening for skin cancer primarily for the detection rather than the treatment of suspicious lesions. Upon detecting such lesions, appropriate referral is made. While

most occupational physicians will not afford the time for biopsy or treatment of suspicious lesions, allotting the time for visual skin cancer screening and referral would be more reasonable. The suggestion is not that the occupational physician rival the dermatologist or primary care physician, rather, that the occupational physician work in tandem with his or her colleagues.

It is key to understand that occupational physicians have the opportunity to detect skin cancer in a population that one, may not routinely see a physician and two, may be at a higher risk than the general population. First, the "healthy worker effect" may preclude many workers from seeing a physician regularly. Many employees have pre-employment physicals, OSHA-mandated physicals, annual physicals, and surveillance exams. The occupational physician will examine these patients as directed, and while the task at hand is of greatest importance, it is reasonable to consider skin cancer screening simultaneously.

Second, risk-stratifying patients either with a pre-screening questionnaire or by personal, demographic and occupational information will help target patients at risk for melanoma and nonmelanoma skin cancer. The highest risk population for melanoma skin cancer is men aged 50 years and older (Geller et al. Cancer, 2002). Indeed, Geller et al. call for "outreach to middle-aged and older men," particularly for melanoma screening. Much of the current workforce falls into this demographic and individuals may have physical examinations in an occupational medicine setting; these older men are a target population for occupational skin cancer screening. Further, possessing skin types I and II and/ or a changing mole increases risk for melanoma, further defining an ideal at-risk population for screening (2002). Additionally, a higher risk for melanoma has been

linked to higher education, intermittent sun exposure, and "white-collar" work, and patients falling into this risk group (including office workers, administrators) could be further targeted.

Non-melanoma skin cancer is associated with lifetime dose of sunlight or ultraviolet radiation, as well as specific exposures outlined in the previous chapter, and patients in this risk group (including farmers, agricultural workers, lifeguards) should be screened with particular focus on nonmelanoma skin cancer. Review of specific occupational exposures more common in a physician's patient population linked to increased nonmelanoma skin cancer would also help determine patients at higher-risk for nonmelanoma skin cancer and therefore important skin cancer screening candidates. The ability of an occupational physician to focus a minute or two of the examination on skin cancer screening, even if only on specific members of these defined high-risk populations may prevent patient morbidity and mortality.

Feasibility of skin cancer screening in an occupational medicine setting should be investigated further. However, it is known that full-body skin examinations are accepted and welcomed by patients (Federman et al., 2004). For many of the examinations performed by the occupational medicine physician, the patient is often in some state of undress or wearing a gown. This makes skin examination easy and convenient for both parties. Furthermore, skin examination could easily be incorporated into the standard examination to decrease effort and time allotted to screening. For example, an examination of the skin on the back after listening to heart sounds or examining the spine would be simple and such a targeted approach could apply to the extremities as well.

Even simply performing a skin examination on the exposed body parts during an exam would be helpful.

Because the clinical time of an occupational physician (and any physician) is valuable, the cost-effectiveness of skin cancer screening must be discussed. Of the few published studies on cost-effectiveness of skin cancer screening, most are supportive of screening. A study by Freedberg and Koh reported that the cost of skin cancer screening per year of life saved to be nearly equivalent to other major screening efforts (1990). In 1999, Freedberg et al. came to a similar conclusion in another study, this time emphasizing high-risk patients. Yet another study supported this same conclusion, the targeting of men over the age of 50 as being a cost-effective population to screen. Furthermore, these authors supported the screening by family practitioners, and suggested that screening be performed every five years (Girgis et al., 1996). Occupational medicine physicians routinely see this group of patients in their offices, and skin cancer screening in this population is likely cost-effective. These patients would not made a separate visit for skin cancer screening, rather, the screening would be an adjunct to the visit, thus perhaps costing even less to the health system.

If an occupational medicine physician were to begin skin cancer screening examinations, either on all patients presenting for examination or only in high-risk populations, he or she should improve his or her skin cancer knowledge. A seminar with individual feedback improved primary care physicians' skills at diagnosing and treating skin cancer to the level of dermatologists in a study by Gerbert et al. (1998) It is likely that these results can be generalized to occupational medicine physicians, particularly because recognition of suspicious lesions would be emphasized, rather than treatment.

Using an internet-based continuing medical education program greatly improved the melanoma clinical skills of primary care physicians (Harris et al., 2001). Since practicing physicians must complete a certain amount of CME yearly, this internet-based CME would both encourage occupational physicians to use the contents of the lesson as well as satisfy professional requirements. A seminar containing similar content could be presented at national or local occupational medicine conferences, thus encouraging secondary skin cancer screening by providers.

Ideally, efforts to increase skin cancer screening would be most effective if supported by large organizations. It would be best if groups such as the American Academy of Dermatology encouraged the American College of Occupational and Environmental Medicine (ACOEM) to begin a campaign to increase screening in occupational medicine clinics. Since the AAD has such experience with screening and education, a collaborative effort would be effective in disseminating information to providers. This information could be distributed to ACOEM members through the organization's website, and the two groups could even link educational materials. A presentation could be given at the national ACOEM/ American Occupational Health Conference encouraging participation.

Collaboration both between and within organizations would be essential, and would likely increase screening efforts in the United States. Most importantly, a population at high-risk (men over age 50, among others) would be reached through a public health partnership. With increased emphasis placed on skin cancer screening by ACOEM in cooperation with dermatology associations, it is likely that awareness of skin cancer will be raised in the workplace. With education and continued efforts, perhaps

management of large corporations will support such screening and encourage the workforce to practice primary skin cancer prevention as well.

Much of the world's population spends a great percentage of its lifetime at a workplace setting. Multiple risk factors for skin cancer, both nonmelanoma and melanoma, have been elucidated. Many of these risky exposures, including intermittent or daily sun, are part of a working environment. In addition, many of the world's workers are healthy and may not routinely visit physicians. The occupational medicine physician is in a privileged situation regarding both primary and secondary prevention in this population. While the workplace has been utilized as a primary prevention site for multiple illnesses and diseases, the opportunity to screen for skin cancer has not previously been considered.

Although the future of occupational medicine has been debated, seizing opportunities to improve worker health and the occupational medicine physician's worth simultaneously would be ideal. I believe that skin cancer screening in the workplace can accomplish both of these ends, and the future of skin cancer screening involves the occupational medicine physician

Table 1-A Summary of International Screening Efforts

Country	Author	Study	Results	Results	Results	Results	Conclusions
Europe-Collaboration	EUROSKIN	Incidence, morbidity and Mortality of NMSC and Melanoma	Future Publication				
United Kingdom-Swansea	Holme et al., Br J Dermatol, 2001	Screening day with follow-up	832 screened (315M, 517F) 57% >50yo	882 lesions suspicious; 6 suspected melanoma 9 suspected basal cell	40 lesions removed from 31 people; 3 melanomas	1 melanoma in 277 screenees	Population was higher-risk and better yield
United Kingdom	Herd et al., 1995; Kirkpatrick et al., 1995; Grover et al., 1996; Holme et al. Br J Dermatol, 2001	Pigmented lesion clinics	Melanoma incidence rates at these specialty referral centers are 1 in 20 patients to 1 in 60 patients				Population at these specialty centers are high-risk and pre-screened/referred affording the high rates of melanoma incidence
United Kingdom-Scotland	Doherty and Mackie, 1988; Ellman, 1991	Public and General Practitioner Educational Campaign Since 1985	Patient demand for specialty referral increased	Skin cancer mortality rates for women decreased	Thinner lesions are being reported		Public education programs may decrease mortality rates from skin cancer in women, though no decrease has been seen in men

BCC= Basal Cell Carcinoma
SCC= Squamous Cell Carcinoma
NMSC= Nonmelanoma skin cancer
AK= Actinic Keratoses

Table 1-A (cont'd)

Country	Author	Study	Results	Results	Results	Results	Conclusions
Austria	Pehamberger et al., 1993	Public and Physician Educational Campaign in 1988	Significant reduction in mean Breslow depth of melanoma the next year, but increase in depth in years following				Educational campaigns may only offer short-term benefit.
Austria	Hofmann-Wellenhof et al., 2000	Skin cancer screenings at 3 large recreational centers 1998	344 screened (185M, 159F) Average age= 36.1 y	45 referred for follow-up for suspicious lesions	Patients were not followed further	72% of participants preferred the outreach screening to a doctor's visit	Sunbathing population was receptive to screening due to already being in a state of partial undress. This suggests more innovative community outreach screening could reach otherwise resistant population.
Belgium	Vandaele et al., 2000	"Melanoma Monday" Screening and educational campaign 1999	2767 screened (almost 2/3 F) Average age= 35yo	644 suspect lesions with 35 suspected melanoma, 59 suspected BCC	25 melanomas confirmed from Melanoma Monday referral; an additional 141 melanomas found in the following month		Public educational campaign likely increased melanoma awareness and increased diagnosis of melanoma (in the short-term).
Switzerland	Buillard et al., 1992	Public health education campaign 1988 and 1989	Doubling of new melanoma diagnoses in the 2 months following the 1st campaign	Subsequent decrease in cases after the surge	Many newly diagnosed melanomas were in patients <60 y		Public educational campaign increased short-term diagnosis of melanoma. In Switzerland many of the new melanoma cases were in people under age 60 (traditionally lower-risk).

BCC= Basal Cell Carcinoma
SCC= Squamous Cell Carcinoma
NMSC= Nonmelanoma skin cancer
AK= Actinic Keratoses

Table 1-A (cont'd)

Country	Author	Study	Results	Results	Results	Results	Conclusions
Denmark	Olsen and Jensen, 1987	Analyzed Danish cancer data from 1970-1979	Melanoma accounted for 2.1% all incident cancers	NMSC accounted for 12% of all malignancies			A central cancer reporting databank aids in the reporting of cancer incidence.
Netherlands	Rampen et al., 1991	Screening and educational campaigns 1989	2564 screened	262 had suspicious lesions; 103 of these were suspicious for cancer	53 screenees had 55 confirmed malignancies: 9 melanomas, 1 lentigo maligna, 40 BCC, 5 Bowen's disease		Having a national healthcare system may have encouraged the impressive 85% follow-up rate of screenees with suspicious lesions.
Netherlands	Krol et al., 1991	Screening and educational campaign at beach	3069 screened	65 had suspicious lesions	6 melanomas confirmed (all < 1 mm Breslow depth)		Screening at a beach area may be acceptable due to partial state of undress. This study found thin melanomas.
Italy	Cristofolini et al., 1993	Educational campaign, 1977 and 1981	Analyzed death certificates to determine mortality rates of targeted area and untargeted area (control) from melanoma before and after the campaigns	Targeted area had significantly less mortality from melanoma in the months following the campaign compared to control areas			Education may decrease mortality from melanoma, perhaps by increased awareness and screening. Whether this decrease is only short-term (and mortality is merely delayed) is not yet known.

BCC= Basal Cell Carcinoma
SCC= Squamous Cell Carcinoma
NMSC= Nonmelanoma skin cancer
AK= Actinic Keratoses

Table 1-A (cont'd)

Country	Author	Study	Results	Results	Results	Results	Conclusions
Canada	Engelberg et al., 1999	Screening clinics in 1994 to 1995	520 people screened (218 M, 302 F) Average age= 39yo	105 people had 177 suspicious lesions	One melanoma, 3 BCC and 4 atypical nevi were confirmed, 2 SCC were clinically agreed upon	Only half of the screenees were older than 40 years, but they comprised 66% of those referred. One in 4 screenees over 65 years was referred.	This study reinforces the need to target a high-risk population. In this case, higher-risk was associated with older age.
Brazil	Passos da Rocha et al., 2002	Cross-sectional population-based study to estimate prevalence of pre-malignant & malignant skin lesions & sensitivity and specificity of skin cancer screening	1292 interviewed at 2112 homes All participants were >49 y.	Prevalence of premalignant and malignant lesions 20.7% Screening Sensitivity= 20.1% Specificity= 86.7% PPV= 29% NPV= 80.4%			This population had a high prevalence of pre-malignant and malignant skin lesions. Targeting an older age population (50 years and older) provided higher-risk statistics of skin lesions. Brazil is close to the equator and the population may have protective skin types III or IV and therefore this study may not be generalizable.
Japan	Naruse et al., 1997; Suzuki et al., 1997	Screening effort in Kasai City (central) to determine actinic keratosis prevalence 1993	4736 screened	36 AK diagnosed 2 BCC 0 Melanoma	Prevalence rate of 414 AK per 100,000 people in this region		Actinic keratosis prevalence rates were estimated for this centrally located city. Skin types III or IV are more prevalent in this population and may be protective for melanoma (none were found).

BCC= Basal Cell Carcinoma
SCC= Squamous Cell Carcinoma
NMSC= Nonmelanoma skin cancer
AK= Actinic Keratoses

Table 1-A (cont'd)

Country	Author	Study	Results	Results	Results	Conclusions
Japan	Nagano et al., 1999	Ie Island (south) skin cancer screening 1993-1996	1690 screened (717M, 973F)	86 AK 9 BCC 2 SCC 0 Melanoma	Prevalence rate of 573 to 1159 AK per 100,000 people in this region from 1993-1996 with statistically significant OR difference (compared to Kasai City) 1.38-2.79	Increased UV radiation was associated with increased actinic keratosis prevalence in Japan.
New Zealand	Martin and Robinson, 2004	Review of the NZ cancer registry 1995-1999	4966 new cases of melanoma years 1995-1999	Increasing Breslow thickness over the years	Greater number of melanomas in males than females	In this population of northern European descent, there exists one of the highest rates of melanoma in the world. Again, males seem to be higher-risk for melanoma than females. Increasing Breslow depth in the study is concerning for morbidity and mortality. Future follow-up studies would be helpful.
Australia	Theobold et al., 1991	Educational campaign "Goodbye Sunshine" with analysis of cancer data	Estimated 750 additional melanomas were diagnosed in Australia due to the campaign	140% increase in melanoma pathology reports in Victoria during the year after campaign	Thinner melanomas were reported-average 0.6 mm Breslow depth after the campaign compared to 1.6 mm before the campaign	Education may be helpful in increasing diagnosis of melanoma, perhaps encouraging earlier diagnosis and thinner lesions. This may be a short-term effect, however, as was seen in Austria.

BCC= Basal Cell Carcinoma
SCC= Squamous Cell Carcinoma
NMSC= Nonmelanoma skin cancer
AK= Actinic Keratoses

Table 1-A (cont'd)

Country	Author	Study	Results	Results	Conclusions
Australia	Pincock, 2004	Analysis of national cancer data and call for skin cancer screening	In people >14y: 374,000 people had treatment for NMSC skin cancer in 2002, compared to 270,000 in 1995 and 168,000 in 1985.	Age-standardized incidence: FEMALES: 745 BCC per 100,000 291 SCC per 100,000 MALES: 1041 BCC per 100,000 499 SCC per 100,000	The article called for a national skin cancer screening effort in Australia because the rise of skin cancer is mostly in Australians over age 50. It is believed that nationally organized screening for this population (secondary prevention) would actually save costs from a public health perspective. In 1996, the government in Australia spent $300,000,000 Australian to treat skin cancer. A national campaign for screening would cost $2,530,000 Australian per year and save the healthcare system about $37,000,000 Australian annually.

BCC= Basal Cell Carcinoma
SCC= Squamous Cell Carcinoma
NMSC= Nonmelanoma skin cancer
AK= Actinic Keratoses

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