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Cost-Effectiveness Analysis of a Skin Awareness Intervention for Early Detection of Skin Cancer Targeting Men Older Than 50 Years

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ABSTRACT

Objectives: To assess the cost-effectiveness of an educational intervention encouraging self-skin examinations for early detection of skin cancers among men older than 50 years. **Methods:** A lifetime Markov model was constructed to combine data from the Skin Awareness Trial and other published sources. The model incorporated a health system perspective and the cost and health outcomes for melanoma, squamous and basal cell carcinomas, and benign skin lesions. Key model outcomes included Australian costs (2015), quality-adjusted life-years (QALYs), life-years, and counts of skin cancers. Univariate and probabilistic sensitivity analyses were undertaken to address parameter uncertainty. **Results:** The mean cost of the intervention was A$5,298 compared with A$4,684 for usual care, whereas mean QALYs were 7.58 for the intervention group and 7.77 for the usual care group. The intervention was thus inferior to usual care. When only survival gain is considered, the model predicted the intervention would cost A$1,059 per life-year saved. The likelihood that the intervention was cost-effective up to A$50,000 per QALY gained was 43.9%. The model was stable to most data estimates; nevertheless, it relies on the specificity of clinical diagnosis of skin cancers and is subject to limited health utility data for people with skin lesions. **Conclusions:** Although the intervention improved skin checking behaviors and encouraged men to seek medical advice about suspicious lesions, the overall costs and effects from also detecting more squamous and basal cell carcinomas and benign lesions outweighed the positive health gains from detecting more thin melanomas.

Keywords: benign skin lesions, cost-effectiveness, early detection, keratinocyte skin cancer, melanoma, skin examinations.

Introduction

Skin cancer is a significant public health problem in many white-skinned populations. The incidence of squamous and basal cell carcinomas (SCCs/BCCs; keratinocyte cancers) and melanoma has been increasing worldwide since the 1980s, although the incidence of melanoma may be plateauing in younger ages in the United States, Canada, and Australia [1]. Survival from melanoma is strongly negatively correlated with the extent of invasion of the tumor at diagnosis [2]. The mean 5-year survival rate after diagnosis and treatment of localized tumors is 96%, reducing to 20% for tumors that have spread to distant sites in the body [3]. Nevertheless, 2-year survival rates (~29%) have improved to 45% in some individuals with the introduction of targeted therapies (e.g., ipilimumab, dabrafenib, and pembrolizumab) for unresectable, late-stage melanomas [4]. Although it is still important to treat keratinocyte cancers, they are very common and are associated with quality-of-life impacts but do not have high mortality potential. In immunosuppressed populations such as organ transplant recipients, keratinocyte cancers are aggressive and can be fatal [5].

Despite the poor prognosis of advanced melanoma, population-wide screening for early detection of melanoma is not endorsed by most leading health authorities [6] because of lack of evidence from randomized trials of the effectiveness of screening to reduce melanoma mortality [7]. In addition, in Germany, large-scale skin cancer screening has operated since 2008 and evaluation of this program shows that it has made no improvements to melanoma mortality [8]. The introduction of any screening program must be based on strong evidence of benefit, given that screening also causes harm to a proportion of the screened population largely because of overdiagnosis and

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unnecessary treatment [9]. Risk stratification to enable targeted screening of those individuals at high risk of developing melanoma is likely to improve the value of early detection initiatives [1].

In addition to the lack of definitive evidence of benefit, there are also economic considerations. Health care expenditure for treatment of skin cancers is among the highest of all cancers in several health systems internationally [10–12] and will continue to climb with increasing skin cancer incidence and population aging. Organized melanoma screening programs are likely to incur high implementation costs on a population-wide scale, and are likely to increase the yield of (and hence cost of treating) other skin cancers and benign skin lesions that would also be detected during skin examinations. In previous skin cancer screening programs with whole-body clinical skin examination (wbCSE) [13,14], the number of excisions of suspicious skin lesions that were benign exceeded histopathologically confirmed skin cancers by fivefold [13]. In a German skin cancer screening study, 20 excisions were performed for every one melanoma found in men 65 years and older [13].

Although Australia does not have a formal population-based skin cancer screening program, informal screening is frequently carried out by general practitioners (GPs) to detect keratinocyte cancer and melanoma. Relative to other segments of the population, older men are reluctant to participate in cancer screening programs or skin examinations [15]; yet skin cancers are more common and mortality is higher in older men than in older women [15]. In response to this, the Skin Awareness Trial was undertaken to assess whether educating men older than 50 years to be skin-aware and check their own skin regularly would lead to targeted skin examinations by their GPs and subsequent earlier detection and treatment of keratinocyte cancer and melanoma [15]. As part of the overall evaluation of the intervention, a cost-effectiveness analysis was also planned [15].

Health economic studies of skin cancer prevention and early detection activities are varied and few have targeted individuals at high risk of skin cancer [16–22]. As economic analysis is relevant to any initiative proposing early detection of skin cancer, this study assessed the cost-effectiveness of the Skin Awareness Trial intervention to investigate whether the intervention would be cost-effective in the wider Australian context. A key question is whether the costs of detecting greater numbers of thin melanomas that would be expected from an early detection intervention will outweigh the inevitable costs of also finding and treating more keratinocyte cancers and benign lesions that may otherwise go undetected and, relative to melanoma, are less harmful.

Methods

Overview

A cost-effectiveness analysis was performed using data from the Skin Awareness Trial combined with data estimates from reviews of the literature. This study included both keratinocyte cancers and melanoma as the end points for screening in keeping with the intervention's goal of increasing awareness and early detection of all skin cancers and the usual clinical practice of examining skin for all types of skin cancers simultaneously. Men older than 50 years and residing in the Australian state of Queensland were selected at random from the Australian Electoral Roll (enrollment to vote is compulsory in Australia). The Skin Awareness Trial randomized 929 participants to either the intervention arm or the control arm [15]. The intervention group received an educational DVD about self-skin examination and the importance of presenting to a doctor if there were lesions of concern, postcard reminders to watch the DVD, a body chart to note down the location of skin lesions, and a colored brochure differentiating benign and malignant skin lesions. The control group received only the colored brochure. Participants completed assessments at baseline, 6 months, and 12 months. The primary outcomes were self-skin examinations, clinical skin examinations (by a GP or other doctor), self-efficacy, and perceived social support [23]. Baseline characteristics of the participants indicated that the two groups were evenly balanced with respect to demographic, socioeconomic, sun exposure, and medical history profiles with few exceptions [23].

Markov Model

A health state transition Markov model was constructed in TreeAge Pro 2015 (TreeAge Software, Inc., Williamstown, MA). The cohort model consisted of mutually exclusive health states so that men would occupy one health state at one time. The health states included 1) melanoma (then divided into in situ or invasive melanomas, the latter branching into thicknesses of <1 mm, 1.00–1.99 mm, 2.01–4.00 mm, and >4 mm); 2) SCCs/BCCs; 3) benign skin lesions; 4) no skin lesions/tumors; 5) five post–skin cancer states (one for each category of melanoma thickness and one for SCCs/BCCs); and 6) a "dead" state (Fig. 1; see also Appendix Figure 1 in Supplemental Materials found at http://dx.doi.org/10.1016/j.jval.2016.12.017). The post–skin cancer states were created to allow for follow-up care, and additional skin cancers could develop. The model tracked a cohort of men with a starting age of 64 years (mean age in the Skin Awareness Trial) through yearly cycles for their remaining lifetime, up to a maximum age of 100 years. To simulate real life, the men may move between the health states when they face different probabilities of developing skin cancers or skin lesions or they can remain in the same state (e.g., staying lesion-free). They all eventually die of a melanoma, other skin cancer, or other causes. Several probabilities (e.g., risk of developing skin cancer and mortality rates) were age-dependent as the men age in the

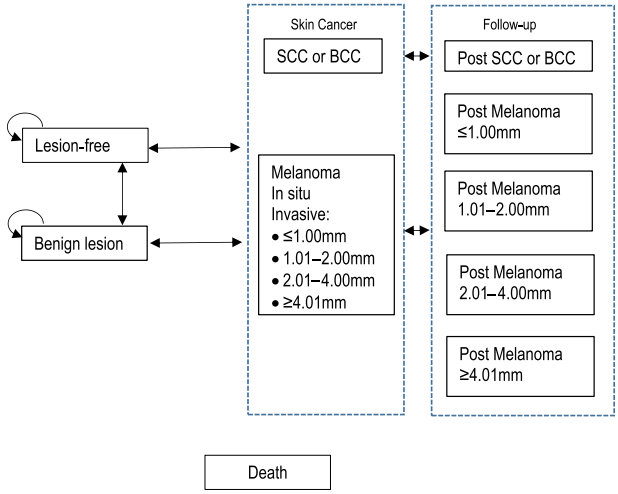

Fig. 1 – Health states used in Markov model. *Note*. **Each box is a health state in the model. If a person has skin cancer in one year, they will move to the relevant post–skin cancer health state and remain unless the person dies, has another skin cancer or benign lesion, or is lesion-free. A person can die at any time from any health state. For illustration of the Markov model in TreeAge, see Appendix Figure 1 in Supplemental Materials. BCC, basal cell carcinoma; SCC, squamous cell carcinoma.**