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Review Article

Skin cancer interventions across the cancer control continuum: A review of experimental evidence (1/1/2000–6/30/2015) and future research directions

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ABSTRACT

While the general efficacy of skin cancer interventions have been reviewed, employing the cancer control continuum would be useful to identify research gaps at specific cancer control points. We characterized the intervention evidence base for specific behavioral targets (e.g., tanning, sun protection, screening) and clinically related targets (e.g., sunburn, skin exams, cancers) at each point in the cancer control continuum. The review included articles published from 1/1/2000–6/30/15 that had an experimental design and targeted behavioral intervention in skin cancer (e.g., specific behaviors or clinically related targets). The search yielded 86 articles, including seven dissemination studies. Of the 79 non-dissemination studies, 57 exclusively targeted primary prevention behaviors, five exclusively targeted screening, 10 targeted both detection and prevention, and eight addressed cancer survivorship. Among prevention studies (n = 67), 29 (43%) targeted children and 38 (57%) targeted adults. Of the 15 screening studies, nine targeted high-risk groups (e.g., men aged ≥ 50 years) and six targeted the general population. Although research has focused on skin cancer prevention, empirically validated interventions are still needed for youth engaged in indoor tanning and for behavioral interventions to pursue change in clinically relevant targets. Research must also address detection among those at highest risk for skin cancer, amelioration of emotional distress attendant to diagnosis and treatment, and survivorship concerns. We discuss essential qualities and opportunities for intervention development and translational research to inform the field.

1. Introduction

The incidence of the most commonly fatal form of skin cancer, cutaneous melanoma, is increasing faster than any other preventable cancer (Surveillance, Epidemiology, and End Results (SEER) Program, 2015). An estimated 76,000 Americans will be diagnosed with melanoma in 2015 (American Cancer Society). Adults of all ages are at risk. For men and women ages 20–29, melanoma is one of the most common cancers. Rates have risen precipitously among middle-aged and older men and women. The mortality rate of melanoma has recently stabilized, a reflection of decreasing rates of mortality in persons younger than age 60 and sharply increasing rates among people ages 60 and above (Surveillance, Epidemiology, and End Results (SEER) Program, 2015). From 2007 to 2011, nearly 5 million adults were treated for skin cancer annually, with average treatment costs of $8.1 billion (Guy Jr et al., 2015).

The *Surgeon General's Call to Action to Prevent Skin Cancer* (SG-CTA) and other publications have identified research gaps for skin cancer prevention intervention (U.S. Department of Health and Human Services, 2014). Improving behavioral intervention and translational research requires identifying research gaps and intervention targets across the cancer control continuum (Lazovich et al., 2012). Conceptualizing skin cancer intervention across the cancer control continuum (SCI-3C) (Miller et al., 2009) can characterize the existence, or lack thereof, of intervention efficacy for specific targets across socio-ecological levels of influence (i.e., individual, family, community, and environment/policy level) along the five phases of the cancer control continuum (Fig. 1) (prevention, detection [screening], diagnosis and pre-treatment, treatment, and survivorship). Such models with distinct points in the cancer control continuum exist for physical activity and

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Cancer Control Continuum Goal	Prevention	Detection	Diagnosis	Treatment	Survivorship
Medical time-point	Prevention	Screening	Pre-treatment	Treatment	Post-treatment

Examples of Behavioral Intervention Targets

Behaviorial Targets (examples)	Sun-protection practices	Skin exam completion	Behavior-aiding treatment	Treatment adherence	Sun-protection practices, Screening
Clinically related Targets (examples)	Sunburn	Nevi	Distress	Distress, Adverse event	Quality of life, Sunburn, Recurrence

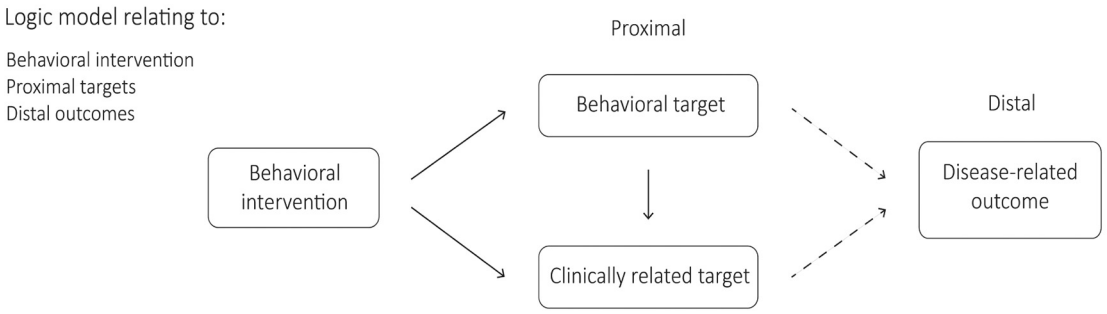

Fig. 1. Skin cancer intervention across the cancer control continuum (SCI-3C) conceptual model. The SCI-3C logic model for behavioral intervention research aligns points in the cancer-control and medical time-point continuums and attempts to identify relevant interventional target behaviors (e.g., sun protection). It also links improvements in behavioral outcomes to change in proximal clinically related targets (e.g., eliminate or reduce sunburn) that are reliably associated with skin cancer. For example, behavioral interventions may lead to changes in proximal behaviors that, in turn, affect clinically related targets that are thought to promote distal effects on disease (skin cancer) outcomes. Behavioral interventions may also lead directly to changes in proximal clinical targets (e.g., shade structure additions that does not change behavior but still reduces UV exposure). Lastly, change in some target behaviors, such as indoor tanning, may lead directly to distal skin cancer outcomes. Solid lines depict causal relationships underpinned by experimental evidence has been replicated in at least two studies, and dashed lines represent hypothesized relationships based on epidemiological data.

informatics interventions (Stange et al., 2012; Rowland, 2008; Courneya and Friedenreich, 2007) but none currently exists for skin cancer intervention research. Targets may include specific behaviors (e.g., sun protective practices, skin exams) or clinical (e.g., sunburn), observable (e.g. skin darkening), or patient reported outcomes (e.g., quality of life or distress), but they must reflect the intended result of behavior intervention.

Recently, the Community Preventive Services Taskforce evaluated the effectiveness of seven multicomponent community-wide interventions which showed a median increase in sunscreen use of 10.8 (interquartile interval = 7.3, 23.2) percentage points, a small decrease in ultraviolet radiation exposure, a decrease in indoor tanning device use of 4.0 (95% CI = 2.5, 5.5) percentage points, and mixed results for other protective behaviors (Sandhu et al., 2016). Given other meta-analyses with much smaller sample sizes that often focus on one component of the continuum (i.e., prevention), we sought to conduct an extensive, descriptive review of the extant literature with a special emphasis detailing the many components of the continuum. The study was intended as a mapping review in which the statistical significance of individual studies was of less importance than capturing the individual components of given interventions (Grant and Booth, 2009).

The objective of the current review was to describe the state of skin cancer intervention research conducted between 1/1/2000 and 6/30/2015 in order to identify research gaps and pressing questions related to specific targets along the cancer control continuum. At each point along the continuum, we group outcomes by research setting and provide information on study features. This characterization of research may communicate research needs to the behavioral research and dermatology investigative community and foster integration, coordination, and collaboration among scientists operating at different SCI levels of influence and scientific domains.

2. Methods

2.1. Search strategy and coding procedure

An electronic literature search was performed to identify studies published between 2000 and the first 6 months of 2015. The search strategy was developed in Medline and adapted for PubMed, CINAHL, Embase, and Cochrane Database of Systematic Reviews. We used a combination of MESH terms and keywords listed in the abstracts, including at least one of the terms: *melanoma*, *skin cancer*, *skin neoplasm*, *UV*, *children*, *adults*, *detection*, *counseling*, *screening*, *self-screening*, *self-examination*, *dermoscopy*, *dermatoscopy*, *early detection*, *treatment*, *policy*, *dissemination*, *prevention*, *protection*, *sun protection*, *sunscreen*, *indoor tanning/salons*, *education*, *intervention*, *experimental*, *trials*, *randomized*. Results were imported into EndNote, where duplicate removal was performed. After initial searches that did not require the words *skin cancer* to be included, subsequent combination searches, for example, counseling and sun protection, required a skin cancer related term. References used for earlier review articles were examined and a manual search of the reference lists of the retrieved articles was also performed to identify any additional studies.

2.2. Identification of eligible studies

Studies were included in this review if they met the following criteria (1) study design: randomized controlled trial or quasi-