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Climate Change & Skin Cancer

Discuss the impact of climate change on skin cancer

'Everything's gunna be alright!'

(Bob Marley - died of Melanoma - 5th November 1981)

Climate change implies a variety of different things to different people. For the purpose of this essay it shall include the popular phenomenology, 'global warming' and 'ozone depletion', that is to say, the increasing temperatures at the earths surface and levels of ultra-violet radiation (UVR) resulting from destruction of the stratosphere. Climate change as a phenomenon is disputed in some quarters whilst others suggest the changing levels of carbon dioxide and shifting weather patterns are not the consequence of man's actions (1). Irrespective of such claims meteorological trends and forecasts clearly depict increasing global temperatures and ultra violet light levels that are higher now than a century ago (2). Governments and scientists have been aware of this problem for at least three decades and are becoming increasingly conscious of the repercussions to agriculture, property and the economy (3). Longstreth's paper dating back to 1991 (4) details the cost of climate change to human health, particularly the relationship between ozone degradation (owing to man's use of chlorofluorocarbons), mounting UVR and increasing levels of skin cancer. This essay will discuss the likely challenges dermatologists will have to embrace if current epidemiological predictions are accurate.

UVR and Skin Cancer

Skin cancer is currently the most common cancer in the United States and is forecast to remain so until at least 2050. Cancer incidence statistics from the American Cancer Society and other resources were used to identify the most common cancers (35,000

cases or more). There are expected to be in excess of one million new cases of non-melanomatous skin cancer (NMSC) in the US in 2008, representing about half of all cancers diagnosed in that country. Melanomatous skin cancer on the other hand will only cause 62,480 new cases in the same time frame (5) yet is increasing yearly.

The extent to which climate change is likely to affect the incidence of these two cancer types differs (6). Cutaneous malignant melanoma is universally recognised as the most serious form of skin cancer, and accounts for 75% of skin cancer related deaths (7). The dysplastic and metaplastic changes of melanocytes that give rise to melanoma are thought to be induced by repeated exposure to UV-A/B, particularly if 'sunburn' occurs in childhood. Other risk factors for melanoma are inherent to the individual including; fair hair, people with a family history of melanoma those individuals with numerous dysplastic moles. Conversely, regular low dose UV exposure during childhood may reduce melanoma risk by stimulating melanin production (8).

Despite malignant melanoma being the most invasive form of skin cancer, squamous sell carcinoma (SCC) and basal cell carcinoma (BCC), collectively referred to as NMSC, also cause a significant burden to health services. However, the financial impact is comparatively small due to efficient management in outpatient departments and general practice (9). The causal link between UVR and the latter two forms of cancer is more concrete that for melanoma, with these cancers occurring primarily on sun exposed sites such as the face and hands and increasing in prevalence towards the equator where the ozone layer is at its thinnest. The mechanism of damage in NMSC is a direct result of UVB degradation of DNA through the dimerisation of thymine

('classical CT mutation'). The mutations are propagated upon mitotic replication of the cells and have been clearly demonstrated in bacterial cultures exposed to UV and via genetic analysis of human skin cancer cells (10). This mechanism contrasts to that of melanoma formation, where UVA is thought to cause DNA mutation indirectly by forming oxidative species in the dermis (11).

The second main way climate change has been postulated to increase skin cancer is through increased temperature. Bain *et al.*, based this hypothesis on findings from skin tumour formation in rats kept at different temperatures. However, this research suffers from the fact assumptions have to be made regarding reproducibility of animal studies in humans. Additionally, the relationship between temperature and skin cancer are not linear and only occur at temperatures above 30°C. Although this does not exclude a causal relationship between the two variables it seems that increasing levels of UVR may be more influential (12). A study by van der Leun and Gruijl (13) also suggests the effects of temperature are likely to be more readily negated in a developed country owing to the prevalence of air conditioning - rather ironic, given it is the use of the air conditioning systems that is contributing to climate change!

Epidemiology

Epidemiological analyses of skin cancer reveals many salient points. First, increasing life expectancy in the developed world provides more time for sun damage to manifest as cancer (14), and BCC and SCC in particular mainly afflict the over 50's (15). Second, at present skin cancers occur more frequently near the equator, despite the populations at these latitudes having generally higher pigment levels (a protective factor). The thinning of the ozone layer associated with climate change will lead to

UVR in the UK approaching levels currently experienced in equatorial regions. Given that the majority of the population in the Northern Hemisphere are Caucasian one can extrapolate that the problems with skin cancer are likely to be magnified even further. (16). Third, current forecasts suggest that within the coming century there is likely to be a peak in skin cancer rates although this is unlikely to occur before 2015 (17). Reasons for this would include the positive fact that recent assessments show UVR levels to be stabilising (18) possibly as a result of worldwide recognition of climate change. The uptake of public health initiatives by the public will also have had time to take effect, as in Australia where the 'Slip, Slap, Slop' campaign is starting to show signs of having a beneficial effect on skin cancer numbers.

Australia and Chile are affected by high level UVR due to their inclusion in the Antarctic O-zone hole and are perfect case studies for skin cancer, particularly Australia where the demographic is reflective of European countries. In addition the level of economic development parallels that of the North West hemisphere so the effect of similar pre emptive public health schemes can also be assessed. Chile was studied (19) over a 13 year period during which melanomatous skin cancer rose by 56% while NMSC increased by 46% despite still accounting for 80% of the total skin cancer incidence. These changes were paralleled with decreasing ozone layer thickness and increased UVB. Australia invests almost 300 million Australian dollars per annum in the treatment of skin cancer alone. This compares to just over £190 million in the UK of which actual NHS treatment costs are though to be in the region of approximately £70 million (20). Once could interpolate that the UK investments must at present be proportionally skewed towards public health awareness campaigns with the additional cost in Australia resulting from treatment costs. It is likely that UK

treatment costs will rise as skin cancer incidence increases to numbers encountered in Australia and thus financial preparations will be required to ensure that challenges can be met (21). Other sources do, however, highlight that the high frequency of NMSC means that although it was the most expensive cancer, it had the lowest cost per case (around $700 per NMSC removed).

The current exponential increase in global population is primarily due to the high birth rates of Africa and India. As these races have higher levels of pigmentation they are less prone to acquiring sun induced skin change. Additionally, the lower life expectancy of India and many African countries due to poorer access to medical care means skin cancer has less time to occur. Both these facts *may* mean that climate changes effect on skin cancer will remain proportionally similar when analysed on a global level. However, this is only a hypothesis and the greater weight of evidence favours the opposite outcome. Particularly in light of the fact although darker skin does provide some protective benefit when cancer does occur it is usually more likely to be fatal as it is both less expected and more prone to ulcerate the overlying epidermis (22).

Dermatologists will be at the forefront of dealing with the increasing burden of disease. Already, skin cancer accounts for 60% of all referrals to the dermatology out patient department in Oxford. The number of cases of melanoma has increased from 101 (2001) to 208 (2007) (23). In the UK, recent government directives regarding two-week urgent and 18 week non-urgent waiting times (24) mean more senior dermatology posts are likely to have to be made available in order to keep pace. Additionally, general practitioners will be expected to treat as well diagnose BCCs where lack of invasion into surrounding tissue means fewer surgical facilities and

equipment are required for tumour excision. Such speculation seems legitimate in light of the current treatment options available to physicians, however, if radical advances are made these problems may not be relevant.

Reasons for Positivity

Examples of recent developments include, CP94 augmented photodynamic therapy for BCC (25) and 'immune priming', the modulation of helper T-cell signalling to cure melanoma (26), both of which clearly demonstrate how a growing awareness of the repercussions of climate change are fuelling research into alternative treatments of skin cancer. Hopefully continuing progress in dermatological and oncological treatments will negate doom and gloom predictions of increasing skin cancer prevalence in the coming years by providing fast and affordable management. It is also worth considering the beneficial effects of UVR which will also increase with climate change. Most notable is the activation of vitamin D which has a directly protective role against the formation of melanoma (27). Indirectly, and albeit somewhat over optimistically, increased vitamin D levels are also likely to reduce the incidence of osteoporosis which is also an increasing drain upon medical resources due to the ageing population of Northern Hemisphere countries (28). Although such hopes can be seen as naive given very mild UVR exposure is sufficient to meet vitamin D requirements, more sunshine could well reduce the incidence of Seasonal Affective Disorder (SAD) which is important given the scale of mild to moderate depression in developed countries and also encourage more people to spend greater time outside being active.

One must also consider that the effect on air quality will mean respiratory illness will probably be a more profound manifestation of climate change than skin cancer (29). The pursuit of perceived beauty through the use of sun beds may also reduce the proportion of skin cancer for which climate change *alone* is responsible (30). Finally, recent reports suggest UVR is peaking due to government initiatives to control pollution such as the Montreal Protocol all of which mean there is reason to remain hopeful about the effect of climate change.

In conclusion, climate change has, is and will continue to compound the increase risk of skin cancer, particularly in the Northern Hemisphere. As a result of this, research will need to pursue further innovative treatments for all types of skin cancer and dermatologists will have to maintain vigilance for suspicious naevi so that current treatments can be implemented quickly. Epidemiological studies also highlight the importance of instigating public health measures which, by educating the public to enjoy the sun in a sensible fashion will help to reduce the current increase in skin cancer. Bob Marley, the legendary reggae musician, who died of malignant melanoma aged just 43 wrote a song called No Woman No Cry containing the lyric, "Everything's gunna be alright." In his case this was unfortunately nothing more than prophetic irony. However, for the rest of us it eloquently summarises the weight of current evidence that, although climate change is in part responsible for increasing skin cancer, the combined efforts of health care teams world wide are helping to reduce the potential impact it may otherwise have had.

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