

SKIN DISEASES CAUSED BY ULTRAVIOLET RADIATION: THE COST OF ILLNESS

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Abstract

Objectives: To assess the annual direct and indirect costs of skin diseases caused by ultraviolet radiation.

Methods: A model for cost-of-illness, including costs for hospital care, primary care, pharmaceuticals, mortality, and morbidity, for approximately 1.8 million inhabitants in Stockholm.

Results: The total annual discounted cost-of-illness in Stockholm was approximately 162 million SEK (MSEK; approximate 2002 exchange rate: 1 U.S. dollar = 10 SEK). The indirect costs were predominant and constituted approximately 91 MSEK (56% of total costs), mainly due to an estimated cost of mortality for cutaneous malignant melanoma of 84 MSEK. The direct costs of these diseases, approximately 71 MSEK, were predominated by hospital ambulatory care costs of approximately 33 MSEK. The direct costs constituted approximately 0.4% of the overall health-care costs for hospital care and primary health care in the area.

Conclusions: Skin diseases caused by ultraviolet radiation result in moderate economic losses in the community. Therefore, it may not be easy to make successful prevention of these diseases economically beneficial.

Keywords: Cost of illness, skin cancer, melanoma, primary prevention.

Solar and artificial ultraviolet radiation (UVR) exposure is a well-known etiological factor in cutaneous malignant melanoma (CMM), basal cell carcinoma (BCC), cutaneous squamous cell carcinoma of the skin (CSCC), actinic keratosis (AK), and melanocytic nevi (MN) (1;20). CMM and CSCC are both very common malignant tumors of the skin. They have been among the most rapidly increasing malignant tumors in Sweden over the past 20-year period (7;15). The incidence of CMM in Sweden has been estimated at 18.1 cases per 100,000 population per year, and it is increasing by approximately 2.4% annually (7). The incidence of BCC in Sweden is increasing annually by approximately 11.9% and that of CSCC (registered as nonmelanoma skin cancer) by approximately 4.1% (7;19), but these diseases have a lower morbidity and mortality.

The steady increase in the incidence of UVR-caused diseases and the well-known etiology emphasize the importance of prevention (14). Cost-reduction strategies in health care must include efforts to enhance both primary prevention (reduction of UVR exposure) and secondary prevention (early detection) (18). An increased survival from CMM has been reported and is attributed to early detection (3). Consequently, concern about diseases caused by UVR has attracted increased interest in the medical profession and in the community. Public education campaigns are considered an effective approach for both primary and

secondary prevention (4;8;9). The long-term effect of primary prevention is uncertain (2). However, an Australian study showed an effect on both behavior and prevention (12).

An economic evaluation of prevention activities must comprise an evaluation of the cost-of-illness of these skin diseases, including a full analysis of all costs generated, which depend on a variety of probabilities. In this study, we attempt to estimate the annual cost-of-illness of UVR-caused skin diseases. This estimate includes the direct health-care costs for diagnosing, treatment, and secondary prevention, and the indirect costs caused by morbidity and mortality.

MATERIALS AND METHODS

Scope

The study concerns data from 1999 relating to approximately 1.8 million inhabitants in Stockholm County, approximately one-fifth of the total population of Sweden. The analysis was performed from the perspective of health-care providers as well as society. Accordingly, both direct and indirect costs were considered. The ICD-10 diagnoses included were CMM, melanoma in situ (MIS), cancer in situ in skin (CIS), BCC, CSCC, AK, and MN (including dysplastic nevi). The difference between a nevus and a CMM can only be determined by a clinical and histological examination. Therefore, the costs for control and removal of nevi in primary health care were included in the cost-of-illness, as they are included in secondary prevention for the diagnoses concerned.

Costing

To estimate the economic burden of these diseases, we used a model for direct and indirect cost-of-illness (5). We used a cost-of-illness approach based on the prevalence (as seen in the health-care system) of these diseases. This strategy has the advantage of relating to measures of total annual health-care expenditure. Furthermore, we used a top-down method of calculating the costs of illness, partitioning the total cost of illness among different diseases (10). This approach requires reliable data on the use of health-care resources and illness-related absenteeism and disability in relation to these diseases. Costs related to reduction of quality of life are not estimated. All costs are in 1999 SEK (Swedish Kronor) (approximate 1999 exchange rate: 1 U.S. dollar = 10 SEK).

Direct Costs

This study includes direct costs that could be identified and measured at point of care in the health-care system: the costs of detection, treatment, secondary prevention, and long-term care. Our measures include costs for hospital inpatient care, hospital ambulatory care, primary health care, and pharmaceuticals. Long-term care provided by the municipalities was not included, because those costs were considered marginal for the diseases considered in this study.

Data regarding hospital inpatient and ambulatory care were available from a database of diagnosis-related production statistics at the Stockholm County Council. The costs of inpatient care were based on data on diagnosis-related group discharge statistics. The costs for ambulatory care were based on the registered numbers and types of encounters for the included diagnoses.

Diagnosis-related costs for primary health care were not a part of the production statistics at the Stockholm County Council. As primary health care in Stockholm is based on health-care centers with registered population lists, we used statistics from patient records as an estimate of costs for these diseases. These costs were estimated using figures from a retrospective study on electronic patient records at the “Skytteholm Health Care Centre” in

Stockholm, with a registered population of 7,614 individuals and an age distribution similar to that in the county as a whole. The average cost per encounter in primary health care in 1999, excluding excision biopsy, was available from the Stockholm County Council. The additional costs for excision biopsy were based on the price level in the county in 2000.

Costs for pharmacological treatments were included only for treatment of CMM with cytostatics, which is normally given in hospital ambulatory care but not included in these costs. Based on regional treatment protocols, we assumed that, for all new severe cases of CMM (group I), 75% of patients were given dacarbazine, and the remaining 25% were given temozolomide. It was assumed that, on average, all these patients underwent six courses of treatment. Costs for antiemetics and corticosteroids were based on average prescription figures. Other diagnoses were considered marginal in terms of pharmacological treatment costs. Direct costs arising from outside the health-care system, for example, costs for home-help service and transportation, were excluded from the estimate because of the lack of diagnosis-related data, and because we considered them marginal.

Indirect Costs

In theory, indirect costs arise from all production losses resulting from short-term absence from work, early retirement pensions, and loss of production because of mortality (11). Indirect costs were calculated for costs related to CMM, BCC, and CSCC. The other diagnoses were not included in the indirect costs as they were considered to generate only minor indirect costs.

Data on short-term absence from work were based on diagnosis-related production statistics from the Stockholm County Council, as these data were not available for specific diagnoses from the Swedish National Social Insurance Board. The costs were also based on average salaries in Stockholm County, which were obtained from Statistics Sweden (16). The number of bed-days for hospital inpatient care for CMM, BCC, and CSCC were used to estimate these costs. Based on regional treatment protocols and clinical follow-up data for CMM, we assumed that there was a short-term absence from work of from 1 week to 6 months in the four clinical stages of CMM.

Costs for early retirement pensions were not included due to lack of age-related data on these diagnoses from the Swedish National Social Insurance Board. The costs for loss of production due to mortality were based on age- and gender-correlated data on average number of years of work until retirement for these patients. These costs were based on mortality figures and average age- and gender-related salaries in the area that were available from Statistics Sweden (16), and a 3% discount rate was applied to these cost figures (6).

Background Data

The total annual health-care costs in the area (pharmaceuticals excluded) are estimated at approximately 16,919 million SEK (MSEK), on average approximately 9,400 SEK per inhabitant (13). These figures include hospital inpatient care (11,803 MSEK), hospital ambulatory care (5,116 MSEK), and primary health care (4,404 MSEK).

There were 290 newly diagnosed cases of CMM in Stockholm County in 1999, 500 of CSCC, 100 of MIS, and 805 of CIS. The yearly incidence of BCC in the area was estimated at approximately 5,000. The total number of individuals treated for these diseases was 26,484, thereof 14,479 in hospital care and 17,538 in primary health care (some patients were treated in both settings) (Table 1). CMM, BCC, CSCC, and AK were the main diagnoses in hospital care, whereas MN was predominant in primary health care.

Table 1. Number and Characteristics of Patients Treated for Skin Diseases Caused by UVR Exposure in Hospital Care and Primary Health Care Among 26,848 Inhabitants in Stockholm in 1999

Setting/subgroup	CMM	BCC/CSCC	MIS/CIS	MN	AK	Total
Hospital care	2,785	4,650	585	3,631	2,828	14,479
Inpatient care	223	179	5	11	0	418
Ambulatory care	2,562	4,471	579	3,620	2,828	14,061
Primary health care	692	1,385	0	14,538	923	17,538
Total number of individuals ^a	2,785	4,972	585	15,261	3,290	26,848
Age group 0–64 yr	1,550	1,413	216	13,624	571	17,374
Age group 65+ yr	1,235	3,559	369	1,637	2,719	9,518
Percentages of women (%)	51.0	51.9	59.0	64.5	52.8	59.3
Percentages of the population (%)	0.15	0.28	0.03	0.85	0.18	1.49

Note: UVR, ultraviolet radiation; CMM, cutaneous melanoma; BCC, basal cell carcinoma; CSCC, cutaneous squamous cell carcinoma of the skin; MIS, melanoma in situ; CIS, cancer in situ in the skin; MN, melanocytic nevi; and AK, actinic keratosis.

^a Some patients were treated in both hospital and primary health-care settings.

RESULTS

Direct Costs

Hospital Care. The cost for hospital inpatient care (CMM, CSCC, and BCC) was 16.5 MSEK, and for CMM only it was 10.7 MSEK (Table 2). The average cost for these hospital inpatients was 39,300 SEK per year. The total cost for hospital ambulatory care was 33.3 MSEK (Table 2). The average cost for these hospital ambulatory patients was 2,300 SEK per year.

Primary Health Care. In the retrospective database study, we found 107 encounters (0.9% of all encounters) during a 1-year period that concerned the selected diagnoses (89 concerned MN). Approximately 25% were encounters in which an excision biopsy was performed, with an estimated cost of 850 SEK per encounter. Approximately 57% were encounters without excision biopsy, with an estimated cost of 450 SEK each. Finally, 18%

Table 2. Annual Direct and Indirect Costs of Illness (Skin Diseases Caused by UVR Exposure) Among 26,848 Inhabitants in Stockholm in 1999, presented in SEK 1000

Type of Cost	CMM	BCC/CSCC	MIS/CIS	MN	AK	Total
Hospital inpatient care	10,674	5,154	382	240	0	16,452
Hospital ambulatory care	11,239	11,138	1,243	5,106	4,557	33,282
Primary health care	404	1,292	0	17,525	888	20,112
Pharmaceuticals	1,285	–	–	–	–	1,285
Total direct costs	23,604	17,584	1,626	22,873	5,445	71,131
Mortality ^a	84,286	4,200	0	0	0	88,486
Morbidity	2,479	294	–	–	–	2,773
Total indirect costs	86,765	4,494	–	–	–	91,258
Total costs	110,369	22,078	1,626	22,873	5,445	162,390
Average cost per inhabitant	4.1	1.2	0.1	1.3	0.3	9.0

Note: UVR, ultraviolet radiation; CMM, cutaneous melanoma; BCC, basal cell carcinoma; CSCC, cutaneous squamous cell carcinoma of the skin; MIS, melanoma in situ; CIS, cancer in situ in the skin; MN, melanocytic nevi; and AK, actinic keratosis.

^a Discounted by 3%.

were other than face-to-face encounters, with a cost estimated at 180 SEK each. The total cost for primary health care was estimated at 20.1 MSEK (encounter costs 19.0 MSEK and biopsy analysis 1.1 MSEK), and this mainly concerned MN (Table 2).

Pharmacological Treatments. The total cost for pharmacological treatment, as defined above, was estimated at 1.3 MSEK for CMM (Table 2). The cost for temozolomide was 0.8 MSEK (15,500 SEK per treatment period), for dacarbazine it was 0.3 MSEK (1,900 SEK per treatment period), and for antiemetics and corticosteroids it was 0.2 MSEK.

Indirect Costs

Short-term Absence from Work. The total cost for short-term absence from work was estimated at 2.8 MSEK and was mainly due to CMM (Table 2). The costs for absence up to 1 week was 1.7 MSEK, for more than 1 week up to 1 month it was 0.6 MSEK, and for more than 1 month up to 6 months it was 0.5 MSEK.

Lost Production Due to Mortality. In 1999, sixty-four patients died from CMM and eleven from BCC/CSCC. Of those, twelve died at twenty to forty-nine years of age and seventeen at fifty to sixty-four years of age, and their production losses in 1999 (discounted) amounted to 61.8 MSEK and 26.7 MSEK, respectively (a total of 88.5 MSEK) (Table 2).

Total Costs

In 1999, the total annual cost-of-illness (direct and indirect) for skin diseases caused by UVR exposure was approximately 162.4 MSEK in Stockholm (Table 2). The indirect costs, at approximately 56% of total costs, were somewhat greater than the direct costs, and pharmaceutical costs and costs for short-term absence from work were minimal by comparison. The direct costs for these diseases constituted approximately 0.4% of the overall direct health-care costs (16,919 million SEK) in the area (pharmaceuticals excluded). The annual average costs per patient were approximately 6,000 SEK per year (Table 2). When comparing diagnosis-related costs, CMM was predominant with approximately 68% of total costs, mainly due to the cost of mortality, which was 88.5 MSEK.

DISCUSSION

We have used a cost-of-illness approach to calculate the economic burden of skin diseases caused by UVR exposure in Stockholm in 1999. The costs were moderate, but given the rising incidences of these diseases, the potential for cost increases in the future is significant.

Models differing both in purpose and design are available for estimating cost-of-illness. The cost model in this study evaluates expenditures over time involving medical conditions known to be caused by UVR exposure, and this study is thus an economic burden analysis. Reductions in quality of life must be added to these “economic” costs.

To our knowledge, no studies have examined the economic impact of these skin diseases as a whole. This approach seems relevant for use in an upcoming cost-effectiveness study in the area, as the effect of all these diagnoses should be considered. Furthermore, the inclusion of indirect costs is advantageous in the analysis of total economic burden, as the economic burden of prevention campaigns concerns the whole community.

This study investigated cost-of-illness mainly by using data sources from day-to-day health care with a top-down approach. This is a straightforward approach, and we consider that the double counting of costs has been avoided in our study. However, this approach may underestimate the true costs, because some of the diagnosis-related data are probably missing in day-to-day health-care registration in both hospital ambulatory care and primary health care.

How indirect costs are defined and estimated is in some respects controversial. When estimating these costs, we have used the traditional human capital theory, which has been criticized, and may have resulted in uncertainties and underestimations in our study. The salaries used to calculate production losses have also been questioned, but in our study, they are based on regional salaries with actual by age and gender distribution.

The data sources are considered valid, as all hospitals and primary health-care centres are run by the county council. These figures could be underestimations, however, as a result of private dermatologists being financed directly by the Swedish National Social Insurance Board. However, we think that this is a relatively small factor. Furthermore, only CMM was included in the indirect costs, and costs for early retirement pensions were not included at all, which would have further underestimated the costs. Diseases in other organ systems (for example, cataracts) and certain skin diseases (for example, lentigo solaris) that could be considered as being caused by UVR were excluded. The limitations regarding diagnoses could also lead to an underestimation. However, we believe that we have covered the vast majority of clinically relevant diseases.

In constructing a model for prevention and management of these diseases, estimating the total cost-of-illness is of central importance. As prevention strategies include both reduction of UVR exposure and earlier detection, cost-effectiveness is complex. The effect of primary prevention is also difficult to estimate due to the long time span of the effect.

Public awareness of skin cancer caused by UVR and the increase in primary prevention are generating costs in primary health care. The proportion of deeply invasive CMM has diminished in Sweden, as is also the case in other countries (17). Thus, the potential for increased early detection, therefore, is probably smaller than for primary prevention.

POLICY IMPLICATIONS

UVR-caused skin diseases were found to cause moderate economic losses in the community. However, the potential for cost increases in the future is significant. Successful primary and secondary prevention of these diseases could be clinically far-reaching, but it may not be easy to make this prevention economically beneficial. The cost-effectiveness of a planned educational campaign for reduction of UVR exposure and early detection of related skin diseases in Stockholm needs to be assessed, and this is the focus of an upcoming study.

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