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Skin cancer healthcare impact: A nation-wide assessment of an administrative database

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ABSTRACT

Background: Skin cancer is an important health concern, with an increasing incidence worldwide.
Objective: To assess the clinical and economic burden of melanoma (MM) and non-melanoma skin cancer (NMSC) at public hospitals in mainland Portugal.
Methods: We used an administrative database containing a registration of all hospitalizations and ambulatory episodes occurred in Portuguese public hospitals between 2011 and 2015. We assessed all episodes with associated diagnoses of MM or NMSC regarding neoplasm location, metastases occurrence, length of stay, in-hospital mortality and hospital costs.
Results: We assessed 15,913 MM and 72,602 NMSC episodes. 14.3% of MM episodes presented with metastases, compared to 1.9% of NMSC episodes. Patients' median age was lower for MM (66 years) than NMSC (76 years). The trunk was the most common location for MM (32.5%), followed by the lower limbs (26.5%). NMSC presented with higher length of stay than MM (median 5 *versus* 4 days; $p < 0.001$), but with lower in-hospital mortality (7.3% *versus* 11.9%; $p < 0.001$). MM episodes had higher average hospital costs than NMSC episodes (1197.7 *versus* 1113.5 €; $p < 0.001$). Overall, NMSC episodes amounted a total of 80.8 million € in hospital costs *versus* 19.1 million € for MM episodes.
Conclusion: Skin neoplasms have substantial impact on healthcare services. NMSC is an important contributor to this burden. NMSC underreporting should be tackled and it should not be downplayed in skin cancer preventative strategies.

1. Introduction

The skin is the most common location of primary malignant neoplasms [1]. In fact, skin cancer has a higher incidence than all other cancers combined [2].

Despite encompassing less than 5% of all skin cancers, melanoma (MM) is responsible in Europe for more than 80% of skin cancer mortality [3], accounting for 1–2% of all cancer deaths [4,5]. According to the European Network of Cancer Registries (ENCR), more than 20 thousand deaths were estimated for MM in Europe in 2008, the largest share (35.5%) for Eastern and Central Europe [5]. Outside Europe, the highest rates of MM incidence are reported in other Caucasian and migrant populations, such as Europeans in Australia and New Zealand, where the annual incidence is more than double the highest rates in Europe [6,7]. Non-melanoma skin cancer (NMSC) incidence is also rising. This condition is often the cause of severe deformation and morbidity. Despite being rarely lethal, NMSC is so common that a relevant number of patients die annually from it, particularly those with advanced squamous cell carcinomas (SSC) [8]. Most NMSC (75–85%) are basal cell carcinomas (BCC), while 15–25% of them are SSC [9].

Overall, not only the incidence, but also the associated costs of skin cancer are increasing. The average annual total cost of skin cancer rose 126.2% in less than ten years in the United States, while the average annual total cost for all other types of cancer rose only by 25.1% [10]. Multiple factors may justify this substantial increment, namely the increase in the incidence of MM and NMSC, awareness of the population with higher diagnostic confirmations and the development of expensive medical treatments. Costs associated with skin cancer treatment are expected to continue to rise, increasing its economic impact for health services [11–15].

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Notwithstanding its frequency and importance, the epidemiology and health services impact of skin cancer remains insufficiently studied. Therefore, this study aims at assessing the clinical epidemiology and economic burden of MM and NMSC – particularly concerning their hospital costs, length of stay and in-hospital mortality – by analyzing an administrative database containing a registration of all public hospital episodes occurring in mainland Portugal from 2011 to 2015.

2. Methods

We assessed the administrative database containing a registration of all episodes (comprising hospitalizations and ambulatory episodes) occurred in public hospitals in Mainland Portugal between January 1, 2011 and December 31, 2015. This database was provided by the Portuguese Healthcare System Central Administration (*Administração Central do Sistema de Saúde*). For every episode, the database contains information regarding the respective main diagnosis (clinical condition responsible for patient's admission) and accessory diagnoses; diagnoses had been coded after discharge with International Classification of Diseases, 9th Clinical Modification (ICD-9-CM) codes. In order to assess episodes with associated diagnosis of malignant neoplasm of skin, we identified all hospitalizations flagged with the ICD-9-CM codes 172.x and 173.x as main or accessory diagnosis. These codes correspond, respectively, to the diagnoses of "MM of skin" and "other malignant neoplasm of skin".

We compared MM and NMSC hospitalizations and ambulatory episodes over their annual frequencies, inpatients' age and sex distributions, hospital costs (costs were indirectly calculated for each hospitalization and ambulatory episode, using a classification system based on Diagnosis Related Groups – All Patient (AP-) DRG Version 27 –, which mostly takes into account diagnoses, performed procedures, and inpatients' demographic characteristics), length of stay, and in-hospital mortality (these latter two variables only concern hospitalizations, but not ambulatory episodes). Hospitalizations were defined as episodes with hospital stays lasting for at least 24 h, while ambulatory episodes encompass medical diagnosis and/or therapeutic procedures lasting less than 24 h [16]. Subgroup analyses were performed for those episodes classified with "skin-cancer related DRG" (as those were episodes for which skin cancer was probably the main condition) - these DRG are listed in Supplementary Table 1. Additionally, for each type of skin cancer, we determined the frequency of episodes according to the anatomic location, occurrence and location of metastases, and performed procedures. For NMSC episodes, we performed separate analyses for BCC and SCC; nevertheless, information on the subtype of NMSC was only available for the period between 2013 and 2015.

We were able to estimate the number of individual patients by identifying episodes which shared the same patient's number, sex, birthdate and residence. We subsequently estimated the frequency of patients with MM and NMSC treated in public hospitals per 100,000 inhabitants (population data was provided by the National Institute of Statistics) [17], as well as average costs *per* patient (total costs – as calculated for hospitalization and ambulatory episodes – were divided by the number of patients). Additionally, we assessed the frequency of patients with skin cancer in each anatomical location according to their sex and age.

Categorical variables were described using absolute and relative frequencies; continuous variables were described using means and standard deviations or medians and interquartile ranges. Categorical variables were compared using the chi-square test, while continuous variables were compared using the Mann-Whitney U test. We performed linear regressions to identify variables associated with increased costs of melanoma and NMSC – independent variables (namely, sex, age, type of episode, presence of metastases, and neoplasm location and subtype) were firstly tested individually with simple linear regressions. Independent variables with marginal association ($p < 0.10$) with hospital costs were subsequently introduced in multiple linear regression models. Statistical analyses were performed using IBM SPSS Statistics®, version 24 (IBM, Armonk, NY).

Table 1
Characteristics of hospitalizations and ambulatory episodes with associated diagnosis of melanoma and non-melanoma skin cancer (NMSC) (Mainland Portugal; 2011–2015).

	Melanoma (n = 15,913)	NMSC (n = 72,602)	p value
Sex – females – n (%)	7986 (50.2)	35,267 (48.6)	< 0.001
Age (years) – median (Q1–Q3)	66 (55–75)	76 (67–83)	< 0.001
Hospital costs (€) – mean (SD) [median (IQR)]	1197.7 (2937.3) [723.7 (758.7)]	1113.5 (2390.9) [1255.0 (531.3)]	< 0.001
Hospitalization episodes[a]	2417.1 (5084.2) [1089.9 (1384.3)]	2563.1 (6715.3) [1535.5 (1384.3)]	0.017
Ambulatory episodes[b]	668.4 (476.7) [496.3 (758.7)]	929.0 (634.6) [1255.0 (531.3)]	< 0.001
Length of stay (days)[a] – mean (SD) [median (Q1–Q3)]	7.3 (12.3) [4 (2–8)]	9.0 (14.6) [5 (2–10)]	< 0.001
In-hospital mortality[a] – n (%)	575 (11.9)	603 (7.3)	< 0.001
Performed procedures[c] – n (%)			
Chemotherapy injection	5115 (32.1)	1232 (1.7)	< 0.001
Radiotherapy	1707 (10.7)	11,818 (16.3)	< 0.001
Antineoplastic biological response modifiers	283 (1.8)	113 (0.2)	< 0.001
Local excision	1720 (10.8)	18,434 (25.4)	< 0.001
Radical excision	4724 (29.7)	28,686 (39.5)	< 0.001

IQR = interquartile range; Q1 = 1st quartile; Q3 = 3rd quartile; SD = standard-deviation.
[a] These data concern hospitalization episodes only (n = 4817 for melanoma; n = 8198 for non-melanoma).
[b] These data concern ambulatory episodes only (n = 11,096 for melanoma; n = 64,404 for non-melanoma).
[c] ICD-9-CM codes for performed procedures were: Chemotherapy injection: 99.25; Radiotherapy: 92.2; Antineoplastic biological response modifiers: 99.28; Local excision: 86.3; Radical excision: 86.4.

3. Results

Between 2011 and 2015, there were 15,913 episodes with associated diagnosis of MM and 72,602 of NMSC (Table 1). During that period, there were, in total, 9,048,742 hospitalizations and ambulatory episodes recorded in the database. This corresponds to a frequency of 0.2% episodes with diagnosis of MM, and of 0.8% of NMSC. Among the latter, BCC comprised 72.0% of episodes occurring between 2013 and 2015 (n = 28,691), SCC stood for 25.4% (n = 10,103), and the remaining 2.6% episodes corresponded to NMSC of non-specified subtype (n = 1036) (Table 2). Hospitalizations represented 30.3% of all MM episodes and 11.3% of all NMSC episodes. These episodes occurred in 52,046 different patients with skin cancer, of whom 6567 had a diagnosis of MM, - corresponding to an average yearly incidence estimation of 13.2 cases/100,000 inhabitants (average of 2.4 episodes *per* patient). For NMSC, we identified 45,479 patients, with an average yearly incidence estimation of 91.6 cases/100,000 inhabitants (1.6 episodes *per* patient). We observed a higher average yearly incidence for BCC (95.9 cases/100,000 inhabitants; 1.2 episodes *per* patient) than for SCC (33.8 cases/100,000 inhabitants; 1.3 episodes *per* patient).

Median age was lower for MM (66 years) than for NMSC (76 years) episodes ($p < 0.001$). Among the latter, SCC episodes had a higher median age than those with BCC (80 years *versus* 75 years; $p < 0.001$). The trunk was the most common location for MM, comprising 32.5% of episodes in which the neoplasm location was reported (Table 3). Additionally, 14.3% of MM episodes presented with metastases, the most common involved sites being the lymph nodes (56.7% of all metastatic MM), the lungs and other respiratory organs (28.0%), and the central nervous system (22.7%) (Table 3). For NMSC, the face was the most common location (67.0%) both for SCC (61.3%) and BCC (70.7%)