

MESTRADO
INFORMÁTICA MÉDICA

Queimados.pt: an enhanced Web-based Information System for burns

Pedro Rocha

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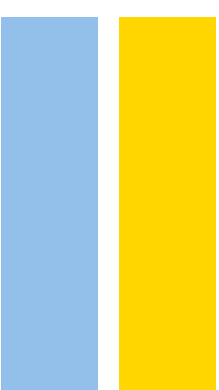
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“Energy and persistency conquer all things”

Benjamin Franklin

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Abstract

Burn injuries are a very serious health issue globally, but the incidence can be decreased through prevention. Children, women and elderly people are the ones with the highest incidence rate of suffering burn injuries. Internet has become the leading source of knowledge of world population for all kinds of situation, including healthcare. Health related searches on Google search engine represent 20% of global searches each day although several websites provide inaccurate and misleading information.

During the realization of this thesis, a web information service with burn injuries contents, was developed. The main objective was to develop a tool that could provide accurate and trustful information to the Portuguese community. This web information system was developed after analysing similar tools, both Portuguese and foreigner. The existent methods used to add credibility and trust to this kind of platforms was also included on the developed tool: queimados.pt

An article intituled “Google/Online trends in searching for burns: a global, cross-country and time trends analyses” was developed in the scope of this project and submitted to Burns Journal. The objective was to evaluate the usefulness of burns information on the internet based on Google searches made by internet users around the world and try to detect seasonality. A comparison was made between burn related searches and other medical conditions like influenza, cancer and myocardial infarction to investigate the Relative Search Volume.

Queimados.pt is going to be promoted on burn centres in Portugal both to patients and medical staff to try to decrease burn injuries in the Portuguese society.

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List of Abbreviations

Cintesis	Center for Health Technology and Services Research
CPR	Cardio-Pulmonary Resuscitation
CRW	Cool Running Water
CSS	Cascading Style Sheets
DALY	Disability Adjusted Life Years
FMUP	Faculty of Medicine of Porto University
GDB	Global Burden of Diseases
GDP	Gross Domestic Product
GT	Google Trends
HON	Health On the Net
ICT	Information and Communication Technology
ITU	International Telecommunications Union
LDC	Least Developed Countries
NGO	NonGovernmental Organizations
PHP	PHP: Hypertext Preprocessor
RSV	Relative Search Volume
TBSA	Total Body Surface Area
UL	Underwriters Laboratories
UML	Unified Modeling Language
WHO	World Health Organization

Introduction

Burn injuries are one of the most traumatic experiences a human being can go through and the aftereffects are very serious, both physical and emotional with substantial loss of quality of life [1]. According to World Health Organization (WHO) 265,000 deaths occur each year from fires alone, excluding deaths from other aetiologies like scalds, electrical or contact burns. About 180,000 deaths occur every year caused by burns. Non-fatal injuries are also a leading cause of morbidity [2][3]. However burn injuries can be prevented as they occur mainly in home and workplace [4]. Burns incidence is particularly high on low and middle income countries, while the burn numbers are decreasing on high income countries [2].

Living on an era that the access to information is easier than ever, the internet has become the master reference to search information online about all kind of subjects, namely, health care [5]. Several studies revealed that even medical class believes the internet is the best way to transmit burn prevention information rather than release sessions or hospital sensitization sessions [6]. Despite the risks, it is also the easier way to promote behaviour changes or passing on knowledge from medical staff to patients [7].

Young parents turn more and more to internet to search prevention and health care for their children. The new generation of parents rely more on the new technologies rather they do on family and friends advices much because of the larger range of opinions and suggestions the internet provides, or just because internet searches become a habit [8]. Statistics show that, in average, 1889 burned children are admitted on hospitals in Portugal. 20% of that cases are children under 5 years old and 53% are caused by hot liquids [9]. These statistics appear to suggest that a big part of the cases could be avoided by domestic prevention.

According to International Telecommunications Union (ITU), almost 50% of the world population have access to internet. The society is becoming more demanding and broadband internet has been increasing every year [10]. Between 2007 and 2017, fixed-broadband subscriptions (speeds above 256 Kbits/s) increased by 183% around the world. The mobile phones internet subscriptions are also reaching high values: almost 60 in every 100 persons have active mobile-broadband subscriptions [11]. The use of internet is even increasing at large scale in some of the low and middle-income countries in the world like Bangladesh, India Colombia, Pakistan, Egypt and Nepal [12]. Some of these countries are the ones with the highest incidence of burn injuries on children: 173,000 Bangladeshi children are burned every year [2].

Easy and quick access to information made the internet search engines grow and the one who gained the public preference was Google with a market share of more than 70% [13]. The expression “google it” (look it up on google) became popular and is today widely used by internet users [14]. The queries typed on Google can be analysed by Google Trends to evaluate market and opinions on the internet [15]. Google Trends (GT) is a web free platform, provided by Google Company, that allows discovering what worldwide users googled about over the last years [16]. With the increase of search engines and social media dependency, it is possible to use that information to study population behaviours and necessities. Google Trends is also important in health care because it is now possible to provide information that is relevant and useful to internet users [16]. Several articles have already described the usefulness of Google Trends on studies regarding health care topics such as HIV, syphilis, influenza or depression but there is no article regarding burns, at the best of our knowledge [17]–[23].

1.1 Context

The present project was designed with the support of Faculty of Medicine of Porto University (FMUP) and Cintesis - Center for Health Technology and Services Research. Cintesis has several published projects evolving burn injuries but they needed a tool to share their knowledge with the community. With the increase of

internet usage, online searches became the first source of information of a big percentage of population around the world. This project consisted in designing a dynamic web information system to share reliable information about burn injuries. Some of the hazards of the internet are the excessive and unreliable information, so their goal was to provide accurate, easy to understand and reliable information and promote prevention strategies.

The designed platform is fully adaptative and responsive, so it can be access by computer, tablet or smartphone with the same quality and functionalities. It was also included a Backoffice so that the webpage administrators do not need to have programming skills to add, remove or replace the contents provided. All the contents of our dynamic website are connected to a database to increase security, performance and to make the maintenance easier.

1.2 Objectives

The main aim of this project was to create a web information system to provide reliable and useful knowledge about burn injuries to the community and to promote prevention strategies. To make that possible they had to investigate what is the best channel of communication with our target, the community, and provide accurate information that is usually helpful to burn injuries information seekers.

To achieve our primary goal, we defined the following secondary objectives:

- Define the best communication channel to reach the largest part of the community (confirm that webpage was the best solution);
- Evaluate the usefulness of burn injuries website to the community and the possible impact on prevention and treatment on burn patients;
- Analyse the available websites with burn injuries information and assess strengths and weaknesses of both website quality and content accuracy;
- Investigate what online information is searched by internet users regarding burn injuries.

Their goal was to become the primary source of information to internet users that are searching information regarding burn injuries, whether they are burn victims, care takers or just citizens seeking knowledge.

1.3 Motivation

The motivation behind this project was to unite two completely different areas but each time more in sync due to computers globalization: Health and Computer Science. People make use of internet to get involved in their health, searching online for symptoms, diagnosis and first aid care regularly. Serious health problems may occur if the information online is not accurate, which often happens. To give support to the community and help decreasing this kind of situations, researchers wanted to make use of Cintesis knowledge and expertise on burn injuries, by providing a web system with reliable information. The provided information has to be what the community search on internet through search engines. Knowing that so many people, especially children, suffer from burn injuries the authors felt the moral obligation to share their knowledge and try to reduce the aftereffects and burn numbers through prevention.

1.4 Methodology

The methodology of this project was based on investigation, gathering valuable information to support the usefulness of this work. This way researchers could evaluate the existent necessities and adjust the course of their work to better suit people demands for knowledge regarding burn injuries.

1. The first phase consisted on evaluate what the best channel to share burn injuries information with the community was and the role of internet in health-related issues.
2. After phase one, the decision was taken: the best tool was an internet information system. On phase two we needed to understand what the impact of burn information websites to our society was. So, our research

was to examine the worldwide time trends of internet searches related to burns. Our secondary objectives are a) understand the seasonality of internet searches; b) investigate the geographic pattern around the world; c) analyse the prevalence of burn searches related to other medical conditions and d) uncover how the information about burns is researched online.

3. The third phase of our project was to evaluate the website quality and content accuracy of the burn-related information webpages. The objective was to find the strengths and weaknesses of each one and use that features to make our project the most complete possible.
4. The fourth phase consisted on the implementation of our website. The layout, database and backoffice was defined so has the domain: www.queimados.pt
5. The fifth phase of our project was to validate the contents of our website. The validation was made by a specialist of FMUP and Cintesis. This validation is essential to the credibility of our project and the contents provided.
6. The last phase was to evaluate the efficiency of this project by reducing the burn incidence on the community.

This way, the guiding principles of this project matched exactly with the needs of internet users regarding burn injuries prevention and treatment. So, our project can be divided on two big phases:

1. on the first one, the studies conducted to investigate what is missing in terms of information about burns;
2. the second consisted on the implementation phase where the website was designed and built according to the information retrieved.

1.5 Dissertation Organization

The organization of this document begins with this chapter where an introduction to the theme is given so as the context.

The second chapter describes burn injuries, risk factors, mortality rates and prevention. In this chapter the importance of properly provided first aid is documented, as well as the educational approaches that seems to have some impact on decreasing burn injuries.

On the third chapter it is given an overview of the dependency of the internet by population around the world, the usefulness of information online and the importance of internet on health-related issues. Websites related to burn injuries are evaluated to qualify their quality both on usability and accuracy.

On the forth chapter the phases of the design and implementation of the developed web information system are described, and the features are explained in detail.

The chapter five describes the online trends in searching for burns. The article was submitted to publication to Burns Journal.

On the sixth chapter, the conclusions of this project are described, the work planned for the future and how to evaluate `queimados.pt`

Burns: facts and prevention

The present chapter begins to describe a burn injury, what are the causes of burns, how is made the classification by degree (or depth) and how it is calculated the extent of the burn. In this chapter are going to be demonstrated the strategies to prevent burns injuries, what is done, and what can be done. The structure of this chapter is the following:

1. Concepts about burn injuries;
2. Enumerate risk factors of burns;
3. Numbers of mortality/DALYs rates around the world;
4. Prevention strategies;
5. Burden of burn victims;
6. Proven strategies to reduce burn accidents;
7. Advantages of providing adequate first aid;
8. Present some educational approaches to reach the community.

2.1 Burn Injuries

A burn, as described by WHO, is an injury to the skin or other organic tissue primarily caused by heat or due to radiation, radioactivity, electricity, friction or contact with chemicals. Respiratory damage resulting from smoke inhalation, as well as skin injuries due to ultraviolet radiation, radioactivity, electricity or chemicals, are also considered to be burns [24]. A heat, or thermal, injury can be caused by hot liquids (scalds), hot solids (contact burns) or flames (flame burns) [2].

Burns are classified according to the presence or absence of an inhalation injury (cause), depth of burn (degree) and total body surface area (TBSA) burned (extension) [25], [26].

2.1.1 Classification of burns by cause

Burns can be classified as thermal or inhalation [25]:

- Thermal injuries involve the skin and may be presented as:
 - Scalds: are caused by hot liquid or steam;
 - Contact burns: are caused by hot solids like hot irons and cooking utensils or lighted cigarettes;
 - Flame burns: are caused by flames or incandescent fire, usually started by candles, lighted cigarettes, lamps or stoves;
 - Chemical burns: are caused by exposure to reactive chemical substances like strong acids or alkalis;
 - Electrical burns: are caused by electrical current passing from an electrical outlet, cord or appliance through the body.
- Inhalation burns are caused by breathing in steam, superheated gases, hot liquids or noxious products of incomplete combustion [25]. Thermal or chemical burns can be caused on the airways and lungs on inhalation injuries. It causes also skin burns on approximately 20% to 35% of the cases [27].

2.1.2 Classification of a burn injury by degree and depth

Burns can also be classified by depth or thickness:

- First-degree or superficial burns are burns to the epidermis that have as consequence a simple inflammatory response. They are usually a consequence of a sunburn (exposure of the unprotected skin to solar radiation) or to a brief contact with a hot substance, liquids or flash flames (scalds). First-degree burns take less than a week to heal, with no permanent changes in skin colour, texture or thickness.

- Second-degree or partial-thickness burns are a consequence when the injury in the skin extends beneath the epidermis into the dermis. However, the damage does not lead to the destruction of all elements of the skin.
 - Superficial second-degree burns take less than three weeks to heal.
 - Deep second-degree burns are the ones that take more than three weeks to heal and usually form hypertrophic scars.
- Third-degree or full-thickness burns are where there is damage to all epidermal elements (epidermis, dermis, subcutaneous tissue and deep hair follicles). As there is extensive destruction of the skin layers, this kind of injuries cannot regenerate by themselves without grafting [25].

2.1.3 Classification by extent of burn

The extent of burn is clinically called as TBSA – Total Body Surface Area burned and is defined as the proportion of the body burned [25], [28]. There are several methods used to calculate the TBSA being the most common the so-called “Wallace rule of nines” – Figure 1. It is a good and quick way to estimate the burn extension on adults and children older than 10 years old. This method assigns 9% to the head and neck region, 9% to each arm (including the hand), 18% to each leg (including the foot) and 18% to each side of the trunk (back, chest and abdomen) [25], [26], [29]. On children is used another method – the Lund and Browder Chart – Figure 2 [25]. This method assumes that the size of a child’s palm is about 1% of the TBSA [30].

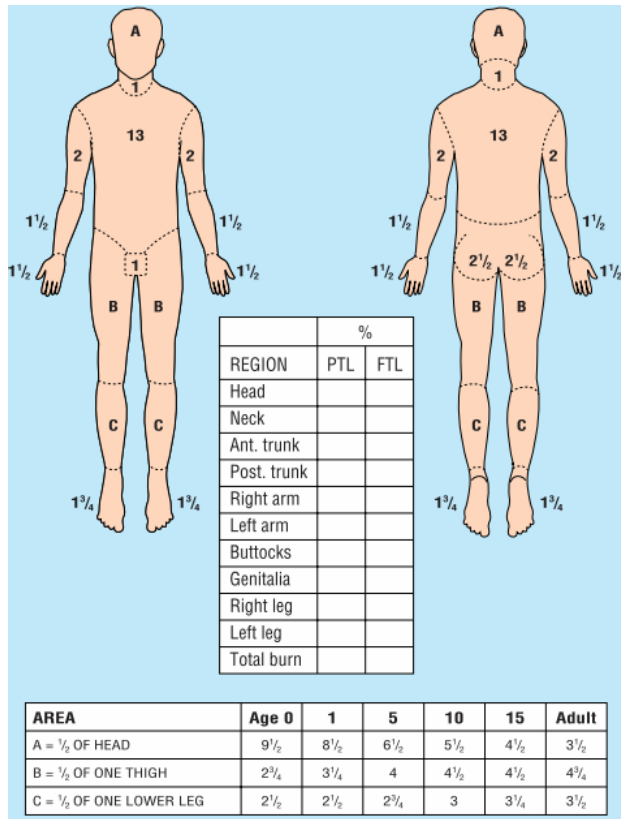


Figure 1 - Wallace rule of nines
Source: [29]

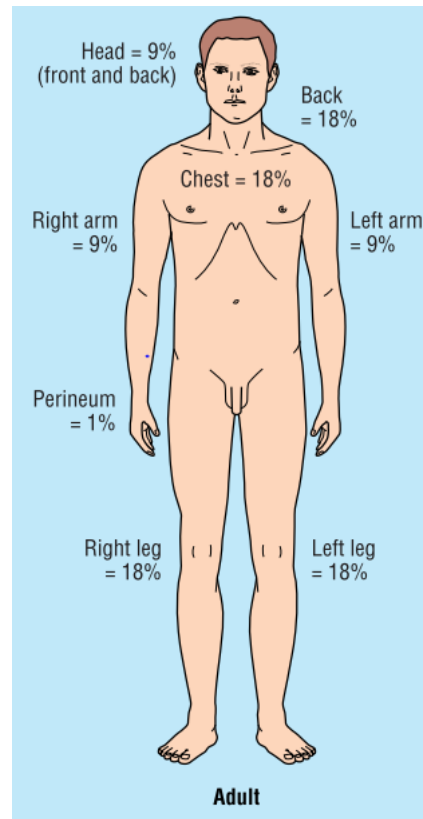


Figure 2 - Lund and Browder chart
Source: [29]

2.2 Risk factors

Females and children are the ones who have higher rates of death from burns. Open fire cooking, unsafe cookstoves and open flames used for heating are some of the risks that make women more vulnerable to burn injuries. Major risks for children include improper adult supervision, child maltreatment, clothing made of flammable materials and skin sensitivity [2], [31].

Most burns occur in the home and workplace. Women and children suffer burn injuries traditionally at home whereas men are most likely to be burned in the workplace [2], [3], [24].

There are several other risk factors for burns, including:

- occupations that increase exposure to fire;
- poverty, overcrowding and lack of proper safety measures;
- placement of young girls in household roles such as cooking and care of small children;

- underlying medical conditions, including epilepsy, peripheral neuropathy, and physical and cognitive disabilities;
- alcohol abuse and smoking;
- easy access to chemicals used for assault (such as in acid violence attacks);
- use of kerosene (paraffin) as a fuel source for non-electric domestic appliances;
- inadequate safety measures for liquefied petroleum gas and electricity [2].

According to WHO, an estimated 265,000 deaths occur each year from fires alone, excluding deaths from other aetiologies like scalds, electrical or contact burns [24]. About 180,000 deaths occur every year caused by burns. Over 95% of burn injuries occur in low and middle-income countries. Non-fatal injuries are also a leading cause of morbidity [2][3].

2.3 Mortality/DALYs rates

Although burns are a serious global public health problem, mortality rates vary across the different regions of the world. Rates are lower on high income countries where, a range of interventions and improvements in the care of burn victims, have been reducing drastically the number of deaths due to all kind of injury related to burns [3], [32].

Mortality rates have very distinct values between low/middle and high-income countries, rising a factor of 10. According to WHO, fire-related mortality rates are especially high in South-East Asia (11.6 deaths per 100,000 population per year), the Eastern Mediterranean (6.4 deaths per 100,000 population per year) and Africa (6.1 deaths per 100,000 population per year). These compare with much lower rates of, on average, just 1.0 deaths per 100,000 population per year in high-income countries – Table 1.

2. Burns: facts and prevention

REGION	Africa	The Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific		WORLD
Income group	low/ middle	high	low/ middle	low/ middle	high	low/ middle	high	low/ middle	high	low/ middle	
Number of burn deaths (thousands)	43	4	4	184	3	21	0.1	32	2	18	312
Death rate (per 100 000 population)	6.1	1.2	0.8	11.6	0.7	4.5	0.9	6.4	1.2	1.2	5.0
Proportion global mortality due to fires (%)	13.8	1.3	1.3	59.0	1.0	6.7	0.02	10.3	0.6	5.8	100

Table 1 - Estimated number of deaths and mortality rates due to fire-related burns by Who region and Income group, 2002

Source: WHO Global Burden of Disease Database, 2002 (version 5)

According to the Human Development Reports 2015, the average mortality rate between high and low/middle income countries differ by a factor 3 (57:106 and 249:291 (women:men) per 1000 respectively), while the access to physicians per 10,000 inhabitants differ with about a factor 10 (27.9 and 2.9 physicians per 10,000 inhabitants, respectively) [33], [34].

Mortality rates among children (1-14 years) are still very distinct between high, medium and low-income countries. A study has been made in 2017, based on data from Global Burden of Diseases (GBD) 2013 and World Bank for economic classification of the countries [31]. When examining the relationship between burn mortality rates and world economies, there is a graded increase in rates with decreasing country economic level globally and in the two regions where the over- all burden is highest, Sub-Saharan Africa and Eastern Europe and Central Asia. This pattern was not present in the five other regions as three regions have the highest child burn rates in the middle-income countries compared to three regions with rates highest in the high-income group – Table 2 [31].

2. Burns: facts and prevention

Region and income level (N countries)	Deaths 1–14 y	Population 1–14 y	Mortality rate per 100,000 (min–max)
All (N = 103) ^a	43,992	1,740,000,000	2.5 (0–9.5)
High income (N = 39)	1069	176,000,000	0.6 (0–2.1)
Middle income (N = 49)	13,052	903,000,000	1.4 (0.2–8.1)
Low income (N = 15)	29,871	663,000,000	4.5 (0.1–9.5)
Sub-Saharan Africa (N = 15)	30,655	685,000,000	4.5 (1.0–9.5)
High income (N = 0)	–	–	–
Middle income (N = 5)	873	34,000,000	2.5 (1.2–4.5)
Low income (N = 10)	29,782	651,000,000	4.6 (0.9–9.5)
South Asia (N = 8)	9190	364,000,000	2.5 (0.3–2.6)
High income (N = 0)	–	–	–
Middle income (N = 5)	9104	353,000,000	2.6 (0.3–2.6)
Low income (N = 3)	86	10,300,000	0.8 (0.3–0.9)
Latin America and the Caribbean (N = 18)	526	75,700,000	0.6 (0.2–4.9)
High income (N = 2)	2	961,989	0.2 (0.2–0.2)
Middle income (N = 15)	522	73,900,000	0.6 (0.2–4.9)
Low income (N = 1)	2.5	855,187	0.3
Eastern Europe/Central Asia (N = 18)	721	41,900,000	1.8 (0–3.1)
High income (N = 6)	402	21,700,000	1.4 (0–2.1)
Middle income (N = 12)	319	20,200,000	2.0 (0.2–3.1)
Low income (N = 0)	–	–	–
Asia East, South East and Pacific (N = 12)	1712	374,000,000	0.5 (0–8.1)
High income (N = 4)	15	3,698,756	0.3 (0–0.5)
Middle income (N = 7)	1697	369,000,000	0.5 (0.2–0.4)
Low income (N = 1)	1	791,218	0.1 (0.3–8.1)
Middle East and North Africa (N = 4)	7	3,135,905	0.2 (0.2–0.3)
High income (N = 1)	4	1,978,422	0.2
Middle income (N = 3)	3	1,157,483	0.3 (0.2–0.3)
Low income (N = 0)	–	–	–
Organization for Economic Cooperation and Development (OECD) (N = 33)	1185	200,900,000	0.6 (0.1–2.5)
High income (N = 30)	650	150,000,000	0.4 (0.1–1.2)
Middle income (N = 3)	535	50,900,000	1.1 (0.2–2.5)

^a Certain countries may fall under different categories, so the total n countries may not add up to 103.

Table 2 - Distribution of child burn mortality rate by region and income level

Source: “The global burden of child burn injuries in light of country level economic development and income inequality” [31]

Burns are also a leading cause of disability and disfigurement [3]. It is estimated that fire-related burns account for 10 million Disability Adjusted Life Years (DALYs) lost globally each year [35]. Last data from WHO shows that DALYs are decreasing all around the world – Table 3. Globally there is a decrease of around 2 million DALYs and by region the rate per 100,000 is also decreasing even if DALYs number are higher, like African region [36].

Year	2016			2000		
Region	Population (thousands)	DALYs (000s)	Rate per 100,000	Population (thousands)	DALYs (000s)	Rate per 100,000
GLOBAL	7,461,884	10,610	0.142	6,140,789	12,876	0.210
African Region	1,019,920	3,284	0.322	665,570	2,993	0.450
Region of the Americas	992,028	679	0.068	833,149	821	0.098
South-East Asia Region	1,947,631	3,351	0.172	1,572,403	4,849	0.308
European Region	916,166	1,106	0.121	868,413	1,691	0.195
Eastern Mediterranean Region	664,335	1,168	0.176	471,223	1,304	0.277
Western Pacific Region	1,889,788	1,005	0.053	1,701,170	1,199	0.070

Table 3 - DALYs by Fire, heat and hot substances and region, 2016 and 2000

Data source: Global Health Estimates 2016: Disease burden by Cause, Age, Sex, by Country and by Region, 2000-2016 [36]

2.4 Prevention

Throughout the last decades, it became clear that burns are preventable, so high-income countries adopted a combination of prevention strategies not only to reduce the likelihood of a fire but also the severity and impact of a burn injury through improvements in the care of people affected by burns [2][3]. The lower rates of mortality on high-income countries can be explained by the burn prevention efforts made over the last years. Some of the strategies have included smoke alarms, hot water heater regulation, sprinklers systems, codes for electrical and other aspects of housing constructions among others [3], [32]. In addition, there are several specific recommendations for individuals, communities and public health officials to reduce burn risk:

- Enclose fires and limit the height of open flames in domestic environments.
- Promote safer cookstoves and less hazardous fuels and educate regarding loose clothing.

- Apply safety regulations to housing designs and materials, and encourage home inspections.
- Improve the design of cookstoves, particularly regarding stability and prevention of access by children.
- Lower the temperature in hot water taps.
- Promote fire safety education and the use of smoke detectors, fire sprinklers, and fire-escape systems in homes.
- Promote the introduction of and compliance with industrial safety regulations, and the use of fire-retardant fabrics for children's sleepwear.
- Avoid smoking in bed and encourage the use of child-resistant lighters.
- Promote legislation mandating the production of fire-safe cigarettes.
- Improve treatment of epilepsy, particularly in developing countries.
- Encourage further development of burn-care systems, including the training of health-care providers in the appropriate triage and management of people with burns.
- Support the development and distribution of fire-retardant aprons to be used while cooking around an open flame or kerosene stove [2].

Unfortunately, these strategies could only be partially implemented on low and middle-income countries. Even on high or middle income-countries it is noticeable the difference of epidemiological patterns for burns, and risk factors, on rural areas or urban poor [32]. Therefore socioeconomic status has a huge impact on burn risk, either on low, middle or high-income countries [2].

2.4.1 WHO Prevention Strategies

Prevention strategies should address the hazards for specific burn injuries, education for vulnerable populations and training of communities in first aid [2]. Although successfully implemented on high-income countries, WHO is facing a major challenge on overcoming the barriers to the development and implementation of burn prevention, care and recovery programs across the world – Table 4. If correctly implemented, these strategies would correct the inequality and lower the rates of death, disability and disfigurement from burns globally [3].

An effective burn prevention should be multisectoral, but the main barriers identified by WHO are the following areas [2], [3]:

- Advocacy: improve awareness
 - There is limited awareness of the magnitude and cost of the burn problem among policy-makers and donors. An awareness that the current high rates of burn death, disability and disfigurement could be brought down by affordable and sustainable improvements in prevention and care is also lacking [3].
- Policy development: develop and enforce effective policy
 - Many of the strategies that have helped to lower the burden of burns in high-income countries have been implemented through policy changes. However, many low- and middle-income countries have not yet developed burns policies, nor have they put into place action plans, legislation or regulations to address the problem of burns. Even when burn policies exist, enforcement is often inadequate [3].
- Data and measurement: describe burden and identify risk factors
 - It is generally acknowledged that accurate problem description is the key to planning effective interventions, yet in many less well-resourced countries, data on burns are scarce and/or inaccurate. In some countries, a lack of reliable data on risk factors further hampers the development and enactment of effective burn prevention strategies, while in others, incomplete reporting of burn events leads to underassessment of the scale of the public health problem [3].
- Research: set research priorities with promotion of promising interventions
 - The reductions in burn mortality that have been seen in high-income countries have been achieved because of the application of scientifically-based programmes for prevention and care. The development and implementation of such interventions owes much to the quality and breadth of the research that underpins them. The research and the tools that have brought about such successes relate specifically to the situation and circumstances of high-income countries. Low- and middle-income countries, however, require

interventions that are appropriate to their circumstances. This means that interventions may need to be specifically developed, or at the very least, adapted to suit low-resource settings, a process which requires considerable research effort. Thus, in many countries, burn control is hampered not just by the lack of basic data, but also by lack of research infrastructure and capability to support the necessary intervention trials, economic analyses, programme effectiveness studies, social science research and health utilization analyses [3].

- Prevention: provide burn prevention programmes
 - Some of the strategies developed in high-income countries would successfully address the risk factors present for burns in some low- and middle-income country settings, particularly urban environments of middle-income countries. These include strategies such as smoke detectors, regulation of hot water heater temperature, and enacting and enforcing housing codes to make electrical wiring safer. However, in low-income countries, especially in rural areas and among the urban poor, the epidemiologic pattern of, and risk factors for, burns differ markedly from those that characterize the high-income countries and thus very different strategies are going to be required [3]. In this regard, some of the factors that are of prime concern include [37]–[39]:
 - the use of cooking pots on ground level (pots on ground level are more readily knocked over, and can increase the risk of scald burns, for example, among toddlers and young children);
 - the use of open wood fires;
 - the use of kerosene (paraffin) stoves and lamps (these can be easily knocked over and then ignite);
 - the wearing of loose fitting cotton clothing which can ignite while cooking on an open fire (a risk factor for women in Asia).
 - It is clear – given that approximately two billion people worldwide cook on open fires or very basic traditional stoves – that in order to

reduce the number of fire-related burn deaths worldwide, evidence-based strategies to address these particular risks are going to be needed [3]. Lectures at the European Burn Conference in 2015 empathized the discrepancies in the causes of burns depending on the income of the country. Thus tailored burn prevention strategies are required for each geographical location to ensure a reduction of burns [40].

- Services: strengthen burn care
 - The type of burn care that is routinely available in high-income countries is currently beyond the reach of the vast majority of the world's poor. Inequity in service coverage means that someone with a moderate level per cent body burn would most likely die in a low- and middle-income country but would be saved in a high-income country. Similarly, in low- and middle-income countries, those who suffer even a fairly small per cent body surface area burn injury to the extremities will often develop significant disabilities from burn wound contractures; in high-income countries this could be prevented with simple physical therapy (physiotherapy) and rehabilitation methods, and in some cases, reversed by reconstructive surgery [41]. It is to the detriment to the health of many that rehabilitation capabilities, whether for burns or other disabling injuries, are among the least developed capabilities in the spectrum of trauma care in many low- and middle-income countries [42]. Inequities are also evident in the availability of support networks: whereas burn victims support groups play an active role in providing peer support and assisting in the recovery of burn victims in high-income countries, such groups are almost entirely absent in low and middle-income countries [3].
 - Capacity: Strengthen capacities to carry out all the above Burn prevention activities demand a workforce with a wide range of skills and expertise: epidemiologists are needed to analyse data on burns and their risk factors; clinicians are needed to understand the broader trauma system issues as they relate to strengthening burn care; and public health practitioners, psychologists and media

experts among others are required to design, implement and evaluate successful and sustainable burn prevention programmes. All these professionals, along with representatives of nongovernmental organizations (NGOs), civil society and members of the public, need to acquire skills in advocacy in order to help raise the profile of burns and ensure its place on the agenda of governments, international agencies and donors. Critically, many low and middle-income countries lack adequate numbers of skilled personnel who can undertake the work that needs to be done to move forward in burn prevention [3].

The BURN PLAN	
1. ADVOCACY	▪ Raising awareness ▪ Promoting and supporting action ▪ International, multisectoral cooperation
2. POLICY	▪ Effective and sustainable burn prevention and care policies ▪ Action plans, legislation, regulations, enforcement
3. DATA AND MEASUREMENT	▪ Magnitude and burden ▪ Risk factors
4. RESEARCH	▪ Set agenda of priorities ▪ Promote and foster trials of promising interventions
5. PREVENTION	▪ Stronger, more effective burn prevention programmes ▪ More countries with national burn strategies
6. SERVICES	▪ Strengthen treatment services available ▪ Acute care ▪ Rehabilitation ▪ Recovery
7. CAPACITY BUILDING	▪ Sufficient knowledge and skill to effectively carry out all of the above components of the Burn Plan

Table 4 - Seven main components which correspond to the challenges
Source: *Confronting the global burden of burns* [3]

2.5 Burden of burn injuries

Thermal injuries have a huge economic impact on the budget of the countries as the burden of burn injuries worth a significant percent of the GDP – Gross Domestic Product [43]. The total costs of fires are divided into three categories: costs in anticipation, costs as a consequence and costs of response [43]–[46].

- Costs in anticipation are the costs of protection and prevention measures taken to prevent or mitigate the damage caused by fire [43]–[45]:
 - Fire safety in buildings;
 - Fire safety measures in structures and infrastructure
 - Fire safety education and training
 - Insurance administration
 - Fire safety in consumer items
 - Fire research
 - Maintenance of fire safety equipment and measures [45].
- Costs as a consequence are the costs that are incurred as a result of fire: exposure of property, individuals or the environment to fire and its products, and the cost is borne by a range of victims [43]–[45]:
 - Cost of injury due to fire
 - Property losses
 - Loss of business
 - Environmental costs
 - Heritage and cultural costs
 - Wider economic distortions [45].
- Costs of response are all the costs of extinguishing the fire and cleaning up that are, for the most part, borne by society [43]–[45]:
 - Fire service response costs
 - Volunteer fire service
 - Private fire brigade response
 - Criminal justice costs [45].

A review of total fire expenditures on high-income countries such as USA, Canada, UK, Australia and Denmark revealed that approximately half of the value is spent on costs of anticipation:

- Costs in anticipation cost between 48 to 55 percent;
- Costs as a consequence worth between 10 to 30 percent;
- Costs in response cost between 15 to 30 percent [45].

The Geneva Association released, in 2014, the World Fire Statistics Bulletin where are compared the direct costs 2010 - Table 5 - and indirect costs – Table 6 - of fires and the percentage of GDP between some countries with data from 2008 to 2010.

Country	Currency	Direct Losses			Percentage of GDP 2008-2010
		2008	2009	2010	
Hungary	Ft		580	210	0.02 [2009-2010]
Singapore	\$S	110	115	115	0.04
Slovenia	SIT				0.07 [2002-2004]
Australia ^{1,2}	\$AUS	1,000	955	940	0.07
Czech Republic	Kč	3,700	2,450	2,200	0.07
Spain ^{3 *}	€	910			0.08 [2008]
Poland *	zł	1,450	1,150		0.09 [2007-2009]
United States	\$US	17,500	14,000	13,000	0.10
Japan	¥	615	610	565	0.12
New Zealand	\$NZ	240		210	0.12
Germany	€	2,850	2,950	2,700	0.12
United Kingdom	£	1,950	1,750	1,750	0.13
Netherlands	€	1,050	925	675	0.15
Finland	€	305	280	330	0.17
Sweden	kr	5,950	5,550	5,650	0.18
Denmark	kr				0.20 [2005-2007]
France	€	4,550			0.20
Italy	€	3,150	3,750	2,600	0.20
Norway	kr				0.22 [2003-2005]

* Derived from raw data with an unknown adjustment.

¹ Australian data are calculated from figures provided in the *Report on Government Services 2012* and may be influenced by specific methodological features of that publication.

² Property losses due to structure fires only; figures adjusted by 20 per cent to account for rural losses as per prior years.

³ Spanish figures rely upon internal WFSC estimates derived from Spanish insurance data and should be regarded with caution.

Table 5 - Adjusted figures for direct fire losses and as average percentage of GDP (million, except for Japan - billions)
Source: Fire and Climate Risk [47]

Regarding direct costs, Singapore continues to demonstrate that his prevention methods are working as the costs are stably low along the years of the study and the percentage of GDP is very low, 0.04. Only Hungary has a percentage of GDP lower – 0.02 – but only the data of the last two years is presented. Czech Republic has a low percentage of GDP, but this can be explained by the low levels of property valuation as the living expenses are very low, although the direct costs continuously decreasing. The remaining analysed countries show a trend of stability or decrease on the percentage of GDP and a reduction on absolute values of direct costs. The descent does not imply a direct improvement in fire loss figures by itself as it can be a result of a correlation with declining GDP figures due to the global financial crisis and austerity measures in individual countries in combination with improving loss results [47].

On indirect fire costs, no definite conclusions can be made as only the US and New Zealand, for 2004, have presented values for entire fire losses. Estimates

have been made for Finland and France, based on industrial fire claims, and for Japan, Germany, Sweden and UK based on indirect fire insurance claims. With the major reservations that these values must be treated, it is possible to conclude that the values of indirect costs suffered an increase on 2010 relatively to 2009, getting back to values very similar to 2008 [47].

Country	Currency	Indirect Losses			Percentage of GDP 2008-2010
		2008	2009	2010	
Norway	kr				0.002 [2003-2005]
Czech Republic	Kč				0.005 [2000-2002]
Japan	¥	60	55	55	0.006
Sweden	kr	345	400	345	0.006
New Zealand ¹	\$NZ				0.007 [2004]
United States	\$US	2,500	1,900	1,700	0.007
United Kingdom	£	310	135	250	0.008
France	€				0.010 [2005-2007]
Finland	€	40	30	45	0.011
Germany	€	665	620		0.014
Italy	€				0.014 [1993-1994]
Slovenia	SIT				0.021 [2002-2004]
Netherlands	€				0.027 [1995-1996]
Denmark	kr				0.029 [1993-1995]

¹ As estimated in the BERL report *The Cost of Managing the Risk of Fire in New Zealand*.

Note: This table must be regarded with severe reservations—the figures are produced on widely varying bases and some differences appear too large for credibility.

Table 6 - Adjusted figures for indirect fire losses and as a percentage of GDP
Source: *Fire and Climate Risk* [47]

A study about burden of burns in Portugal made a comparison between mean charges of hospitals with and without burn centres and concluded that the difference is quite significant: 11,144€ to 3,855€ respectively [48]. In Bangkok, a study concluded that the reimbursement made to hospitals was not enough to cost the burns injuries, so the hospitals need to use resources from other areas of care to fund the burn centre [49]. A recent study from United Kingdom revealed that the average cost of an uncomplicated paediatric scald was around £1850 or US\$ 3618 [50]. On United States a hospitalization from burns has a range of US\$ 1187 for scalds up to US\$ 4102 for injuries resultant from fires [51]. These studies document the heavy economic impact of burn injuries on a country healthcare system [25].

The families of burn victims (especially children) also have heavy and expensive burden to support. The costs of the long-term rehabilitation, social rejection, lost school days and education, possible unemployment on the future and other

psychological issues are some of the costs associated with burn injuries [49]–[55].

2.6 Strategies with proven or promising evidence or effectiveness

The effectiveness of burn injuries prevention strategies is documented using several types of data, on high-income countries. This is where the strategies have been implemented and because these countries have well developed data sources that permit tracking the effectiveness of the interventions – Table 7 [32].

Prevention	Background	Solution
<i>Fire detection systems and sprinkler</i>	House fires are still a major cause of burns and inhalation injuries.	Fire detection devices (based on smoke detection) and sprinklers should be mandatory for all new buildings.
<i>Temperature regulation on hot water heater</i>	In children, scald burns are more common than flame burns.	To lower the set temperature of water heaters to roughly 50 °C (~120 °F).
<i>Nonflammable fabrics</i>	Clothes can easily catch fire, especially from contact with open fire (cigarettes, candles) or stoves.	The use of nonflammable sleepwear especially for children and toddlers.
<i>Electrical safety</i>	Electrical burns are the most severe type of burns and usually result in severe sequelae.	To ensure that electricity is used and delivered safely. Techniques for safety such as adequate insulation are necessary.
<i>Fire-Safe-Cigarettes</i>	Fire from tobacco products are also a leading cause for burn injuries worldwide.	Ideally, stop the use of tobacco and smoking would be the best prevention. However, stopping indoor smoking is a step forward.
<i>Safer fireworks</i>	Burns from fireworks are a problem of both, high- and middle-income countries.	The purchase and use of fireworks needs to be more strictly regulated.
<i>Safer stoves and lamps</i>	Even nowadays, many households in middle- and low-income countries use open fires for daily cooking.	The goal is to create a safer methods for daily cooking in those countries. New type of stoves and lamps are part of ongoing developments.
<i>Combating acid-throwing</i>	The throwing of acids on faces leading in severe damage and disfigurement has become very popular.	Prevent the disposal of acids as well as the prevention of violence are the main goals to prevent those chemical burns.

*Table 7 - Burn prevention strategies adapted from the WHO
Source: "Burn prevention in the face of global wealth inequality" [40]*

2.6.1 Smoke alarms

The majority of burn deaths, on high-income countries, result from smoke inhalation on house fires [56]–[58]. Most people only know their building is on fire until is too late to escape or call for help. Typically, house fire victims become trapped or they become overwhelmed by smoke, hypoxia (low oxygen) and carbon monoxide poisoning. On night fires many people die in their sleep from hypoxia and carbon monoxide. Smoke alarms – Figure 3 - can save many from death or injuries because can alert people sooner that a fire had started and therefore give them time to escape [32].



Figure 3 - Smoke alarm on ceiling

There are available on the market a large variety of devices to give a loud sound to early alert occupants in the case of a fire. These devices are based on the detection of heat, smoke or carbon monoxide – Table 8 [32]. These devices proved to be very effective on reducing fire-related deaths and injuries. Studies revealed that a working smoke alarm decreases by at least 50% the risk of death in a residential fire [58], [59]. A study showed the cost/benefit of smoke alarms on USA: every US\$1 spent on smoke alarms saves US\$28 of health-related expenditures [60].

FIRE DETECTION AND ALARM EQUIPMENT	SMOKE ALARMS	CARBON MONOXIDE ALARMS
Fire detection and alarm equipment refers to equipment designed to rapidly detect unwanted fires and to notify occupants. Detection systems are of several different types. The earliest versions were heat detectors, which were essentially basic thermometers with associated alarms for threshold temperatures. used in the 1950s and 1960s, they are no longer in common use.	Smoke alarms come in two types – ionization and photoelectric. Ionization alarms have two electrically charged plates and a small amount of radioactivity that ionize the air and allow a current flow between the two plates. Smoke disrupts the current flow, activating the alarm [59]. Photoelectric alarms have a light source aimed away from the detector. In the presence of smoke, the reflected light triggers the alarm. These two types of alarm have a different sensitivity – photoelectric alarms are more sensitive to smouldering fires and ionization alarms are more sensitive to flaming fires. Both types generally provide adequate warning.	Carbon monoxide alarms indirectly detect the fire by sensing a dangerous gaseous by-product. While not more effective than smoke alarms at preventing fire-related injury, they have been shown to be a helpful adjunct to preventing carbon monoxide poisoning. They are especially useful in circumstances where carbon monoxide alone, rather than within smoke, is the main risk, such as from gasoline powered generators, motor boat engines, and other gasoline powered appliances and heating equipment [59], [61], [62].

Table 8 - Types of fire detection systems

Source: Burn Prevention Success Stories Lessons Learned [32]

2.6.2 Temperature regulation on hot water heater

Burn by scald are very common, nearly as flame burns, especially on children [32]. Around the world, 5% of all burn deaths are from scalds and the numbers are much higher on non-fatal burns [63]. 25% of all children scald burns are caused by hot tap water (mostly in the bathroom) and the damages tend to be more severe than other types of scalds [32]. Nearly 75% of burns in young children are from hot liquid, hot tap water or steam [64].

Burns with hot water happen very quickly: water at 60°C causes a burn within 3 seconds of exposure whereas water at 49°C takes almost 10 minutes to cause a significant skin thermal injury [32], [65]. Therefore, the solution to prevent a large number of scalds is to adjust the hot water heater to a safe temperature (generally 50°C) at which scalding would take more than 10 minutes to occur – Figure 4 [32].



Figure 4 - Hot water heater regulator

A study from Canada found that a program to reduce hot water heater temperature resulted on a 56% reduction in scald burns [66]. This strategy incurs no cost itself to the community (it is just limiting the temperature) although there are the costs of public health efforts to bring such changes into effect [32].

2.6.3 Non-flammable fabrics

Flammable clothing is another leading cause of burns, especially on young children and the elderly. Young children because they don't understand the risks and the elderly because the reaction time is slowed. These types of burns can happen from contact with stoves, cigarettes, matches, lighters or other sources.

The highly flammable materials used on the fabrics from which children sleepwear (clothing intended to be worn primarily for sleeping or activities related to sleeping) was made were one of the major problems – Figure 6. Several types of synthetic fibres (such as polyesters) are less flammable than cotton and tighter fitting garments are also less flammable than loose ones. The loose fitting garments are more flammable as they allow greater passage of air through the cloth, requisite to keep the fire burning [32]. The strategy to get lower flammability fabrics into general use was made by a totally legislative approach. Since the 1950s legislation has been applied to lower flammability of fabrics in several high-income countries, not only on children clothes but for all the population [67]. However, the flammability of fabrics is still a big risk factor in several low and middle income-countries, especially on women. Loose saris worn by women in India – Figure 5 - or loose-fitting clothes worn by women in Algeria have been implicated in burns related to cooking fires [67]–[69].



Figure 5 - Woman cooking wearing saris



Figure 6 - Children non-flammable sleepwear

2.6.4 Electrical safety

Electrical burns have a low rate incidence in society but they are still considered one the most serious ones due to their high morbidity and mortality [70]. Electrical safety includes prevention of fires in houses and other structures and prevention of electrical burns and electrocution resulting from human contact with electrical

wires – Figure 7. Several safety techniques were enforced over the years such as insulation of wires, fuse and circuit-breaker systems that prevent overloading from electrical surges, methods to safely route electrical wires within structures, and safe design of electrical appliances. The enforcement of this techniques was established by insurance companies to minimize their risks from insured properties. Nowadays is required by law in many countries, almost in all high-income countries, that a product must be certified by companies that insure safety regulations were applied. On USA a product must be certified by UL - Underwriters Laboratories - and on Europe products must be certified by CE marking certification. On high income countries the deaths by electrical burns have been decreasing and most of these accidents occur on the workplace. On several countries mandatory safety measures are enforced which includes: employee training in basic electrical theory, safe work procedures, hazard identification, proper use of protective equipment, and first aid such as cardio-pulmonary resuscitation (CPR) and rescue procedures [32]. A study made on US documented the decrease of deaths by electrocution on more than half [71]. These strategies need to be enforced also on low and middle-income countries to reduce the number of electrocutions around the world [32].

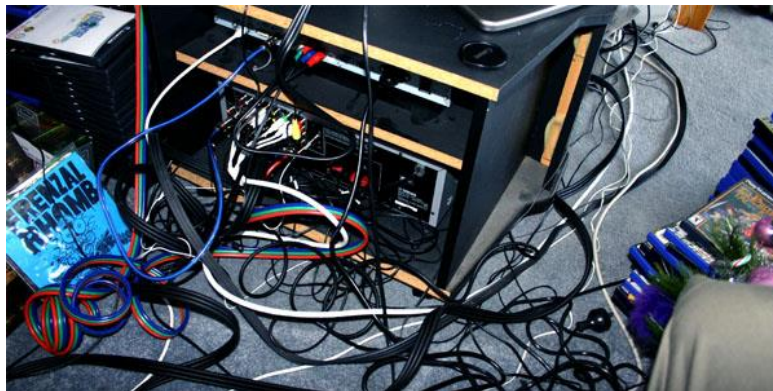


Figure 7 - Dangerous wires exposure

2.6.5 Sprinklers

The severity of a building fire could be decreased, on injuries and property damage, by equipment that quickly detects fire and put it out automatically by dousing with water. This can be done by an automatic fire sprinkler – Figure 8. Sprinklers are triggered by smoke alarms and water is channelled to inside of

buildings by sprinklers systems [32]. The effectiveness of these systems is well documented by real-world experience [72]. The risk of death is reduced by 80% in a home protected with sprinklers. The change of survival in a household with smoke detectors and sprinklers is almost 97% [73], [74]. Sprinklers not only saves human lives during a fire, it also decreases property loss in buildings to one fifth compared to buildings without sprinklers [75].

Due to the high costs associated with installation of sprinklers, only less than 2% of households are fitted with sprinkler systems [76]. The situation is similar on all high-income countries, despite the documented high effectiveness. Sprinklers installation may not be feasible on most of family homes but can be feasible on new apartment buildings and large public buildings. The potential of this strategy is obvious but if it is difficult to implement on high-income countries, it is nearly impossible to implement on low and middle-income ones [32].



Figure 8 - Fire sprinkler

2.6.6 Fire-safe cigarettes

Lighted tobacco products are the leading cause of fire-related deaths and injuries around the world [32]. According to a National Fire Protection Association report, an estimated 540 deaths and 1,640 people injured were caused from 90,000 smoking-material fires in 2011 on USA. These numbers represent about 20% of overall fire-related deaths in residential structures, resulting on US\$621 million in direct property damage [77]. In the European Union, it is estimated that in 2006 cigarettes caused 650 deaths, 2400 injuries and €48 million in property damage from 12,900 fires [78]. One on four deaths from smoking-material fires (24%) is not the person whose cigarette started the fire [77].

The best solution to reduce lighted tobacco fires is to reduce smoking to the minimum possible. Efforts have been made to reduce smoking through campaigns that show some of the diseases caused by cigarettes such as lung cancer and heart disease. Other efforts have been made by including educational messages (and pictures) on cigarette packs and promote smoking only outdoors to reduce the potential of fires inside the buildings [32], [77]. Cigarette industries also changed the materials of construction of cigarettes to make them self-extinguish if not puffed. The so-called reduced ignition propensity, self-extinguished, low fire risk, reduced fire risk or fire-safe cigarettes decreased the fire-related deaths – Figure 9 - [79], [80]. Smoking-material fire deaths decreased from an average 43 per year in 2000-2002 to an average of 25 per year in 2006-2008, a 41% reduction [32], [77]. Fire-safe cigarettes should be enforced in all the countries around the world to help decrease fires on buildings which results on several deaths per year [32]. In addition to cigarettes, also lighters were enforced by law to be child resistant around the world, at least on high-income countries like USA and European Union countries [81], [82].

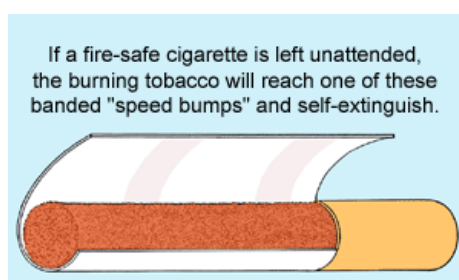


Figure 9 - Fire-safe cigarette

2.6.7 Safer fireworks

Nowadays, fireworks are used all around the world on national and cultural celebrations, holidays and party's [65]–[68]. Fireworks – Figure 10 - are a big threat for children, especially adolescent boys [32]. In Greece, 70% of fireworks burn injuries involved boys aged 10 to 14 years old, normally by setting off fireworks by themselves. Usually the girls who got injured were innocent bystanders [84]. In Australia 50% of burn injured by fireworks were male under 18 years old [87].

Temperatures of ignited fireworks may exceed 650°C, such high heat production can cause severe injuries in addition to the blast effect [32]. Almost 50% of fireworks burn injuries that get medical attention are burns and approximately 33% of these are contusions and lacerations which affects especially hands and eyes [88]–[90]. The risk of injury and death associated with fireworks handling, makes it one of the dangerous types of consumer product available [89].

The enforcement of legislation has a great impact on decreasing the fireworks-related injuries. The number of burn injuries in the UK dropped from 707 in 2001 to 494 in 2005 [91]. The efficacy if fireworks legislation is proved to work as often after restrictions are repealed, there is an increase in the number of children suffering fireworks-related burns [92].

Enforcing fireworks regulations and restrictions worldwide is a major challenge for WHO, especially on low and middle-income countries [32].



Figure 10 – Fireworks

2.6.8 Safer stoves and lamps

These strategies are especially destined to low and middle-income countries. Most of the households on these countries, nearly 3 million people, depend on open fires for cooking and heat [32]. The use of open fires – Figure 11 - as well as paraffin stoves – Figure 12 - and lanterns – Figure 13 - are a major risk for burn injuries, in particular for children [93]–[98]. Legislation is almost non-existent or not correctly enforced and there has been low progress in providing electricity to residences [99], [100]. The combustibility of the fuel and the instability of kerosene stoves make countries like Egypt, Ethiopia, India, Nigeria or Pakistan

the leading countries with documented serious burn injuries [99], [101]–[107]. These stoves often leak fuel and can leak into clothes or its vapours can ignite when heat and flames are present. Two promising alternatives to open fires and kerosene lamps are the “plancha” and the safe bottle lamp respectively [32].

A study conducted in Guatemala concluded that an improved chimney stove, the “plancha” – Figure 14, can make a big difference by decreasing the incidence of burns on children by almost half and the severity of the burns was much lower in the majority of the accidents [25]. The “plancha” wood stove still uses a solid fuel (in the majority of the cases wood) but is much safer. The combustion chamber is enclosed and the cooking area is in a higher place, away from young children reach. It also uses a chimney what reduces smoke inhalation in the cooking area. The large majority of the “planchas” was funded by NGOs – Non-governmental organization [108].



Figure 11 - Open fire cooking



Figure 12 - Kerosene or paraffin stove



Figure 13 - Kerosene lantern



Figure 14 - The "plancha" wood stove

Sri Lanka is one the countries with the highest incidence of burns caused by kerosene lamps that are easily tipped over, thus causing kerosene spills and easily start a house fire [32]. A successful project was introduced in Sri Lanka by a general surgeon, Dr. Wijaya Godakumbura, who founded the SBLF - Safe Bottle Lamp Foundation - and developed the award winning Safe Bottle Lamp [39][41]. The Safe Bottle Lamp received three prestigious international awards: the Rolex Awards for Enterprise, Lindbergh and Reader's Digest Awards [109], [110], [111] and it's success of the initiative is well documented in several studies [25], [39], [41]. It was named "Sudeepa" – Figure 15 - and it make the difference because was designed to be more resistant to tipping over. It still is marketed in Sri Lanka and the main features are:

- Is squat and heavy, so that it would not tip easily
- Has a near globular shape and thick glass, so that it does not crack if it falls
- Has 2 flat sides, so that it would not roll if it does tip
- Has a screw-on metal lid, to prevent oil spill if it does tip
- Is capable of mass production at low cost
- Could be used for several years, as there are no delicate or moving parts [25], [32], [112]

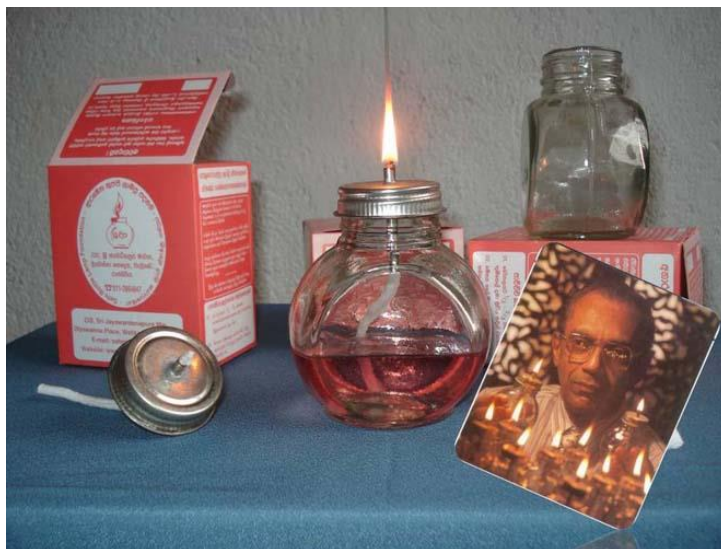


Figure 15 - "Sudeepa" safe lamp and inventor Dr. Wijaya Godakumbura

These two strategies to reduce burn injuries and deaths on low and middle-countries income, the “plancha” and the “Sudeepa”, prove that the best way to reduce burns is through prevention. The adage “Prevention is better than cure” is well appropriate about burn injuries to decrease burn accidents worldwide [112].

2.7 First aid

First aid is the first emergency treatment given to a victim after the injury occur and before specialized medical assistance can be obtained [113].

The first aid given to a burn victim is crucial to minimize tissue damage and associated morbidity [114], [115]. Several studies found quality evidences that properly given first aid lessens pain, reduces the severity of the injury (decreases burn depth, therefore speeds healing time), reduces hospital length time and decrease the risk of scarring [114]–[119]. Unfortunately, there is a low knowledge about first aid in the population which lead usually to inadequate first care. The primary objective of first aid is to cool down the area of the burn injury, so first responders needs to be adequately trained in what to do in case of a burn injury, either it is a family member, bystander or emergency medical technician [32],[113]–[121]. The principles of first aid treating thermal injuries victims incorporates four principles: removing clothing and jewellery from the burnt area, applying cool running water, covering the wound with cling film or a clean cloth and seeking specialized medical attention [122]. Although there is a little inconsistency about the duration of water cooling time, several studies demonstrated that 20 minutes is the optimal cooling time, as soon as soon as possible but up to three hours after the burn injury has occurred – Figure 16 [102], [103], [116], [109], [110].

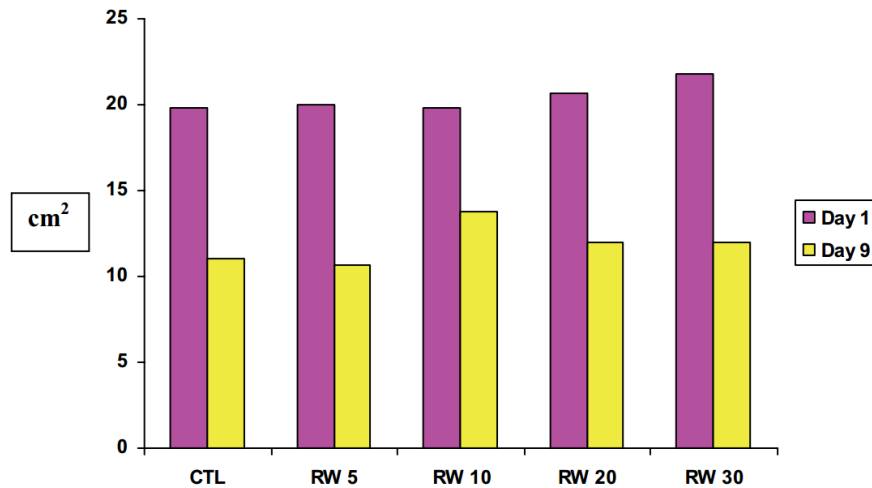


Figure 16 - Mean area of burn (cm²) at days 1 and 9 and Running Water (RW) time
Source: Optimal Duration of Cooling for an Acute Scald Contact Burn Injury in a Porcine Model [120]

There are other methods available to decrease the temperature around a thermal injury, like wet towels or water spray, but they proved to be not as efficient as cool running water – Figure 17 [119],[123].

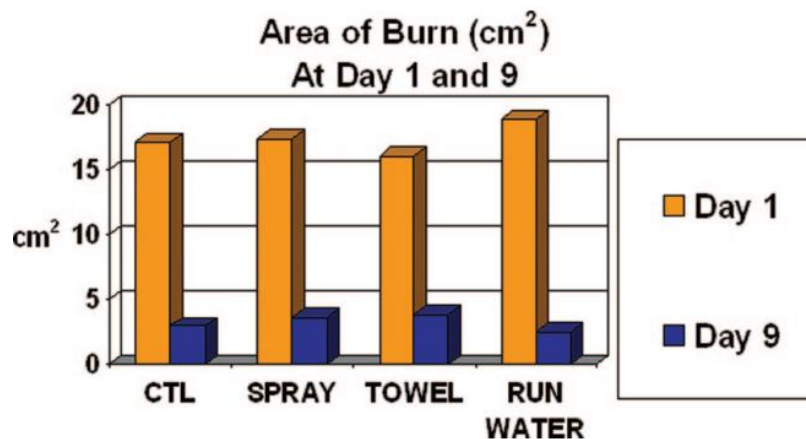


Figure 17 - Mean area of burn (cm²) at Days 1 and 9
Source: Assessment of Cooling on an Acute Scald Burn Injury in a Porcine Model [119]

Although applying first aid to burn injuries is quite easy to memorize – Figure 18 – and burn injuries are usual on children, society in general and parents in particular, have little knowledge about first aid treatment [124]–[129]. A study made in the UK concluded that only 32% of the parents, attending healthcare centres with burnt children, have adequate knowledge of first aid treatment that could help their children [127]. The main errors committed by the parents are the method to cool the burn area and the duration to apply cool water among the ones who use running water – Figures 19 and 20 [128]. Other dangerous first aid

options used, by lack of knowledge of the first responder, to try to cool down the burnt area are butter, ice, sugar water or toothpaste that are worse than don't administer first aid to the victims [32]. With such a high incidence of burn injuries in children, victims of burns and scalds, it is imperative that society in general acquire knowledge about first aid treatment.

WHAT NOT TO DO	WHAT TO DO
▪ Do not apply paste, oil, kumkum (a paste made from turmeric) or raw cotton to the burned area. ▪ Do not apply ice. ▪ Do not open the blisters with a needle or pin. ▪ Do not apply any material directly to the wound as it might become infected. ▪ Avoid application of topical medication (medication applied directly to the skin) until the patient has been placed under appropriate medical care.	▪ Ensure your own safety before commencing first aid (switch off electrical current, wear gloves to protect against chemicals etc.). ▪ In flame injuries, extinguish the flames by allowing the patient to roll on the ground, or by applying a blanket, or using water or other fire-extinguishing liquids. ▪ Stop the burning process by removing clothing and irrigating (rinsing or washing) the wounds. ▪ Apply cool water or allow the burned area to remain in contact with cool water for some time.* ▪ In chemical burns, remove or dilute the chemical agent by irrigating the wound with copious amounts of water. ▪ Obtain medical care.

Figure 18 - Recommended first aid treatment for burns

**avoid applying cold water to large areas of the body, especially on very young or very old, to minimize the risk of hypothermia*

Source: Burn Prevention Success Stories Lessons Learned [29]

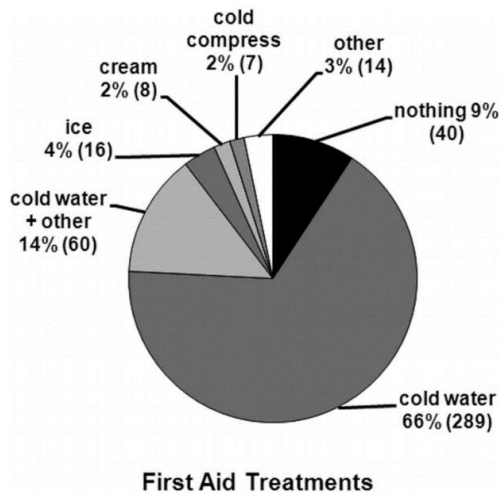


Figure 19 - First aid treatments used by parents
Source: An Audit of First-Aid Treatment of Pediatric Burns Patients and Their Clinical Outcome [128]

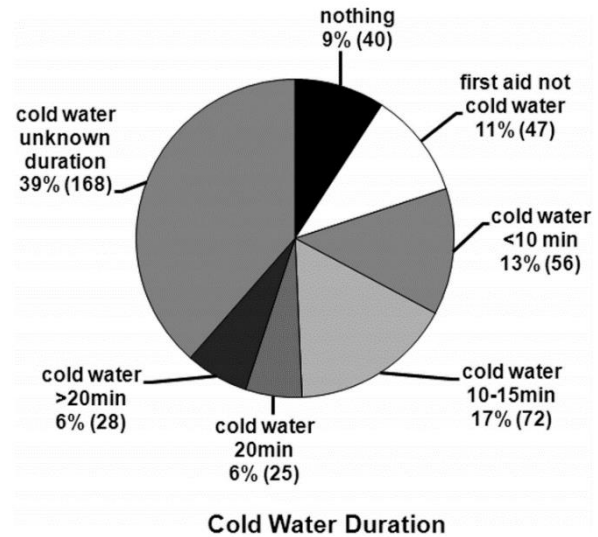


Figure 20 - Cool water duration applied to patients
Source: An Audit of First-Aid Treatment of Pediatric Burns Patients and Their Clinical Outcome [128]

2.8 Educational Approaches

If burn injuries can be prevented and most of the burn injuries occur on households, then it should be possible to reduce burn accidents through education of household residents [25]. Solid studies proved that children knowledge and awareness can affect the behaviours and habits of adults, namely their parents [130], [131]. One step in the right way is to increase knowledge of young children about burn injuries, risk factors and how to make households safer for them. Educational programmes in schools and communities proved to result on increasing burn knowledge on children [132]. Although the lack of rigorous evaluation of these programmes and their direct effect on reducing the incidence of burns, at least rises the knowledge of burns on the society [133].

Other strategies to educate parents about burns are community programmes to ensure good supervision of children, especially those with disabilities, advise against storage of flammable products at home. Using prenatal consultations to advice and prepare new parents to the risks and factors of burns has also been proposed as primary prevention strategies for burns [25],[41]. Advising parents about safety equipment is documented to increase knowledge but is yet to be evaluated if this leads to a reduction of burn injuries occurrences. Home visitation

programmes suggest that their effectiveness is not as high as it is on families that visit children centres or when added on-site access to reduced price safety products [134], [135]. Educational programmes complemented with changes enforced by law appear to have more chances of success [25]. A study in Canada concluded that through a combination of educational and legislative measures, 531 Canadian dollars (US\$ 507) could be saved by scald on scald burns prevention [66].

2.9 Chapter Conclusion

Burn injuries are a very serious problem around the world with high incidence particularly on low and middle-income countries where over 95% of burn injuries occur. WHO estimates that 265,000 people die every year from fires alone and other 180,000 resultant of scalds, electrical or contact burns. Not only the deaths represent a problem but also the morbidity that is a leading consequence of burn victims. On high-income countries there is still a very large number of victims, but the incidence seems to be decreasing over the last years. Most of the victims are children and women and the majority of the accidents occur at home.

Burn injuries can be reduced through prevention and WHO appoints prevention as the reason why burns occurrence is decreasing on high-income countries. Several proved effective preventions strategies like installation of smoke detectors and sprinklers, hot water temperature regulation, non-flammable fabrics, electrical safety, safer stoves and lamps could only be implemented on high-income countries. On low and middle-income countries is very difficult to implement most of these strategies due to lack of electricity and poor quality of life. Some strategies proved to be very useful for these countries like the “plancha” or the “sudeepa” but are still very little improvements for what is needed to decrease burn occurrences on low and middle-income countries.

First aid procedures are very important to reduce the severity of burn wounds but there is a lack of knowledge on society in general, especially parents, on what to do in case of a burn accident occur near them. Several studies proved the

effectiveness of properly given first aid care to a burn victim in decreasing the recuperation period, tissue damage and so the risk of scarring.

Families and community healthcare systems also have a huge burden to bear due to burn injuries. Families must support the costs with the severe consequences of burn injuries like long-term rehabilitation, social rejection, lost education days, possible future unemployment and possible psychological problems. The countries healthcare system also has large costs to support has burn centres are hugely expensive to maintain and funds from other health areas are frequently diverted to fund burn centre costs.

The potential to reduce individual and societal costs by carrying out effective burn prevention interventions is huge. Educational strategies combined with law enforcement seems to be more effective than any of them alone. Introducing burn safety procedures at school and try to make them alert their parents to the risks of burns injuries and at the same time reduce the hazardous on the households is a strategy implemented but still lacks proof of effectiveness. Advising recent, or future, parents with on-site access to reduced price safety products also seems a way to achieve success on burn prevention.

Impact of the internet on burn injuries

In this chapter the impact of the internet is analysed, not only in healthcare but first, how does affect the lives of the world population. The second part of this chapter is reserved to analyse the quality of some of the websites, available worldwide regarding burn injuries. The chapter is organized as follow:

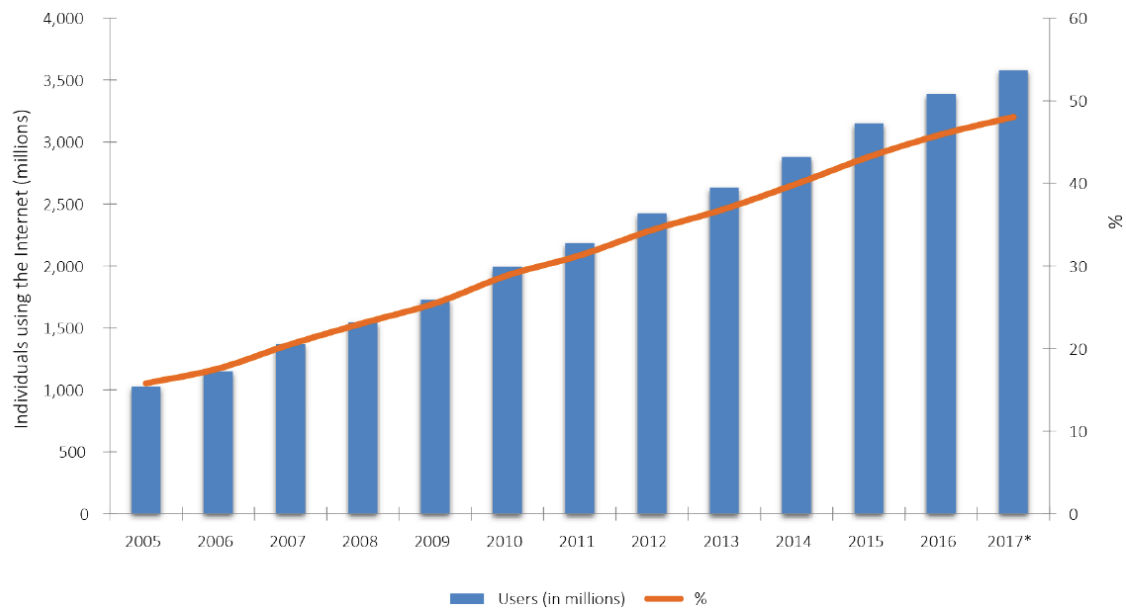
1. Development of Information and Communication Technology - ICT;
2. Importance of ICT on healthcare;
3. Advantages and disadvantages of internet health information;
4. Evaluation of burn injuries websites.

3.1 ICT development

The rapid expansion and evolution of the ICT – Information and Communication Technology - on society, over the last two decades, led us to a worldwide globalization and social interaction. The modern society, people of all ages, embraced the modern technology through the usage of computers, smartphones and the internet [16].

Internet usage has been rising year by year around the world. ITU - International Telecommunication Union - estimates that in 2017 almost 50% of the world population (3,500 million individuals) had access to internet - Figure 21.

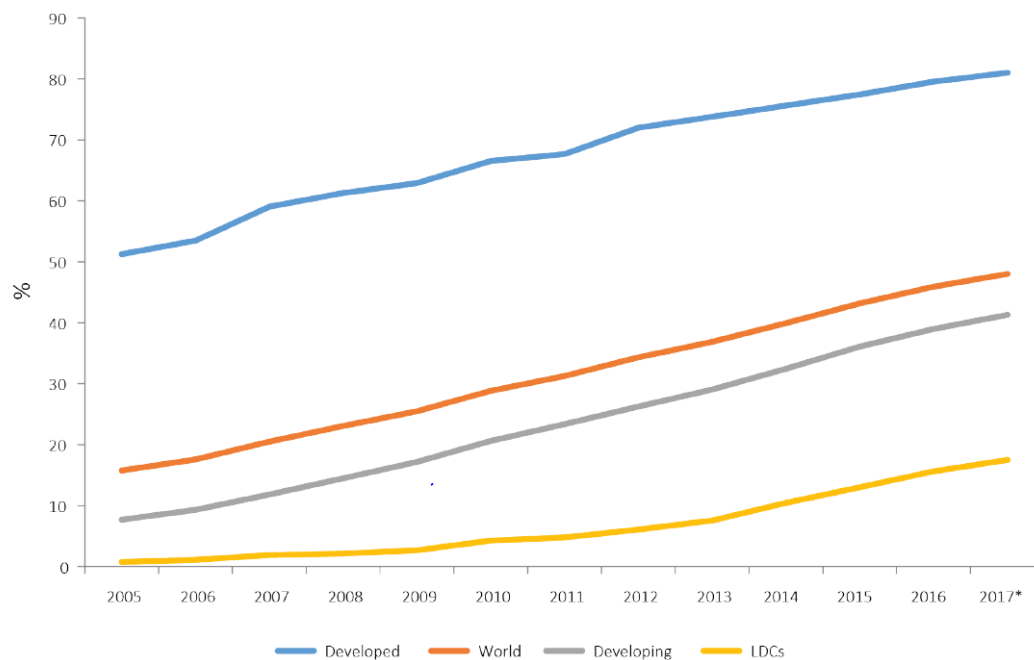
3. Impact of the internet on burn injuries



Notes: * ITU estimate.
Source: ITU.

Figure 21 - Individuals using the Internet, 2005–2017

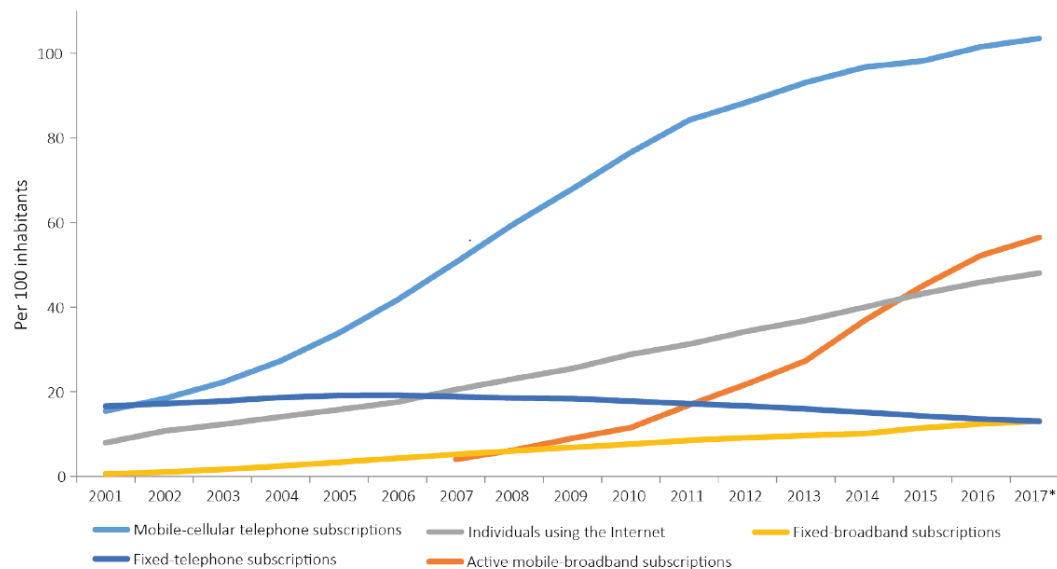
The upwards trend of individuals using the internet has been maintained also on developing and LDCs – Least Developed Countries - but still very far of the developed countries – Figure 22.



Notes: * ITU estimate.
Source: ITU.

Figure 22 - Proportion of individuals using the Internet by development status, 2005–2017

The increase of internet usage was largely influenced by mobile phones proliferation on society. ITU estimated that, in average, 100 in each 100 inhabitants had a mobile-cellular telephone subscription in 2017. The mobile-broadband subscriptions have been rising exponentially since 2007, the date of release of the first-generation iPhone – Figure 23 [136].



Notes: * ITU estimate.
Source: ITU.

Figure 23 - Global ICT developments, 2001-2017

With the worldwide spread of smartphones and internet usage, more and more people around the world are interconnected and dependent on technology both for work or recreation purposes. There is even a concern about the excessive dependency of technology on our society and the tendency is to increase as younger and elderly citizens are also becoming frequent internet users [15], [136], [137].

It became routine search any doubt, about any subject, on internet instead of searching on books or newspapers. The internet search engines quickly became an external memory source that can be accessed at any time [15], [16], [136]–[138].

Google search engine became very popular and today is the leading search engine with a market share of around 70% on accesses from desktops and laptops, rising to above 85% on accesses from mobile phones and tablets [13].

Expressions like “Google Know everything” and “Google it” became popular over the last few years [139].

3.2 ICT on health

As the internet usage increased and the access to information is easier than ever, health-related websites become the first source of health information for patients or caretakers. Making a prior assessment of symptoms and possible disease before seeking professional medical assistance for a diagnosis became a habit [140], [141]. People want to stay more involved in their health and feel that internet can increase their knowledge about their medical condition. It is not unusual people self-medicating by querying online the symptoms and reach to a diagnosis instead of going to a medical centre and wait several hours until getting seen by a doctor [140], [142]. According to Google Company: “one in 20 Google searches are for health-related information” [143].

Internet is also being largely used in parenthood, especially the new generation of parents. Young parents turn more and more to internet to research prevention and health care for their children. The new generation of parents rely more on the new technologies rather they do on family and friends advices because of the larger range of opinions and suggestions the internet provides [8]. The concern about safety and healthcare begins even before the child is born. A recent study conducted with pregnant women concluded that 76% of them had searched the Internet for medication safety information [144].

The majority of parents report they find healthcare related websites primarily through the use of search engines [8].

3.3 Pros and Cons of internet health information

Internet access brought good things like easy access to information and universal connectivity but also brought a few problems and concerns. People get more involved on their health issues and have more knowledge to take part on health decision making. With the knowledge they acquired on the internet, patients have also a better understanding of what the professional health care says. It also

facilitates the interaction and conversation between patient and doctor that can lead to some doubts the patient may have [142]. Patients that have been already been diagnosed are better informed about their disease and internet also helps reduce loneliness and isolation on patients with low mobility [140].

Several studies revealed that even medical class believes the internet is the best way to transmit burn prevention information rather than release sessions or hospital sensitization sessions [6]. Despite the risks, it is also the easier way to change behaviours or passing on knowledge from medical staff to patients [7].

On the other hand, studies suggest that the habit of using search engines regularly may lead to a decrease of memorisation ability by knowing that the answer is on the internet [145]. The information available online is not always accurate. Quality control of healthcare websites is a very serious issue and cannot be regulated because several websites are only blogs and personal webpages that can easily misinform patients. The misinformation could lead to wrong self-medication and can have serious consequences on health as the false sense of security and knowledge may prevent patients to seek professional medical attention [140]. When the diagnosis made by a physician is not in line with the self-diagnose made by the patients, it can generate a discussion between patient and doctor. Usually the outcome is a lack of believe and trust of the patient towards the professional medical staff [142].

3.4 Health information websites

Much of the information available online is not accurate and that can easily mislead people to take wrong choices when they need do advice or put in use to help someone, as it is documented on several studies [146]–[148]. As one of our goal is to battle against the disinformation available online we need to uncover what websites about burns exists, study their strengths and weaknesses so that our website can be a reference between the ones about burn injuries. Also burn injuries first aid information available online was considered not very helpful by a study conducted in 2006 [149].

A study from Australia analysed burns websites to evaluate content accuracy and website quality (based on accessibility/usability, credibility and currency) [122]. We used the evaluation of this study to know how to turn our website in a strong platform and try not to make the same mistakes of the existent websites with many inconsistencies [122], [149]. As there is no tool to select sample websites for research purposes, they selected their websites through search engines entering “burn first aid” [122], [150]. The authors based their evaluation on two areas: content accuracy that was assessed by the site’s attachment to the basic four principles of burn first aid – remove, cool, cover and seek [151]; and website quality (accessibility/usability, source credibility and currency) was assessed by a criterion developed by Hoffman-Goetz and Clarke [146] and on Health on the Net Code of Conduct (HONcode) [152].

3.4.1 Website Quality Assessment

The information available online, not just about health, is too much and is became difficult to distinguish author from shill, fact from opinion, science from hype or even evaluate the quality of editorial content. The principles to allow users to judge the quality of information are the same as the ones from a scientific article:

- Authorship: Should be provided information about authors and contributors, their affiliation and relevant credentials;
- Attribution: All content references and sources should be explicit as well as all the relevant copyright information;
- Disclosure: the ownership of the website should always be disclosed, as should any conflict of interest, sponsorship, advertising, commercial funding or support, including arrangements in which links to other websites are posted because of financial benefits;
- Currency: Should be indicated the dates of the posted contents and updates [153].

The two methods used to assess the available websites about burns was: Hoffman-Goetz and Clark criteria and the HONcode.

3.4.1.1 Hoffman-Goetz and Clarke criteria

The Hoffman-Goetz and Clark criteria was used on a study to evaluate the quality of breast cancer websites [146]. It was an updated method previously used on a study, made in 1998, whose objective was to uncover how to assure the quality of the medical information available online [153].

The criteria used included:

- Site disclosure: credentials of site owner, copyright information and financial charges for site services;
- Site currency: date contents posted and updated as measures of timeliness;
- Source attribution: identification of references or sources for information contents;
- Site authorship or ownership: individual, group, government or non-profit organization, commercial organization, not identified;
- User interactivity: email communication or telephone and links to other sites;
- Privacy protection: security and disclaimer for the information sent by the internet user;
- Type of site: news or support groups, chatrooms, government or non-profit organization information sites, commercial sites, other groups such as health maintenance organizations; individual or personal sites; or sites that could not be classified into the above categories [146].

3.4.1.2 HONcode – Health on the Net Code of Conduct

Health On the Net is a non-governmental and a non-profit organization who has official relations with the World Health Organization and promotes transparent and reliable health information online. Health On the Net introduce themselves as the most widely accepted reference for online health and medical publishers, used by over 7,300 certified websites, more than 10 million pages, covering 102 countries and their site is visited by 27,000 visitors worldwide per day [154], [155].

The HONcode is a certification that aim to improve the quality of health information and allow the user to judge if the information available is trustful or not. If the website passes successfully the examinations and verifications, the websites is promoted by The Health On the Net Foundation and gets a certified seal of the HONcode to promote its certification [156].

The HONcode has eight principles that every certified website must oblige:

1. Authority: Any medical or health advice provided and hosted on this site will only be given by trained and qualified medical professionals unless a clear statement is made that the advice offered is from a non-medically qualified individual or organization.
2. Complementarity: The information provided on this site is designed to support, not replace, the relationship that exists between a patient/site visitor and the patient's/site visitor's physician.
3. Privacy policy: Personal information about patients and visitors to a medical site, including their identity, is confidential. The website's owners pledge to respect the legal requirements for medical information confidentiality applicable in the country in which the server (as well as any mirror sites) is located.
4. Attribution and date: The source of the information provided on the site is explicitly mentioned and includes, if possible, a hyperlink to the original source. The date of the last modification of the content must appear on the web page (for example, at the bottom of each page).
5. Justifiability: Any claims relating to the benefits or performance of a particular treatment, product or commercial service will be supported with appropriate and balanced evidence and referenced according to principle 4 above.
6. Transparency: The creators of the site aim to provide the information in a manner as transparent as possible and will provide contact information for visitors who seek further information or support. This address (email) must be clearly displayed on the website pages.
7. Financial disclosure: The financial support of a site must be clearly identified, including the identities of commercial and non-commercial organizations that provide funding, services or materials for the site.

8. Advertising policy: The site will clearly indicate if advertising is a source of funding. The website owner will provide a brief description of the advertising policy adopted. Advertising and other promotional material will be clearly presented to the user to differentiate it from the information created by the institution managing the site [154], [155].

3.4.2 Websites evaluated features

After combining these two methods, the study named “A content analysis of burn first aid information online” the features to evaluate was defined [122]:

- Website quality:
 - Provided languages
 - External links to other webpages or scientific articles
 - Content authorship
 - Source attribution
 - Financing sources and potential conflict of interest
 - Content information currency (initial posted information and update dates)
 - Crisis usability (how quickly burn first aid could be found on the website):
 - 2-3 mouse clicks
 - Information easy to understand and follow
 - Images to explain the process
 - Step by step indications
 - Information about burn degrees (severities)
 - 1st, 2nd or 3rd degree
- Website accuracy:
 - Four basic principles on burn first aid (remove, cool, cover and seek)
 - Provided information simplicity
 - Inclusion of images and videos to help on first aid

3.4.3 Websites evaluation conclusion

After analysing the websites, the study concluded a series of inconsistencies and inadequate contents available on some of the websites but also some useful strengths. Content accuracy scores and website quality scores are represented on Figure 24. Most of the analysed websites have much better quality than content accuracy [122].

3.4.3.1 Content accuracy

- Cool Running Water – CRW – time is not accurate (from several minutes to 10-15 minutes)
- Almost any websites warned against the danger of hypothermia when applying CRW
- Not mentioned alternative treatment when water is not available
- Lack of first aid advices in the case of the victims are children
- Alert against the use of ice on burn injuries but one site advice to use it
- It should be different first aid advices whether is a superficial or deep dermal burn.
 - Burn severity indication are not uniform: some websites use the correct terms like 1st, 2nd or 3rd degree burns others use terms like superficial, partial or deep dermal.

3.4.3.2 Accessibility/usability

- Only a few sites offer languages different from English
- Text resizing possibility is almost inexistent
- Lack of additional media such as video and audio
- All the sites are adaptative to mobile phones
- Most of the sites include a search mechanism
- About half of the websites provide images to help explain first aid procedures
- All websites provide external links to another webpages, although:
 - the majority are to commercial and products and services
 - a few are to health-related sites

3.4.3.3 Credibility

- Medical institutions/organization connections help increase credibility
- Authorship of the contents of webpages should have medical background
- References or sources for borrowed contents
- It should always be included a disclaimer that the information available on the website does not intent to replace the advice of a health professional
- The source of funding, or lack of it, should be included

3.4.3.4 Currency of contents

- It is very important to display the date of when the information was published online;
- It is equally useful to display any date of updated contents

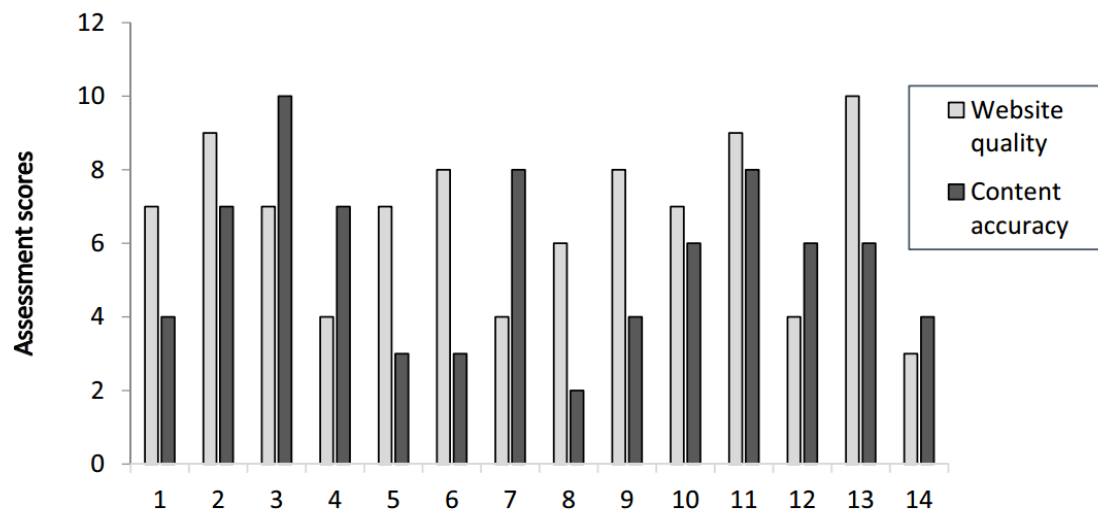


Figure 24 - Content accuracy scores (out of 10) and website quality scores (out of 12) for each of the 14 included websites

Source: Inaccurate , inadequate and inconsistent : A content analysis of burn first aid information online [122]

3.4.4 Portugal websites analysis

In order to evaluate the quality of the websites about burn injuries in Portugal, a search was made through Google search engine. The history and cache of the browser was deleted so that the results were not biased. The used query was “primeiros socorros queimaduras” (“Burn first aid” in Portuguese) and the language selected was Portuguese from Portugal. The goal was to avoid the webpage results coming from Brazil - Portuguese from Brazil. This search returned seven results on the first page of the google search engine. Four of the webpages were immediately excluded: three results have the domain .com.br (domain from Brazil country) with language terms used exclusively on Brazil and one was from slideshare.com (slideshow presentation). The remaining three results were analysed as follow:

1. The first website seems to be a blog, with very little information and without authorship of the contents. The affiliation of the website also remains unknown, it does not disclose whether it is a personal blog, healthcare centre or an investigation project.
2. The second analysed webpage has the information accurate with additional media (video/images) and authorship of the contents. The affiliation of the project is disclosed and is HONcode certified (section 3.4.1). Although the origin of the project is from Brazil, it is notable a special care in the used language to approach the Portuguese from Portugal Languages. Maybe one of the reasons it is because of the team has Portuguese and Brazilian collaborators. It lacks prevention strategies, but it is a generic health platform, not exclusively dedicated to burn injuries.
3. The third analysed result is from a Portuguese healthcare centre. The contents are text only, without images or video and the authorship is not disclosed. As it is a website from a medical centre it is logical to assume that the information was validated by a physician. The contents are clear but not very accurate: ice is advised to be used in burn hounds, but the ice is usually advised against in several investigation articles (section 2.7).

3.5 Chapter Conclusion

Internet access is now a feature of a large part of households around the world. Internet quickly became a source of knowledge to every unknown topic, healthcare included. Although internet usage can be positive and useful, it can also be dangerous because of the incorrect contents available and can mislead users to a wrong sensation of knowledge [157]. A large part of internet users reaches to information websites through search engines, being Google the market leader and mobile phones users leading accesses. The new generation of parents use internet when in doubt about children illnesses or prevention. People are more and more self-diagnosing and self-medicating instead of searching professional healthcare.

It is clear the importance to have accurate and reliable information online to decrease the misinformation take over society. Since most of internet accesses are originated from mobile phone and through Google search engine, a website is the best form to provide burn information to the community.

The quality of the available websites is also lacking accuracy, despite the quality of the design being very good. Although an appealing and functional website can have a high number of visitors, what can save lives is the information in it. The accuracy of the information on most of the analysed websites, was not very encouraging. On the study analysed on section 3.4, there were a high number of websites to search information but the number of websites in Portugal is way less. With the conclusions gathered from this chapter, the web information system that the researchers want to develop can be a reference worldwide. There are several techniques to make a web system both accurate and with quality of information and this chapter exposed some of them: currency of contents, credibility, usability/accessibility and content accuracy.

Queimados.pt

The aim of this dissertation is to develop a tool with useful, reliable and trustworthy information about burn injuries. Given the huge number of victims by burns – Chapter 2 and, the dependence of the internet by society nowadays to search topics about health, the continuous increase of internet connections around the world – Chapter 3, It was concluded that a web information system would be the best tool to achieve our goals. The objective of this platform is to increase the knowledge of the Portuguese society about burn injuries and use Cintesis expertise to try to decrease burn occurrences in Portugal. For this reason, the developed tool was designed in Portuguese in the first phase, but with the incorporation of other languages in the horizon.

This chapter describes the features implemented on the web information system and the development process is explained with detail.

4.1 Queimados.pt features

After doing the state of art of burns websites - Chapter 3 - (foreigner and in Portugal) and studied all their strengths and weaknesses we had a clearer view of what features must be implemented on our website.

4.1.1 Website quality features

- Adaptative to all platforms (computer, tablet, mobile phone)
- Different languages (on the first stage only PT but prepare the structure to add later without major difficulties)
- Dynamic contents (use of databases)

- Develop Backoffice to provide quick maintenance even for users without programming knowledge
- Optimized to be on the first positions of search engines
- Information provided must be recognized and validated by a healthcare professional
- Display the date of inserted contents to insure updated information to internet users
- First aid recommendations:
 - Quick to find on the website (quick links)
 - Simple topics but enlightening, easier to understand and follow
 - Step by step procedures
 - Educational images to provide additional information and easier to follow
 - Add videos of the procedures whenever is possible
 - Different guidelines to provide first aid to children or adults
 - Provide alternatives to CRW (in case there is no water available)
 - Provide forbidden substances like ice or aloe vera
 - Different recommendations for each cause of burn and depth or degree.

4.1.2 Website Information to provide

- Burn facts
 - Worldwide and country percentage of incidence on children and adults
 - Hospitals statistics
- Commonly burn causes
 - Friction, contact, electricity and sunburn
- Prevention strategies
 - Prevention for children burns on households
 - Prevention for elderly people
 - Prevention at workplace
- Provide information about burn injury by degree
 - Present photos

- Display time of recovery for each degree
- Demonstrate the information about the effectiveness of first aid
 - Statistics with proved benefits
 - Lessens pain
 - Decreases scaring
 - Reduces the severity of the injury
 - Speeds healing time
 - Reduces hospital length time
- Explain with detail the four basic principles of first aid burns
 - Remove, cool, cover and seek
- Alert to wrong myths on burn treatment
 - Apply ice, aloe vera, moisturizer and antiseptic cream or hydrocortisone
- Display common first aid errors
 - Not applying CRW for enough time
 - Use of creams not recommended for first aid
 - Not warming the victim to reduce the risk of hypothermia
- External links to provide additional information
 - Health related institutions
 - Scientific articles
- Burns related news
- Contacts from burn centres, burn associations

4.2 Development process

This project was based on the creation of a platform to provide burn injuries information to the Portuguese community. To achieve our goals, we needed to evaluate the best way to transmit the information to the largest part of the community as possible. At this moment the target group is only the Portuguese community, but we have the ambition to reach other communities with the incorporation of other languages on our project.

We went through several processes and steps to be able to reach our objectives of developing a bridge of knowledge between healthcare professionals and the general population. After deciding the best way to do that was to develop a website, several options needed to be made so we began the development process of our software development.

The development process of a software consists on several activities such as:

- Requirement analysis – Understanding the problem
- Design – Deciding a plan for the solution
- Coding – Coding the planed solution
- Testing – Testing the program [158]

There are several approaches to developing a software development process model starting with a waterfall process, moving to spiral development and currently focused on object-oriented (OO) design [158], [159].

The waterfall model was introduced in the 1970's and is characterized by the sequential evolution of typical life-cycle phases, allowing iteration only between adjacent phases – Figure 25. Some of the recognized advantages are: easy to understand and implement, reinforces good habits: define-before-design and design-before-code, identifies deliverables and milestones and works well on mature products and weak teams. The appointed disadvantages are: Real projects rarely follow the sequential approach, there is uncertainty at the beginning of the project regarding requirements and goals; this model does not accommodate these uncertainties very well, it does not yield a working version of the system until late in the process [158]–[161].

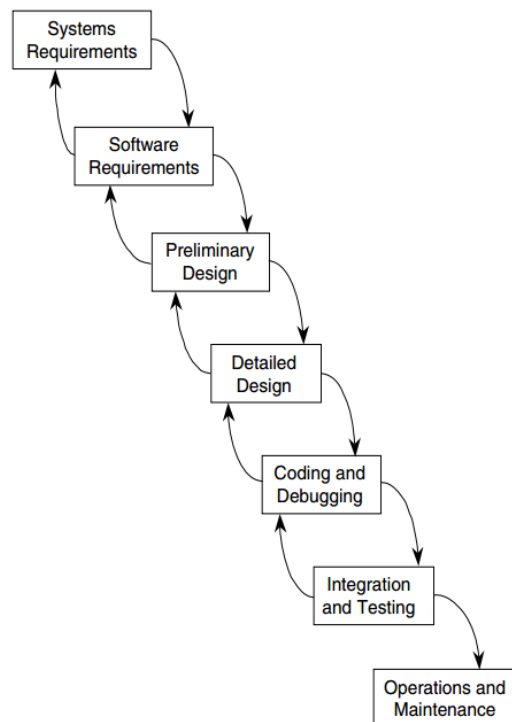


Figure 25 - Waterfall model

Source: *The Engineering Design of Systems: Models and Methods* [159]

The spiral model was developed in the 1980's, modified several times and has two distinctive features: one is cyclic approach for incrementally growing a system's degree of definition and implementation while decreasing its degree of risk and the other is a set of anchor-point milestones for ensuring the stakeholder commitment to feasible and mutually satisfactory system solutions – Figure 26. The advantages of spiral mode are: was designed to include the best features form Waterfall and Prototyping Model, good for large and mission-critical projects, includes risk assessment, an initial version of system is developed and modified based on input from customer. The disadvantages are: can be a costly model to use, risk analysis requires highly specific expertise, project's success id highly dependent on risk analysis phase and doesn't work well for smaller projects [158], [159], [161].

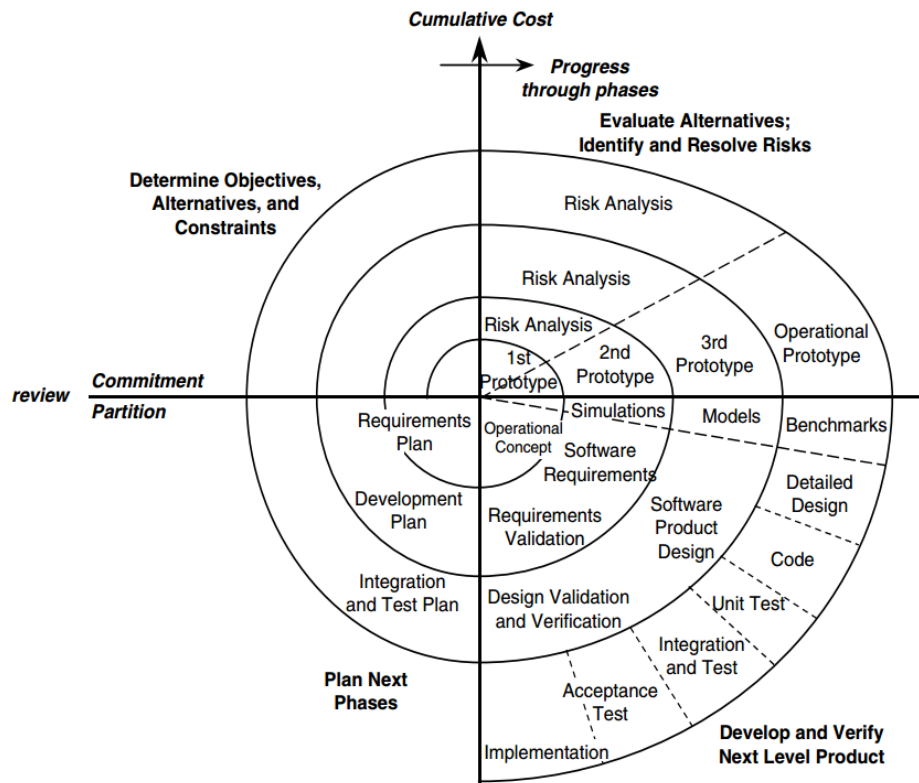


Figure 26 - Spiral model

Source: *The Engineering Design of Systems: Models and Methods* [159]

Object-oriented design was developed following object-oriented programming. OO design is a bottom-up process that begins by defining a set of objects that need to be part of the system in order to achieve the system-level functionality desired. Agile approaches - Figure 27 - are a model-driven approach of software development [159]. The agile development approaches are typically concerned with maintaining user involvement through the application of design teams and special workshops. The delivered increments tend to be small and limited to short delivery periods to ensure rapid completion [158]. Some of the recognized advantages of Agile are: Lightweight methods suit small-medium size projects, produces good team cohesion, emphasizes final product, Iterative, test-based approach to requirements and quality assurance. It also has some disadvantages like: difficult to scale up to large projects where, needs experience and skill if not to degenerate into code-and-fix, programming pairs is costly documentation is essential and test case construction is a difficult and specialized skill [158], [160].

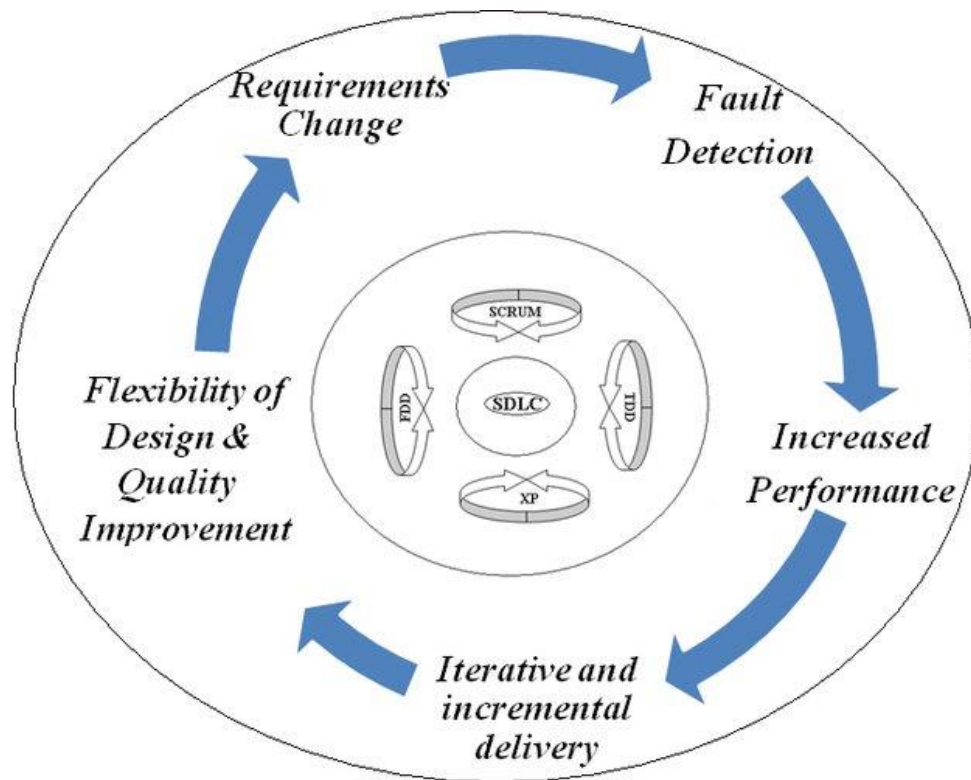


Figure 27 - Agile model

Source: *Impact of Agile Methodology on Software Development* [162]

The chosen development model to our project was the waterfall approach due to the necessary steps to implement the solution, as it is necessary to conclude a step before initializing the next. The spiral model was not an option because our project was not divided in cycles therefore the development stages was done at the same time. The agile approach was also excluded as the features of our software was all defined in the beginning of the project.

Due to the complexity of a project like this study that requires so much investigation, each activity had to be divided into smaller steps. The full path to reach our goals - Figure 28 - includes the following steps: Previous assessments and planning, Requirements, Analysis and conception, Implementation, Evaluation and Validation. These steps are described, with more detail, on the following sections.

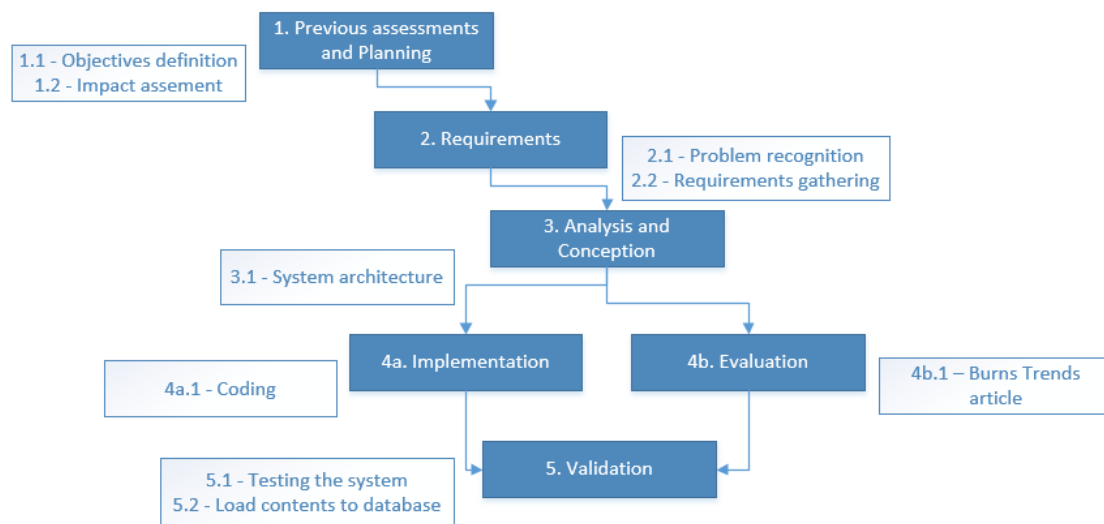


Figure 28 - Development process Queimados.pt

4.2.1 Previous assessments and planning

The previous assessments and planning were divided in two tasks: Objectives definition and Impact assessment.

The main objective was to provide reliable burns information to the Portuguese community. At this point it was unknown what the best channel was to share the information with the community, so the team began to assess the impact of the internet in the society. The researchers begin to study the Information and Communication Technology (ICT) on society. We realise that the demand for internet access is rising day by day around the world, even on low and middle-income countries (section 2.1). So, the next step was to assess the impact of ICT on health (section 2.2). With this assessment it was found that internet is having a great impact on healthcare these days and people with the easy access to internet are getting more involved with their health. It was discovered that 20% of internet searches made though Google search engine (market leader on search engines) were related to healthcare. Even parents nowadays are using the internet to get information, and feedback for other parents, on how to become better at parenting. Despite the pros and cons of the internet on health-related issues (section 2.3), we can only seize the cons and try to minimize the effects of the cons.

After confirming that most parents use search engines to find healthcare websites on the seek for knowledge, the choice was made: it would be very useful to the community to develop a web information system with burn injuries information.

4.2.2 Requirements

The requirements phase was divided on problem recognition and requirements gathering.

On problem recognition it was needed to study how serious and global the burn injuries problem is (chapter 3). It was used mostly the information provided by the World Health Organization (WHO) to classify burns by cause (presence or absence of an inhalation injury), by degree (depth of burn) and for extension Total Body Surface Area burned (section 3.1). By Identifying the risk factors, we discovered that women, children and older people are the most affected by burns and the majority of burns occurs at home and on the workplace (sector 3.2). We analysed the mortality and the Disability Adjusted Life Years (DALYs) and found out that the problem is more serious on low and middle-income countries, where about 95% of burn injuries occur (section 3.3). The problem with burns is global, although is more serious on lower-income countries where burn preventions cannot be applied like on high-income countries (section 3.4). This way, we concluded that burns can be prevented and WHO has been pushing for changes around the world to help decrease thermal injuries incidence – The BURN PLAN (section 3.4.1 and Appendix A). Burn injuries represent a huge burden not only to families who suffer with the after effects of the accidents but also on the countries healthcare system. Documented information was found, on how much more expensive it is to the hospitals to have a burn centre to treat burn victims, compared to those who do not have a burn centre (section 3.5). According to our research, burns are preventable but there is still a big lack of knowledge about how to avoid burn injuries, but there are many proven prevention methods to help reducing these accidents (section 3.6). When is not possible to avoid burn accidents, correctly provided first aid has, documented, impact on the after effects. There is almost a complete disregard for first aid information, but it is vital that the fundamentals of burn first aid make part of public knowledge (section 3.7). Although preventions strategies avoid accidents, not always people are

receptive to these advices as it is proven that educational approaches together with law enforcement works way better than simple education. Implemented strategies like reaching to parents through children education at school, appears also to be effective but still lacking scientific validation (section 3.8).

On the requirements gathering phase a study was used, published on the Burns Journal, that analysed the online available sites about burn first aid – Inaccurate, inadequate and inconsistent: A content analysis of burn first aid information online (Chapter 4). By studying their conclusions, it was made a made a list of all the pros and cons found on the analysed websites regarding website quality and website accuracy (section 4.1.2). On the website quality assessment, the analysed topics were: provided languages, external links, content authorship, source attribution, financing sources and conflicts of interest, content information currency, crisis usability and information about degrees of burns. The website accuracy was measured by analysing the information about burn first aid, provided information simplicity and inclusion of images and videos to help on first aid assistance. After a quick analysis on burn webpages information in Portugal (section 4.1.3.5), we came up with the features and accuracy that we needed to include on our system in order to make it the most complete possible (section 4.2). The goal was to develop a website with the following quality features: adaptative to all platforms, different languages, dynamic contents, Backoffice development, optimized to be on the first positions of search engines, recognized and validated information, content currency dates and detailed first aid recommendation. The information to be provided was also defined: burn facts, burn causes, prevention strategies, burn injuries by degree, demonstrate the effectiveness of properly provided first aid, detailed first aid with commonly committed errors and myths, external links, burns related news and contacts from burn centres and burn associations.

4.2.3 Analysis and conception

The analysis and conception phase included the system architecture and design of the website. The first step was to come up with the name for the website to buy the domain. After some suggestions in a meeting between the team involved in the project, the name was defined: Queimados.pt. A quick investigation revealed

that the domain was for sale and therefore available, and it was enough to advance to the process with CINTESIS funding the purchase.

After analysing the different development processes available we decided to choose the waterfall approach (section 4.3). The next step was to choose the programming language and the layout of the website. The obvious choice was to use the free open source PHP/MySQL for two big reasons: it is free so minimizes the project costs and because the developer has a background of using this platform on his professional life. Without a web designer involved on the project, the solution for the layout was to find one template, on the internet, that could be the source for queimados.pt – Figure 29. The layout was chosen by the simplicity and bright colours in a meeting with all the involved in the project.

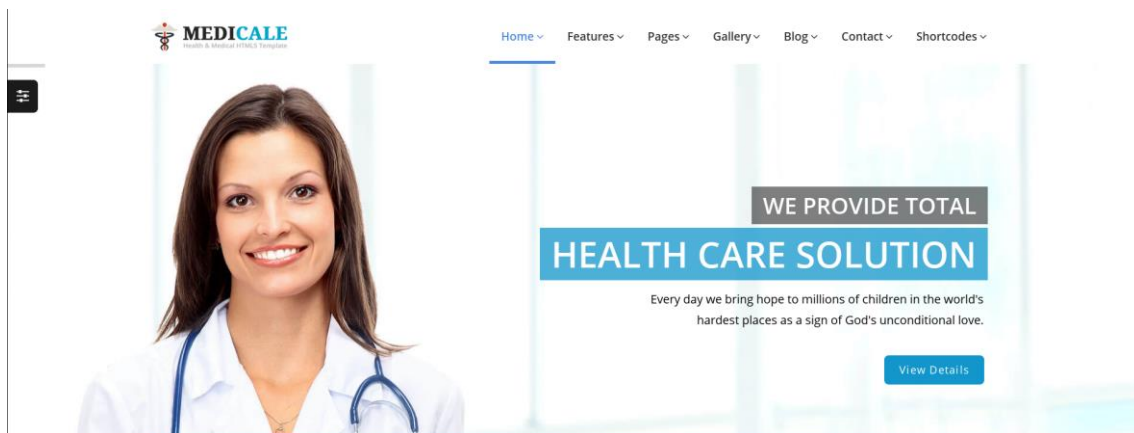


Figure 29 – Chosed layout for queimados.pt

A Solution Requirements was also made to queimados.pt, which was divided in two: Functional Requirements and Nonfunctional Requirements. This analysis was made to describe the characteristics that our product must have to meet our goals. The functional requirements describe how a product must behave, what are its features and functions. The nonfunctional requirements describe the general characteristics of a system [163].

4.2.3.1 Functional Requirements

- Quick access to the featured news from database: more relevant news on a dynamic timed slideshow;
- List burn causes with link to more detailed information from database;

- Provide detailed information about burn severity from database;
- Display burn first aid advantages and benefits;
- Provide simple, detailed and step by step information regarding burn first aid with additional media: images and/or video;
- Display four random burn facts on the first page of the website;
- Provide detailed information regarding burn prevention for households, children, elderly people and for the workplace;
- Display dynamic useful burn testimonials from database;
- List, by date, three latest news about burns at homepage with a link to the listing of all the news from database;
- Provide a footer section with quick access links to both internal and external pages;
- Permit search of key words to the web users;
- Permit access to the Backoffice to the webpage administrators (after login) so that contents could be easily added, changed or removed – Figure 30.

Queimados.pt	News - Featured	Load from database
		Dynamic timed slideshow
	Burn causes	Load from database
		Display Information
	Burn severity	Load from database
		Display Information
	First aid	Load from database
		Display Information
	Fact sheet	Load from database
		Four random facts
	Prevention	Load from database
		Display information
	Testimonials	Load from database
		Dynamic timed slideshow
	News - list	Load from database
		Display three latest news
		Display information
	Footer	Load from database
		Display information
	Backoffice	Log on
		Load from database
		Insert/Update/remove information

Figure 30 - Functional Requirements

4.2.3.2 Nonfunctional Requirements

- Alert population to burn injuries incidence and facts;
- Decrease burn injuries incidence;
- Increase the knowledge of the community about burn first aid benefits;
- Reduce the severity of burn victims;

4.2.4 Implementation

The implementation phase consisted on the development of the platform through programming skills. On the coding process several coding techniques for web were used like PHP – PHP: Hypertext Preprocessor, JavaScript and CSS – Cascading Style Sheets. MySQL was the relational database management system as it is open-source and widely used by programmers around the world.

4.2.4.1 Functionalities

Before starting coding, it is very useful to know what functionalities are to be included on the platform. One of the best forms to have a clear perception what are the functionalities that need to be included on the project, is to use UML – Unified Modeling Language – and draw a use case diagram. The purpose of a use case diagram in UML is to demonstrate the different ways that a user might interact with a system. An effective use case diagram can help teams discuss and represent: scenarios in which the systems interacts with people, organizations, or external systems; goals that the applications helps those entities (known as actors) achieve and describes the scope of the systems [164].

This project has only two actors: internet user and website administrator as it is represented on the Figure 31. The internet user has access to almost every functionalities of the system without login access (to make the access faster) and the administrator must log on to access the Backoffice where he can add/replace/delete contents of the web system.

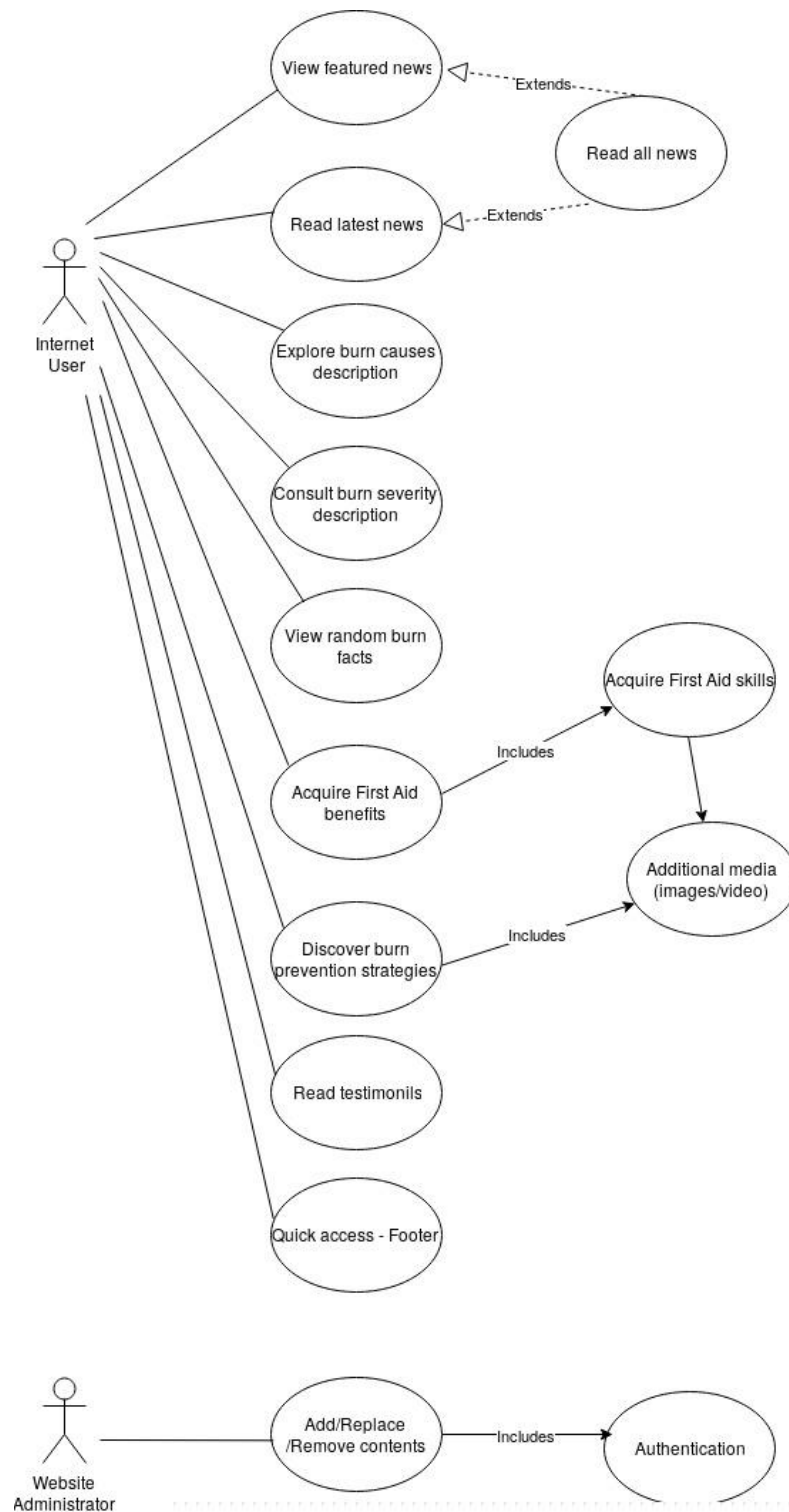


Figure 31 - Use Case Diagram

4.2.4.2 Database construction

As it was defined by the researchers, the web information system had to be fully dynamic. The only way to achieve that goal is to use database connections on the project and the team decided to use MySQL.

All the information included on the web information system is stored on the database, starting by the menu – Figure 32. If a change on the menu is needed, the changes are made on the database where three levels for the menu were decided as enough for this project.

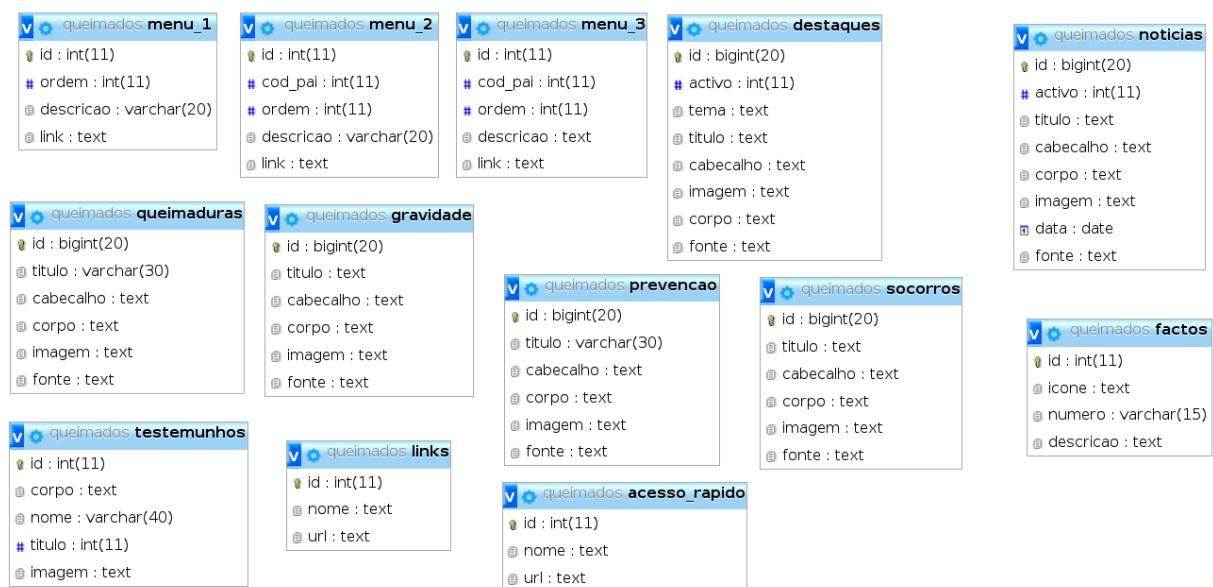


Figure 32 - MySQL database structure

The decision to store all the information on the database was made not only for security reasons but also to simplify the process of maintaining the information online. For security reasons, the information is stored on the database on a Linux Server where backups are made every week. For maintaining the information online, database usage is also easier as the administrator, or administrators, do not need to have programming skills as all they have to do is access to the Backoffice (after logging on) and change the information using a text editor.

4.2.5 Evaluation

The evaluation phase was developed at the same time as the implementation phase. To evaluate this project, the research team decided to investigate what was the information that internet users search online through search engines. As demonstrated in section 3.2, Google is the most popular search engine around the world. After some research, the team found Google Trends: a tool provided by Google that permits to analyse the searches that internet users made online, namely burn injuries – Figure 33.

Google Trends (GT) is a web free platform, provided by Google Company, that allows discovering what worldwide users googled about over the last years [16]. All Google searches are collected, categorized, connected to a topic and all personal information is removed. According to the developer, Google Trends data is an unbiased sample of Google search data which includes Google Search, Google News and YouTube [136]. With Google Trends we can explore real time Trending Stories by category and location or non-real time data from 2004 up to 36 hours before to our search. GT excludes automatically searches made by very few people, duplicate searches and special characters [15], [136], [137].

The platform is very easy to use: we can just type a search term or keyword and GT provides the Relative Search Volume (RSV) for a given period. We can adjust the region or country as well as the time we are most interested about. The results are provided within a graphic where the horizontal axle represents the period of time and the vertical axle represents the volume of searches with a scale from 0 up to 100. These numbers represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. Likewise, a score of 0 means the term was less than 1% as popular as the peak – Figure 26a.

It is showed the interest by region (or city) with a scale from 0 to 100, where 100 is the location with the most popularity as a fraction of total searches in that location, a value of 50 indicates a location which is half as popular, and a value

of 0 indicates a location where the term was less than 1% as popular as the peak – Figure 34.

The lists of results also include the related topics and related queries – Figure 35. The related section are the topics and queries also searched by the users that searched our term. We can view this section by two metrics: Top and Rising.

With the Top metric we can see the most popular topics or queries. Scoring is on a relative scale where a value of 100 is the most commonly searched topic or query, a value of 50 is a topic searched half as often, and a value of 0 is a topic or query searched for less than 1% as often as the most popular topic or query.

With the Rising metric we can analyse the related topics or queries with the biggest increase in search frequency since the last time period. Results marked "Breakout" had a tremendous increase (over 5000%), probably because these topics or queries are new and had few (if any) prior searches [15], [16], [136]–[138].

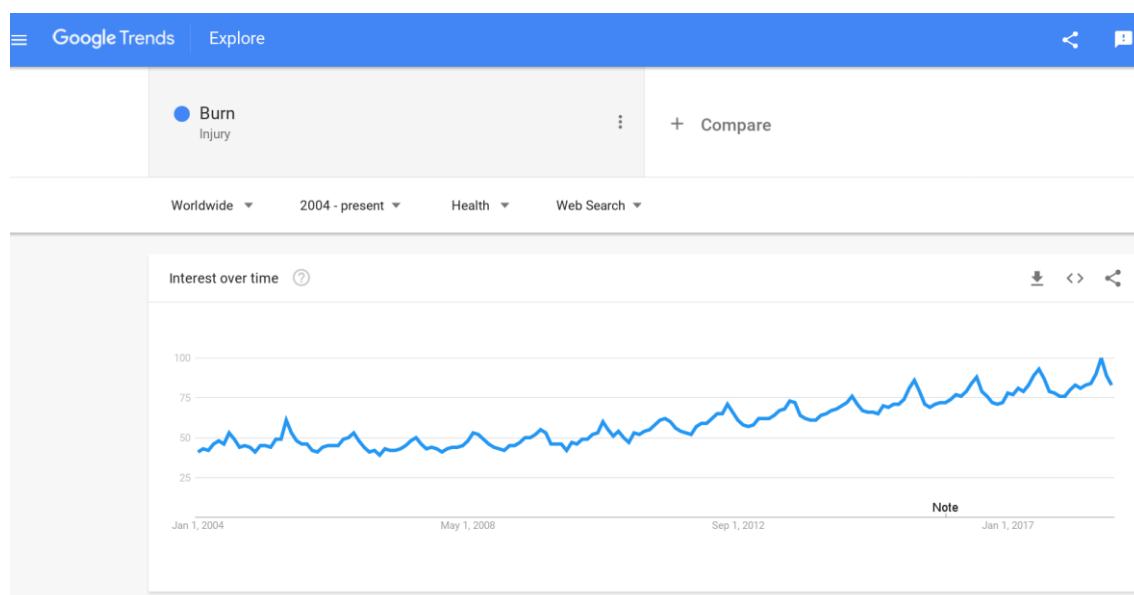


Figure 33 - Google Trends tool – Interest over time

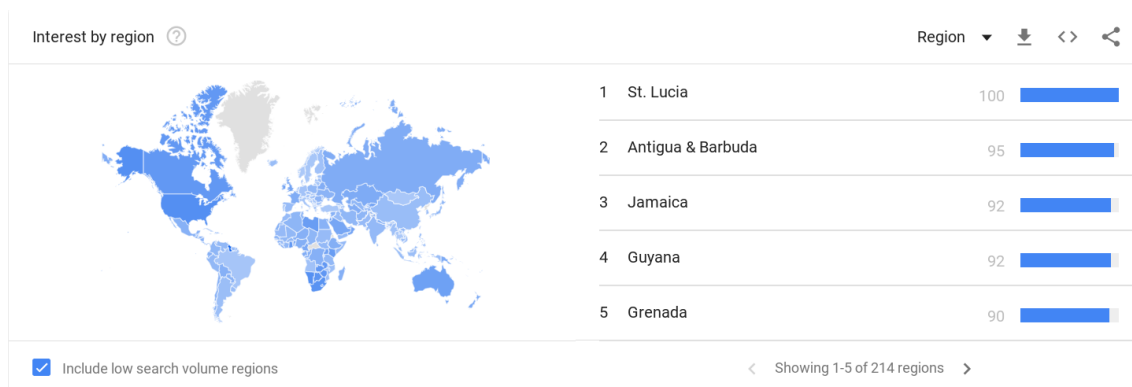


Figure 34 - Google Trends tool – Interest by region

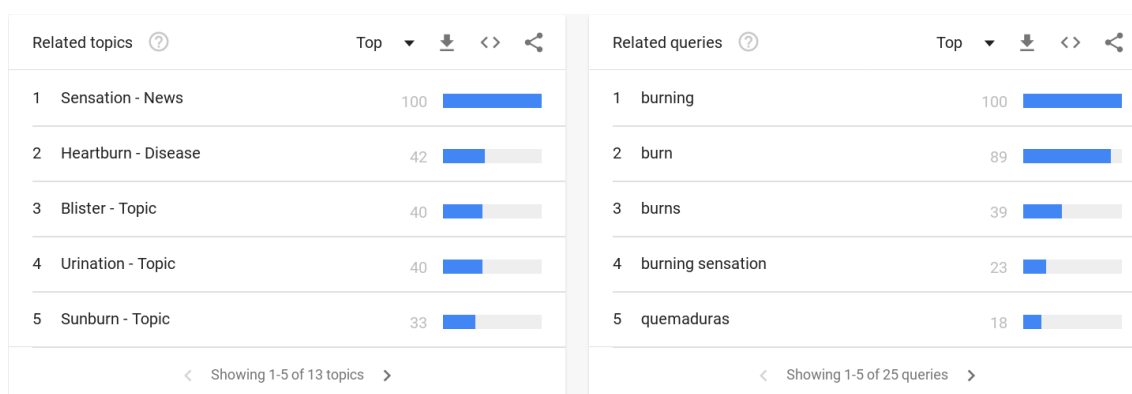


Figure 35 - Google Trends tool – Related topics and Related queries

Google Trends is widely used by journalists and marketing companies in their work to be more effective on reaching the target market [165]. With this information, it is possible to discover what internet users queried about and provide the information relevant to them, in a easier and reliable way. To analyse trends and internet users preferences, health related investigators are gradually using more and more GT functionalities and information [16].

Several articles have already described the usefulness of Google Trends on studies regarding health care topics such as HIV, syphilis, influenza or depression [17]–[23]. At the best of our knowledge there is no article regarding burns, so the research team decided to make a study about using Google Trends to evaluate online trends in searching for burns. The article will be described in detail on Chapter 5 and submitted to publication on Burns Journal.

4.2.6 Validation

The validation phase includes testing the web information system, searching for flaws or bugs, and loading the validated contents to the database.

The testing phase was conducted by the entire team evolved in the project and was requested to elements of other teams to test the system as well. A few minor errors were found and later corrected, but most of the critics were only suggestions that later were discussed inside the authors team meetings to decide is should be implemented or not.

As described on section 3.4, the authorship and attribution should be disclosed for credibility issues. To ensure that the contents of queimados.pt were accurate and can help the community, all the information provided was validated by a medical team. All the pages of the developed web information system have the authorship and if borrowed from another source, the source is maintained but the validation must be given by the medical team. The proof that the information is being maintained is given by the date, that is displayed, when the content is inserted or updated.

4.3 Chapter conclusion

The web information system was developed after analysing the strengths and weaknesses of other tools available online. The researchers followed the best methodologies to build this tool to help the community. The use of the development process helped the implementation of the system to follow the planning without any major setbacks. Throughout the planning (during the impact assessment) it became clear that the potential of helping people with this project is huge. To have a medical team available to validate the contents of this project is of high importance and gives credibility and trust to the developed web information system.

Google/Online trends in searching for burns: a global, cross-country and time trends analyses

This chapter describes a study performed with Google Trends to evaluate the interest of burn injuries on the searches on Google search engine. This study was submitted on the form of article to Burns Journal for publication.

The structure of this chapter is as follow:

- what were the used methods of research;
- encountered results;
- the discussion of the results;
- Conclusions of the study.

5.1 Methods

We performed a retrospective study, based on Google Trends. Two time frames were considered for different analyses: 14 years (from January 1st 2004 to December 31st 2017) and 3 years (from January 1st 2015 to December 31st 2017).

5.1.1 Google Trends

Google Trends (GT) is a web free platform, provided by Google Company, that allows discovering what worldwide users googled about over the last years[16]. All Google searches are collected, categorized, connected to a topic and all personal information are removed. According to the developer, Google Trends data is an unbiased sample of Google search data which includes Google

Search, Google News and YouTube [136]. With Google Trends we can explore real time Trending Stories by category and location or non-real time data from 2004 up to 36 hours before to our search. GT excludes automatically searches made by very few people, duplicate searches and special characters [15], [136], [137].

The platform is very easy to use: we can just type a search term or keyword and GT provides the Relative Search Volume (RSV) for a given period. We can adjust the region or country as well as the time frame. The results are provided within a graphic where the horizontal axle represents the period of time and the vertical axle represents the volume of searches with a scale from 0 up to 100. These numbers represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. Likewise, a score of 0 means the term was less than 1% as popular as the peak. The same applies for regions. The lists of results also include the related topics and related queries, including both to and rising queries.

With the rising metric we can analyse the related topics or queries with the biggest increase in search frequency since the last time period. Results marked "Breakout" had a tremendous increase (over 5000%), probably because these topics or queries are new and had few (if any) prior searches [15], [16], [136]–[138].

5.1.2 Query design and time frame

For this study, using Google Trends, we searched "Burn as a Topic" (instead of Search term) and selected "Health" (instead of all categories). We selected Burns as Topic rather than Search term to make GT to include all searches related to the query and also other queries suggested via google autocomplete service. This option broadly nets relevant queries, including those in multiple languages, even if this function is still under beta function. We included also Web Search so that GT could use the searches made by internet users on Google features like Image Search, News Search, Google Shopping and YouTube Search. Since one of the aims of our study was to describe the time trends of internet searches in low income countries we included low search volume regions.

GT goes only far back to 2004 so it is our start date and to have full years we choose December 31st 2017 as the finish date to our study. We studied the data on a year by year basis. As many countries lacked information about RSV on several years before 2014, we have used only the last three years (2015-2017) for some specific analyses.

To understand the seasonality of internet searches and investigate the geographic pattern around the world we analysed the RSV of the countries around the world. We also divided the countries by hemisphere to analyse the geographic world pattern vs population.

In order to understand the burden/frequency/seasonality of burn search, we compared it with other three medical conditions (i.e. influenza, cancer and myocardial infarction). Influenza was included because it is traditionally a seasonal disease [145]. Cancer is the second leading cause of death and myocardial infarction is increasing at younger ages [166], [167].

5.2 Results

Worldwide, between 2004 and 2017, there was a RSV average of 61.2 with a standard deviation of 14.1. The lowest RSV is 42 in two occasions: December of 2006 and December 2007, while the maximum was found on July 2017 - Figure 1a. The RSV has been growing in the last years, after a few downs in 2006 and 2007, with these years representing approximately half of the maximum achieved in 2017 - Figure 36. The highest RSV's are obtained in the months of June, July and August - Figure 37.

5. Google/Online trends in searching for burns

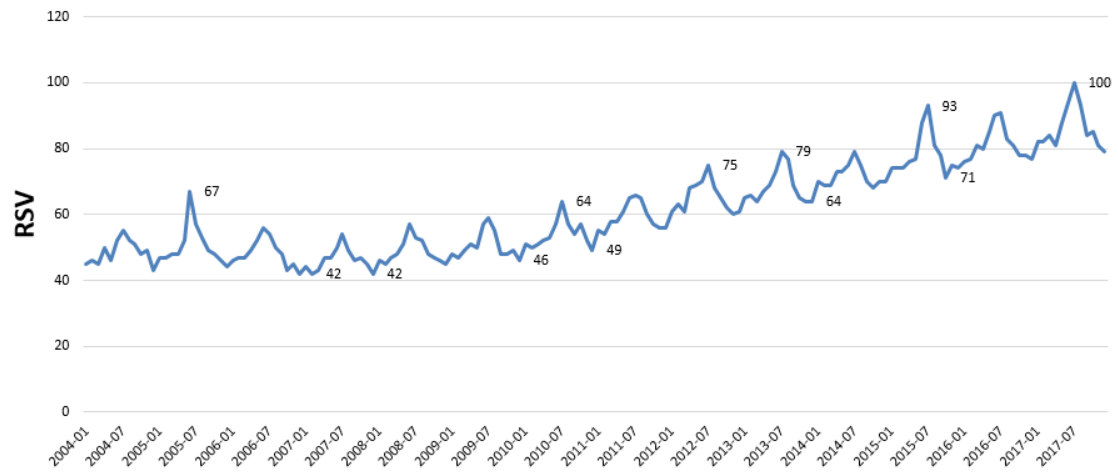


Figure 36 - RSV between 2004-2017

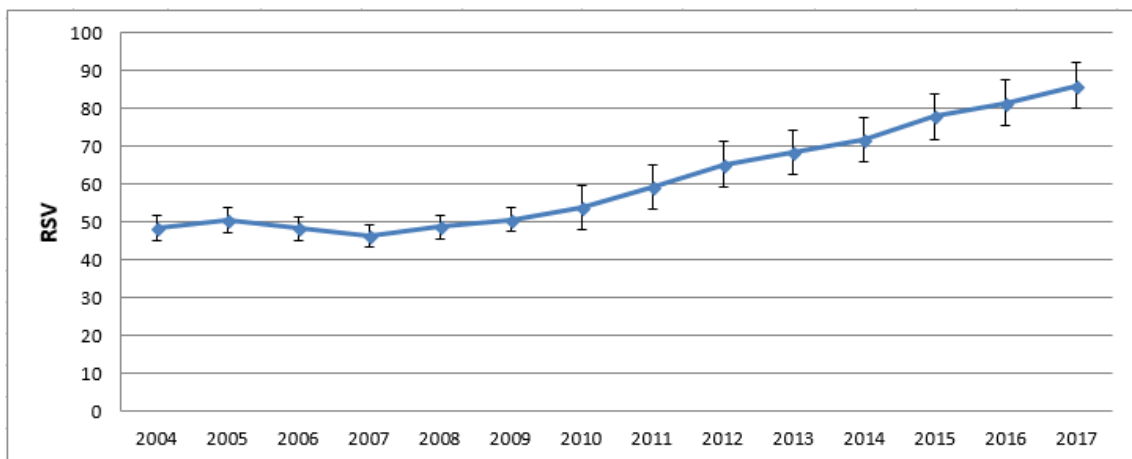


Figure 37 - Average RSV per year, with standard deviation (calculated by month)

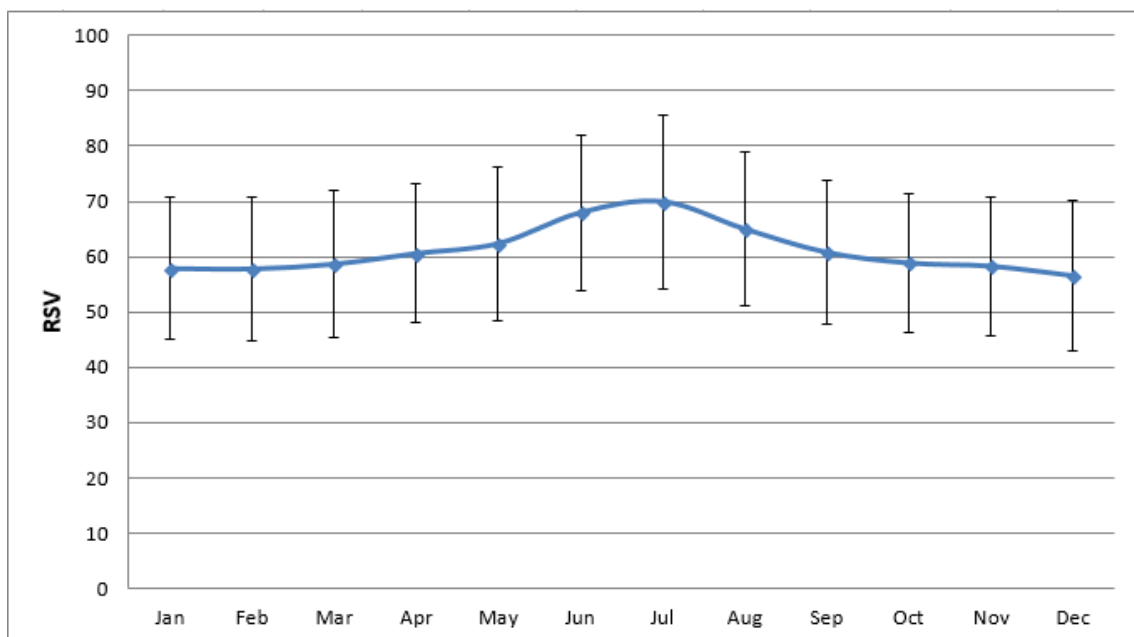


Figure 38 - Average per Month, with standard deviation, between 2004 and 2017

Comparing the data of the two hemispheres separately by year, it is visible that the South Hemisphere has higher RSV than North hemisphere in all the years of our study – Figure 39.

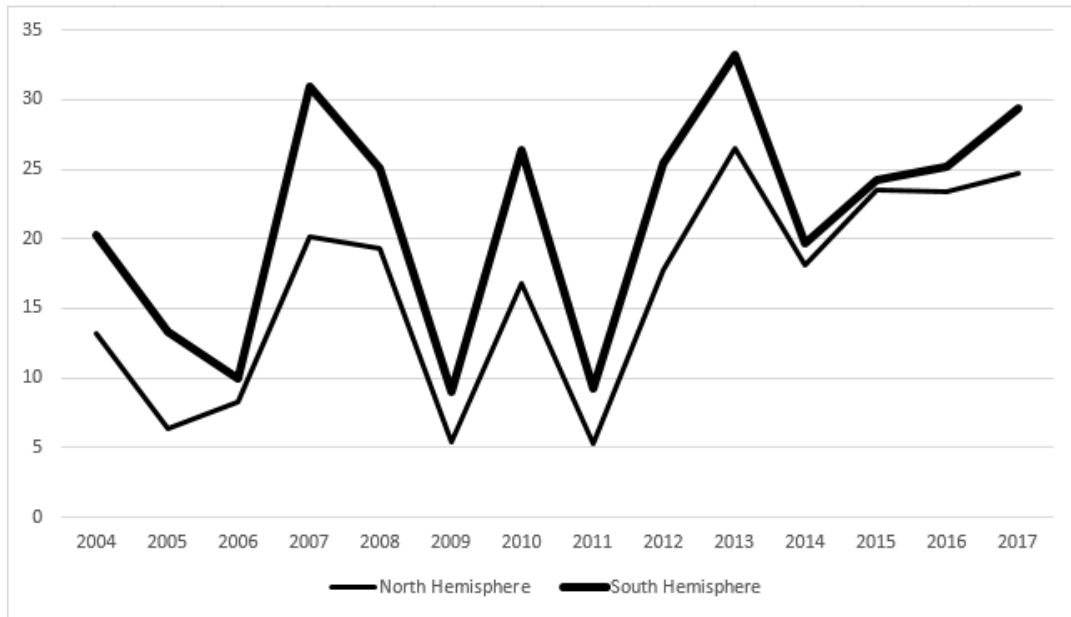


Figure 39 - Average RSV per hemisphere between 2004 and 2017

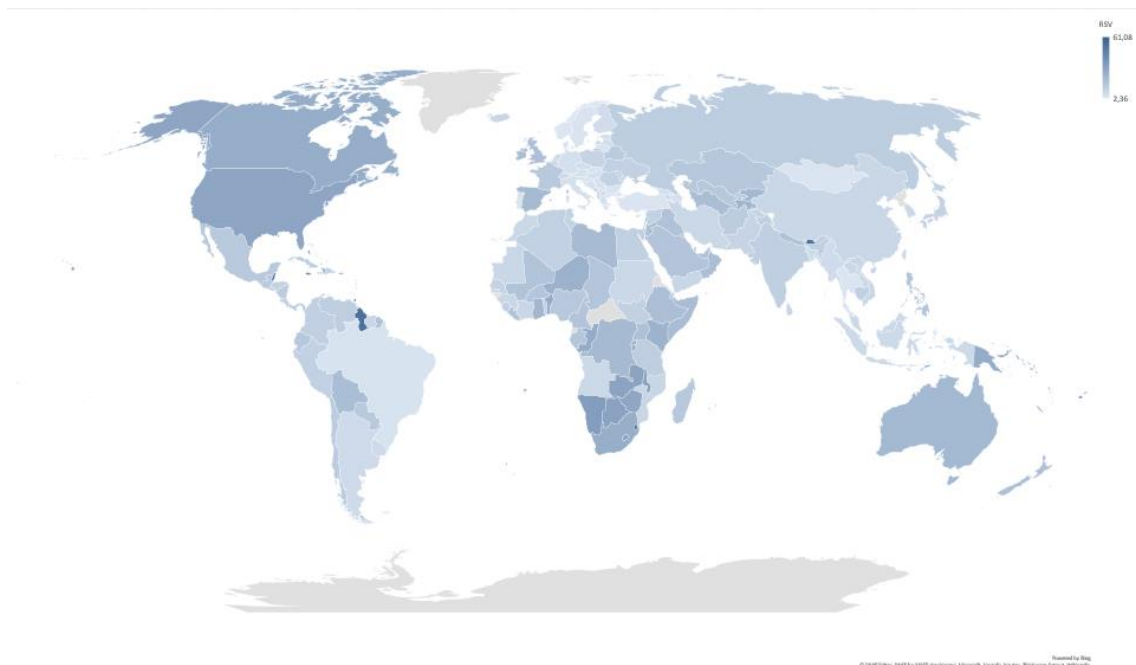


Figure 40 - Worldwide RSV between 2004 and 2017

We made a worldwide comparison between the periods of 2004-2017 (Figure 40) and from the last three years (2015-2017) (Figure 41). The RSV are higher on

the last three years globally and particularly the countries of the South Hemisphere have much higher than on the overview the period between 2004 and 2017.

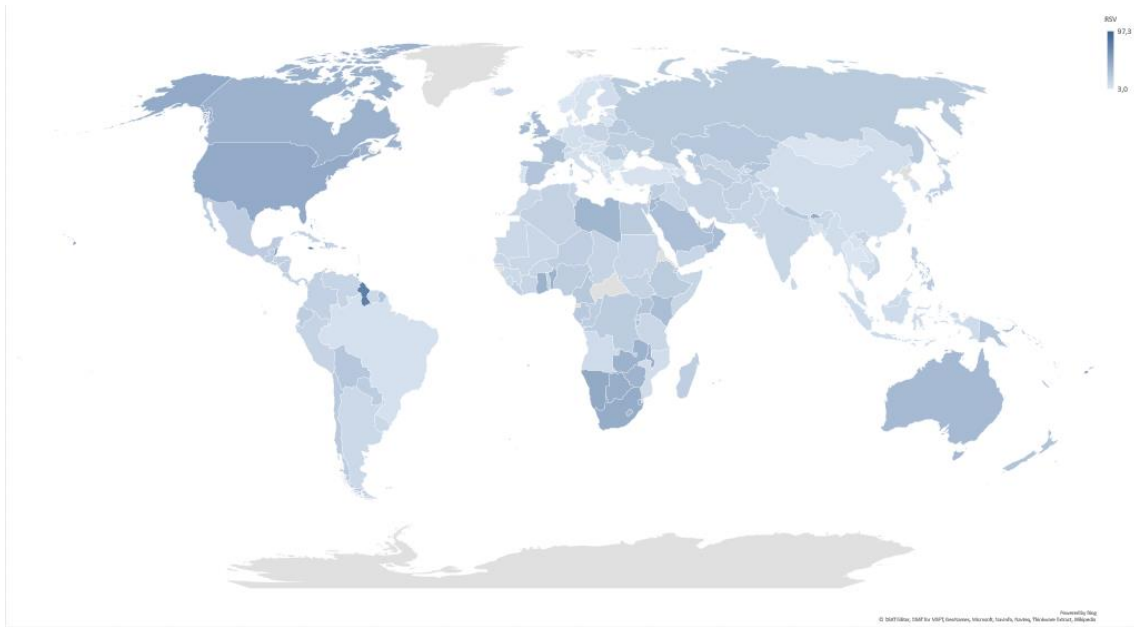


Figure 41 - Worldwide RSV between 2015 and 2017

In average, burn is the third interest after cancer and influenza, but more searched than myocardial infarction – Figure 42.

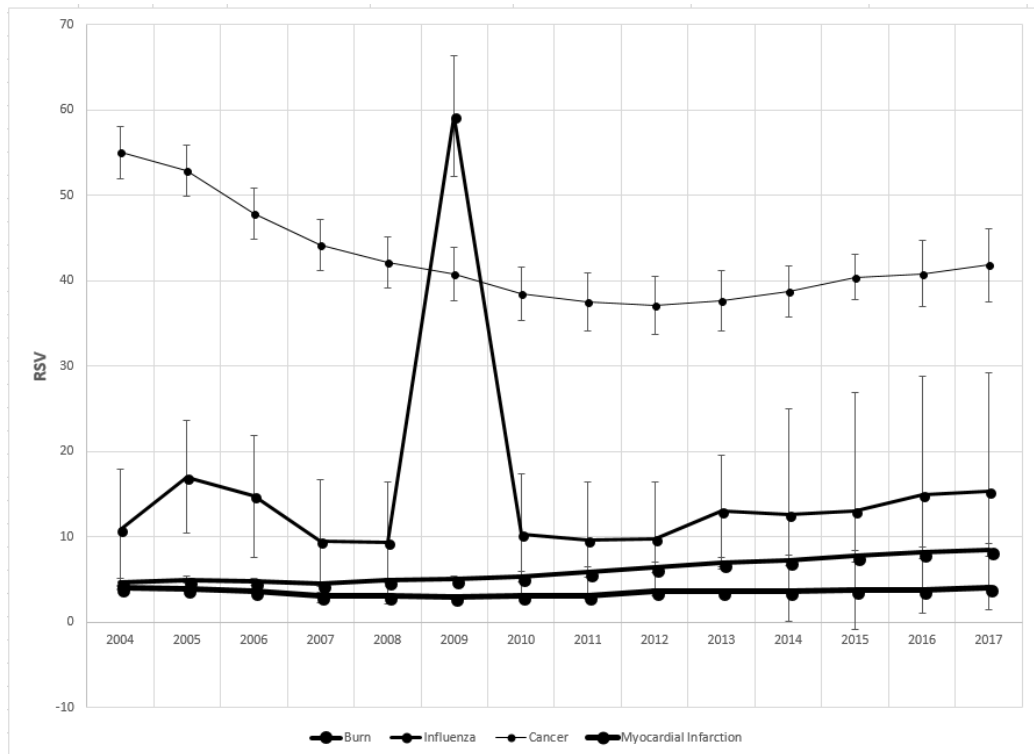


Figure 42 - Diseases RSV comparison, with standard deviation (calculated by month)

Comparing only the last three years, on a month by month analysis, influenza seasonality stands out – summer-winter-ratio. Cancer – as burn - also has a slightly noticeable seasonality at the end of summer, September and October, whereas burn seasonality is shown during the summertime (June, July and August). Myocardial infarction is more constant across the time, lacking seasonality (Figure 43).

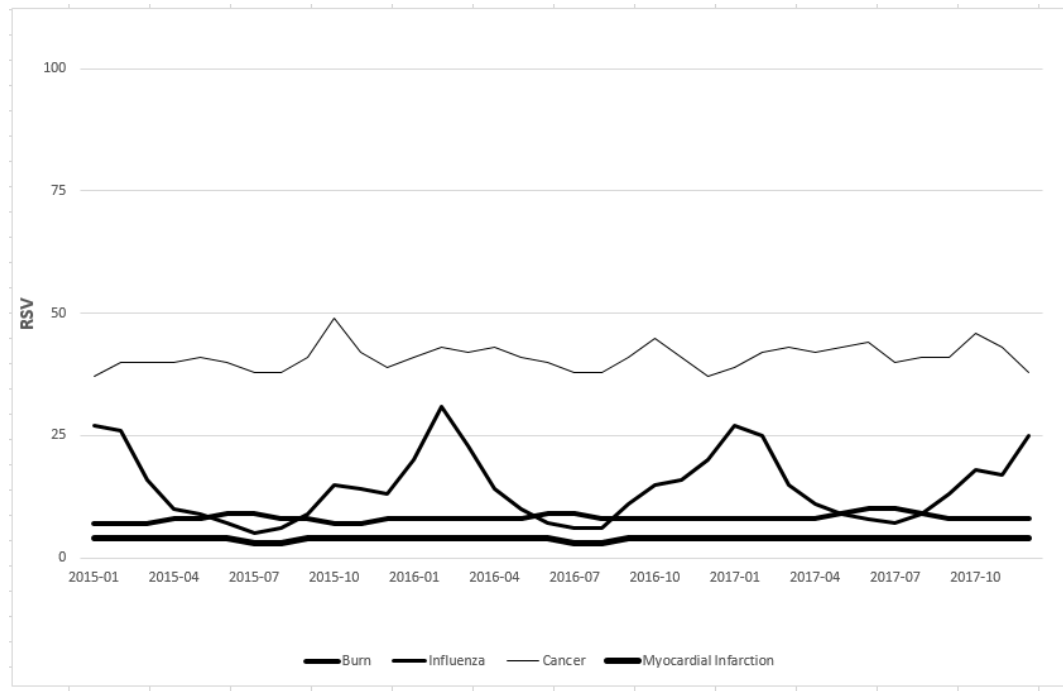


Figure 43 - Diseases RSV comparison between 2015 and 2017

Ignoring the irrelevant queries like burning sensation or stomach burning, that leaves us with the most relevant to our study: burn and burns, burn treatment (similar to how to treat a burn), burn blister, degree burns, burn scald and sun burns. The information searched online reveals that internet visitors use google search engine to discover how to treat burns: “burn treatment” and “how to treat a burn”. Information about the difference between the degrees of buns are also important to internet users – Figure 44.

Queries	Language	Translation	Scoring
burning	English		100
burn	English		81
burns	English		34
burning sensation	English		23
quemaduras	Spanish	burns	17
brulure	French	burn	16
stomach burning	English		8
やけど	Japanese	burn	8
ожог	Russian	burn	6
heart burn	English		5
burn treatment	English		4
火傷	Japanese	burn scald	4
burning in stomach	English		4
burning eyes	English		4
burn blister	English		3
vaginal burning	English		3
how to treat a burn	English		3
second degree burn	English		2
quemaduras de sol	Spanish	sun burns	2
ожоги	Russian	burns	2
how to treat burns	English		2
brulure estomac	French	stomach burning	2
2nd degree burn	English		2
3rd degree burn	English		1
first degree burn	English		1

Figure 44 - How information is searched online between 2015 and 2017

5.3 Discussion

Journalists and marketing companies are using Google Trends in their work to reach more effectively the target market [165]. With this kind of information, it is possible to discover what the users queried about and provide that information in an easier and reliable way. Health related investigators are increasingly using GT functionalities and information to analyse trends and internet users preferences [16].

Our research revealed that burn injuries is a topic with very interest among internet users around the world as it is demonstrated by RSV values since 2004. Unfortunately, we can only measure the usefulness by RSV because the lack of absolute values, but we demonstrated that global interest is growing. The interest is rising at a very steady pace since 2009 almost doubling the RSV value from 2009 until 2017. This is surely connected to the human dependency of mobile phones nowadays. As reported earlier, internet access is increasing exponentially in the whole world: even more on low and middle-income countries.

We confirmed that burn injuries are a very well-defined seasonal subject. The lowest RSV months are December, January and February, traditionally cold and wet months on the Northern Hemisphere (winter season). On the opposite side, the highest RSV months are June, July and August, usually warm and dry months in the Northern Hemisphere (summer season).

Regarding the geographic pattern the Southern Hemisphere has higher values of RSV than the North Hemisphere and the pattern is the same since 2004. This fact could be surprising given that almost 90% of the population lives on the Northern Hemisphere, but this does not mean that more web searches were made on Southern Hemisphere as we only studied RSV and not absolute search numbers.

Since 2015, the low and middle-income countries have higher RSV values, especially on the African continent. All the countries that suffer the most with burns (identified by WHO) are represented but with RSV values below average: Bangladesh 9, Colombia 19, India 17, Egypt 21, Pakistan 15 and Nepal 28. This can be justified by low access to internet (and also mobile phones or computers also) by the social classes that typically suffer the most with burns, the lower income classes.

Our results also demonstrated that burn injuries RSV are quite low when compared to Cancer, but Cancer disease has several types and it is the most feared medical condition of actual society, therefore was expected to have higher RSV. When we compared Burns with Influenza, more common than Cancer, the results are more similar, showing that Burns is not as seasonal as Influenza. Influenza had a maximum RSV value in 2009, when WHO declared a pandemic because a strain of Influenza called H1N1 virus with a total of 74 countries and territories reported laboratory confirmed infections.

Analysing what users search online, we concluded that the information online about burns must contain not only first aid help but also information like degrees burns and prevention recommendations. Assuming the fact that most of internet users only search information about treatment after the burn occurred, the information available online should be direct, reliable and precise. These discoveries seem to indicate lack of knowledge about burn injuries, specially kinds and degrees of burns.

5.4 Conclusion

Our study confirmed that Google Trends, with all the pros and cons, is a powerful tool to analyse the usefulness of burns information online. The interest and doubts about burn injuries is global as low and high-income countries suffer with this kind of injuries. This tendency is expected to increase since the internet access is rising all around the world, even in low-income countries. It is important that direct, reliable and precise information regarding burns exists online and on different languages. The information provided should include first aid recommendations, burn degrees but also prevention information to try avoiding some of the most common burns in each region.

5.4.1 Limitations

Our study has several limitations. We only examine data from Google, although it's the most used engine search all around the world. The algorithm used by GT is not public domain so can be not 100% accurate. If Google makes an optimization of the algorithm the results can be slightly different. Also, the results below 1% are removed which alter the results even slightly. The values of RSV that are missing we don't know if it is because they are below 1% (and ignored) or because that is no data on that country on that year. We also have only access to RSV and not to number of searches executed, that data would be important to analyse but it is unavailable for us.

5.4.2 Strengths

To the best of our knowledge, this is the first study to use Google Trends platform to assess burn injuries queries of internet users. We are also unaware of any study to confirm the relation between the increase of internet access and burn doubts online. With the lack of absolute number of searches, we decided to compare our target (burns) with other diseases so that it was possible to have data to compare.

Conclusions

On this chapter will be disclosed how was (and will be) made the process of evaluation of *queimados.pt*. There are also big plans to continue the evolution of this project and will be disclosed on this chapter. Finally, the final conclusions retrieved from this work are going to be announced.

6.1 Evaluation of the project

The evaluation of this project was to be made by survey to the first-year master's students of medical informatics but due to the end of the school year, that was not possible. Instead, the researchers focused on the investigation of the trends regarding burns around the world from 2004 onwards (Chapter 5). The conclusions retrieved on the article seems to give a very positive feedback of the usefulness of this project. It was proved that there is a lot of interest regarding information about burns injuries and despite the high number of sources of contents, at least in foreigner languages, the accuracy and reliability is not very high.

The development team has plans to evaluate the web information system on the future after the project is online. The plan is to promote *queimados.pt* on burn centres in Portugal, not only to patients but also to medical staff like physicians or nurses. The goal is to spread *queimados.pt* first around burn patients and their families to begin to get momentum to reach the Portuguese community. As the accesses to this system is going to be analysed, it will be possible to record the number of accesses and the geographic location of the internet users that used it. The next step is to compare the number of accesses to *queimados.pt* to the number of victims that search healthcare due to burn injuries. This way it will be finally possible to evaluate the success of this project with real numbers.

6.2 Work for the future

There are already some ideas and plans on how to improve this project on the future. The first improvement is to get `queimado.pt`, HONcode certified. As documented on section 3.4, the HONcode certification is a great feature to have because of the reliability and credibility that brings to a project like this.

The next projected improvement is to add more languages to the web information system. Given the proven difficulty to find quality information online, about burns, this project can be of great usefulness for abroad countries and communities.

Another improvement that can be implemented is to add a recommendation system to the list of features of `queimados.pt`. Two possible useful recommendations systems would be first aid assistance and TBSA. The researchers believe that a feature who could give interactive step by step instructions to first aid providers, depending of the type of burn, would be very useful to internet users. Another possibility could be an interactive image that could calculate the TBSA – Total Body Surface Area, using the internet users mouse clicks on the members that suffered burns both on adults or children.

The structure of `queimados.pt` was developed with the forecast of similar projects studying other medical conditions, can use the database and most of the coding functions for projects of their own without starting from scratch. This could be especially useful if the researchers involved do not have a lot of coding skills.

The article based on the Chapter 5 of this document was submitted to the Burns Journal for publication and a positive decision is expected.

6.3 Conclusion

The aim of this project was to find a tool capable of reaching the Portuguese community to give knowledge regarding burn injuries. There are a lot of facts about this medical condition that the community around the world is not aware of. Thousands of people die every year with burn injuries and others get scars (both

physical and emotional) that can ruin an entire family life. The burden with burn victims is very high not only to families but also to the public healthcare systems.

Several documented studies proved that burns can be prevented but the lack of knowledge of most of the population is a big constraint in decreasing burn occurrences. WHO – World Health Organization, has been working very hard to spread proven strategies to prevent accidents involving burns. Burn victims are decreasing especially on high-income, not at the rhythm that WHO wanted but the latest numbers are encouraging. On low and middle-income countries, the numbers are not as good because most of the strategies that are working on high-income countries, cannot be applied.

When it is not possible to avoid the accidents, properly provided first aid can have a huge impact on the victim not only regarding instant pain but mainly to the future. Studies proved the efficiency of first aid on decreasing scarring, healing time and therefore hospitalization time. Once again, public knowledge on how to perform first aid treatment to victims, is very low as it was documented along this document.

The number of people using the internet is rising by the day and internet users often access the internet to search information about all kinds of subjects, including healthcare. Self-diagnosing and parenting are two of the most popular subjects searched online nowadays.

After investigating the importance of the internet for the population and the preferred point of access to healthcare information, search engines, the team of this project decided to develop a web information system. This platform was defined as the best way to provide knowledge about burns to the Portuguese community. The next phase was to analyse the quality offer of the webpages regarding burn injuries. The features available on the developed web information system, queimados.pt, was a combination of the strengths of the analysed systems, both Portuguese and foreigner. This phase was vital to understand that quantity is not a sign of quality: most of the analysed burn websites, and healthcare in general, have low accuracy contents that can easily put in jeopardy the public health.

The usefulness of a tool with information about burns injuries, like queimados.pt, was confirmed by a study made by using Google Trends. On this study, the interest on searches about burns was confirmed and the interest is global. With this study, the queries made by internet users, about the burns theme, helped confirming the relevance of the contents provided by queimados.pt.

Although the objectives defined for this project were fully obtained, there is much to be done in order to help, not only burn victims and their families, but also the population to better prevent burn injuries in their households. The team of researchers involved on this project, have the feeling of mission accomplish for being able to provide a tool that can help so many people.

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