RAMPEN MANAGEMENT

Potential effect of a heat wave on core temperature of patients in the emergency department and the hospital.

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Potential effect of a heat wave on core temperature of patients in the emergency department and the hospital.

Thesis proposed to achieve the degree of master in disaster medicine by

Dr. Devloo Jan

Promotor: Prof. dr. Sabbe M.

Emergency Medicine

Cover letter

Dear editor-in-chief

Please find enclosed our scientific manuscript entitled "Potential effect of a heat wave on core temperature of patients in the Emergency Department and in the hospital" by Jan Devloo (MD) – student in the postgraduate course of disaster medicine, promoted by prof. Marc Sabbe (MD, Ph.D.). Data used in the manuscript were previously collected by fellow students Juul Heedfeld and Jill van In. For this thesis no approval was obtained of the University of Leuven Ethics Committee. We declare that this article has not been published or submitted elsewhere.

This thesis is divided into 2 parts. In the first part, we study the potential effect of a heat wave on the core temperature of a patient population at the emergency department of the University hospital of Leuven in the heat wave period from 11 to 13 August 2020. In a second part of the manuscript, we study the effects on body temperature in patients already hospitalized during the same heat wave. Both patient groups were compared with a period (10 and 20 October, and 5 November 2019), where there was no mention of a heat wave, nor the manifest presence of patients with infections, such as covid.

Several studies investigating the effect of heat waves on admission body temperature have already been published. To our knowledge, this is the first article to discuss the effect of a heat wave on body temperature of already hospitalized patients.

By examining the data, we try to determine whether a hospital is sufficiently prepared for the impact and dangers due to an increasing incidence of heat waves. We consider this manuscript especially of interest for the readership of those interested in preventive medicine, hospital medicine and disaster medicine.

Thank you for reading this scientific manuscript

I am available for any questions.

Yours sincerely,

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Potential effect of a heat wave on core temperature of patients in the Emergency Department and in the hospital

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Keywords:

Heat wave, Body temperature, Environmental heat, Heat-related illness, Hospitalized patients

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Abstract

Background: Record-breaking droughts and more and longer heat waves are observed every year. Global warming is one of the next big challenges for hospitals and nursing homes. We need to brainstorm how to protect our patients from impending heat waves.

Aim: We investigated the impact of a heat wave on body temperature of patients being admitted to the ED and of patients already hospitalized. This can provide insight into the measures already in place or the infrastructural adjustments that still need to be made to protect patients against extreme heats. Finally, we discuss the possible impact of prevention measures within disaster hospital management.

Methods: First, we conducted a literature search to identify and select possible articles containing evidence of the impact of a heat wave on body temperature. Second, we conducted a retrospective study comparing measured temperatures of patients admitted to the ED and patients already hospitalized during a heat wave from 11-13 August 2020 with a period in which no heat wave, nor the manifest presence of covid, nor other endemism was present (10 and 20 October, and 5 November 2019). We created two groups of collected data: morning and afternoon measurements.

Results: A total of 25 articles were extracted out of a literature search. At the ED, no statistical difference was observed in the morning temperature measurements comparing the non-heat wave period vs heat wave. In the afternoon temperature measurements, a statistical difference was measured comparing the non-heat wave period vs heat wave. For hospitalized patients, statistical difference was measured in the morning and afternoon temperature measurements comparing the non-heat wave period vs heat wave.

Conclusion: Heat waves lead to increased morbidity, mortality and costs. This study emphasizes the rise in body temperature during a heat wave, independently of other factors that influence body temperature. Knowledge about heat wave-related syndromes can help to better respond to patients' needs. Hospitals should focus on preventive measures, whereby air conditioning provides the best temperature control. Further research is needed for UZ Leuven, whereby the different departments are approached separately with regard to orientation and the infrastructure already available.

Samenvatting

Achtergrond: Elk jaar worden recordbrekende droogtes en steeds meer en langer durende hittegolven waargenomen. De opwarming van de aarde is een van de volgende grote uitdagingen voor ziekenhuizen en woonzorgcentra. We moeten brainstormen over hoe we onze patiënten het best kunnen beschermen tegen dreigende hittegolven.

Doel: We onderzochten de impact van een hittegolf op de lichaamstemperatuur van patienten die worden opgenomen worden op de spoedeisende hulp en van patiënten die al in het ziekenhuis zijn opgenomen. Dit kan ons inzicht geven in de maatregelen die er al zijn of de infrastructuur aanpassingen die nog gerealiseerd moeten worden om patiënten te beschermen tegen extreme hitte. Tot slot onderzoeken en bespreken we de mogelijke impact van preventiemaatregelen binnen de rampenzorg.

Methoden: Eerst hebben we literatuuronderzoek gedaan om artikelen te identificeren en te selecteren die bewijs bevatten van de impact van een hittegolf op de lichaamstemperatuur van patiënten. Ten tweede hebben we een retrospectief studie uitgevoerd waarin temperaturen gemeten bij patiënten die op de spoedeisende hulp en patiënten die al tijdens een hittegolf van 11-13 augustus 2020 in het ziekenhuis waren opgenomen, werden vergeleken met een periode (10 en 20 oktober en 5 november 2019) waarin geen hittegolf, covid, noch ander endemisme aanwezig was. We hebben twee groepen verzamelde gegevens gemaakt: ochtend- en middagmetingen.

Resultaten: Uit het literatuuronderzoek zijn in totaal 25 artikelen geëxtraheerd. Op de spoedgevallen werd er geen statistisch verschil waargenomen tussen de ochtend temperatuurmetingen van de niet-hittegolf periode en de de hittegolf periode. In de middag werd wel een statistische verschil gemeten tussen beide periodes. Voor de gehospitaliseerde patiënten werd zowel voor de ochtend- als middag tempertuurmetingen een statistische verschil waargenomen tussen de niet-hittegolf periode vergeleken met de hittegolf periode.

Conclusie: Hittegolven leiden tot verhoogde morbiditeit, mortaliteit en kosten. Deze studie benadrukt de stijging van de lichaamstemperatuur tijdens een hittegolf, onafhankelijk van andere factoren die de lichaamstemperatuur beïnvloeden. Kennis over hittegolfgerelateerde syndromen kan helpen om beter in te spelen op de behoeften van patiënten. Ziekenhuizen moeten zich richten op preventieve maatregelen, waarbij airconditioning zorgt voor de beste

temperatuurbeheersing. Voor UZ Leuven is verder onderzoek nodig, waarbij de verschillende afdelingen afzonderlijk worden benaderd qua oriëntatie en reeds aanwezige infrastructuur.

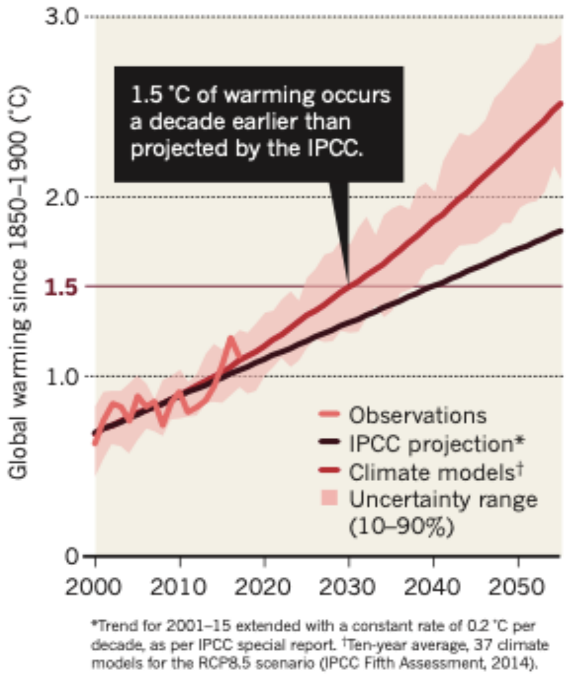
Abbreviations:

Emergency department	ED
Ambient temperature	AT
Body temperature	BT
Royal Meteorological Institute	KMI

1. Introduction

Global warming

Global warming is a topic that is getting more and more attention over the years. Every year deadly wildfires plague the continents of the United States of America and Australia. The rest of the world, too, is faced with unprecedented temperatures in recent decades. Record-breaking droughts and heatwaves are proof of this extreme weather. The 2020 report of The Lancet Countdown on health and climate change, announced that 157 million more people were exposed to heatwave events in 2017, compared to 2000 (Watts et al., 2021). Such environmental disasters will only intensify. Governments, rightly, want to know what to do. Yet the climate-science community is struggling to offer useful answer (Marx et al., 2021). If the planet warms by 2 °C, the widely touted temperature limit in the 2015 Paris climate agreement, twice as many people will face water scarcity than if warming is limited to 1.5 °C. That extra warming will also expose more than 1.5 billion people to deadly heat extremes, and hundreds of millions of individuals to vector-borne diseases such as malaria, among other harms (Kalkstein & Greene, 1997). But, more and more researchers report another alarming fact, namely: global warming is accelerating (Fig 1)(Xu et al., 2018). Now, more than ever, we need to think about how we can slow down global warming and how we can prepare for these scorching heat waves.



While policymakers are puzzling how to combat global warming, we, as physicians and prevention advisors, need to brainstorm how to protect patients from impending heat waves. Research and emergency planning are crucial. In hospitals, we see that staff, patients and infrastructure are often not prepared for these extreme weather phenomena. We must assess which policies can be enacted most swiftly and successfully to reduce morbidity and mortality from heat waves.

Fig 1: Accelerated global warming

Climate simulations predict that global warming will rise exponentially if emissions go unchecked.

IPCC: Intergovernmental Panel on Climate Change

Hyperthermia

Heat waves have been linked to adverse human health effects, including higher rates of all-cause and cardiovascular death, and these health effects could be exacerbated with ongoing climate change. The temperature of our body is carefully regulated by control mechanisms. These homeostatic controls ensure that body temperature exhibits a predictable daily rhythmicity, the circadian rhythm, rising from a low of about 36°C in the early morning to about 37.5°C in the late afternoon (Desforges & Simon, 1993; Harding et al., 2020). To study the effect of a heat wave on a patient, we search for a correlation between the ambient temperature (AT) and the possibly elevated body temperature (BT). Hyperthermia is a well-known condition that can manifest in several ways, such as neurological and cardiovascular symptoms. BT increases when the rate of heat production exceeds the rate of heat dissipation. The main mechanisms of hyperthermia are excessive heat production, diminished heat dissipation, or hypothalamic thermostat malfunction (Desforges & Simon, 1993). The real origin of a patient's hyperthermia tends to be often a mix of these mechanisms (Fig 2). In case of a heat wave, when AT exceeds BT, heat is also absorbed from the external environment. People can facilitate their thermoregulation with shade, cold water, fans or other cooling methods until the peripheral mechanisms are unable to maintain a BT that matches the hypothalamic set-point. In contrast, fever occurs when the hypothalamic set-point is increased by the action of circulating pyrogenic cytokines, causing competent peripheral mechanisms to conserve and generate heat until the body temperature rises to the elevated set-point (Dinarello et al., 1988). Despite their physiologic differences, hyperthermia and fever cannot be differentiated clinically on the basis of the height of the temperature (Simon, 1976) nor its pattern (Musher, 1979). Hopp et al. identified 11 diagnoses with a higher admission risk on heat wave days, with heat stroke and sunstroke having the highest risk. Heat stroke has been shown to have high emergency department case fatality rates (Hess et al., 2014).

Disorders of excessive heat production
- Exertional hyperthermia
- Heat stroke (exertional)*
- Malignant hyperthermia of anesthesia
- Neuroleptic malignant syndrome*
- Lethal catatonia
- Thyrotoxicosis
- Pheochromocytoma
- Salicylate intoxication
- Drug abuse (e.g., cocaine and amphetamines)
- Delirium tremens
- Status epilepticus
- Generalized tetanus

Disorders of diminished heat dissipation
- Heat stroke (classic)*
- Extensive use of occlusive dressings
- Dehydration
- Autonomic dysfunction
- Use of anticholinergic agents
- Neuroleptic malignant syndrome*

Disorders of hypothalamic function
- Neuroleptic malignant syndrome*
- Cerebrovascular accidents
- Encephalitis
- Sarcoidosis and granulomatous infections
- Trauma

Fig 2: Mixed pathogenesis of hyperthermia

Mild to moderate heat illness is reversible with prompt treatment; however, its rapid development can be fatal if left untreated. Additionally, hyperthermia associated with heat stroke can lead to a failure of body temperature control and regulation system, making the body more susceptible to other bacteria and infection, such as septicemia or urinary tract infection. Another major factor that can cause heat-related illness is dehydration, which can reduce thermoregulation ability through sweating an can lead to an increase in body temperature. Kidney failure has also been associated with several factors that could induce hospital admissions during heat waves, including direct thermal injury and prerenal acute injury correlated with dehydration (Bobb et al., 2014). In addition, these risks tended to be higher among adults in the oldest (>85years old) category (Hopp et al., 2018).

Research

We conducted a retrospective study which was divided into two parts. In the first part, we compared the effect of a heat wave on the registration temperature of a patient population at the emergency department (ED) of the University hospital of Leuven in Belgium in the period from 11 to 13 August 2020. In a second part, we studied the BT in patients already hospitalized during the same heat wave. Both groups were compared with a period where there was no mention of a heat wave, no presence of covid, nor other endemism (10 and 20 October, and 5 November 2019). Several studies investigating the correlation of heat waves on admission BT have already been published (Harding et al., 2020; Lu et al., 2009; Lu & Dai, 2009). This is the first article to discuss the effect of a heat wave on BT of already hospitalized patients. This can give insight into the measures already in place or infrastructural adjustments that still need to be made to protect the hospitalized patients against such extreme heats. Finally, we will discuss the possible impact of preventive measures within disaster hospital management.

2. Methods

The study consists of two parts. First, we conducted a literature search to identify and select possible articles containing evidence of the impact of a heat wave on BT. Second, we conducted a retrospective study comparing measured temperatures of patients admitted to the ED and patients already hospitalized during a heat wave from 11-13 August 2020 with a period in which no heat wave, no covid, nor other endemism was present (10 and 20 October, and 5 November 2019).

Literature search

Between January 1st and February 10th 2022, we searched Medline (PubMed), Embase and ResearchGate for studies related to our research question. Following MeSH terms were used to find eligible articles: “Heat wave”, “Body temperature”, “human’, “Environmental heat”, “Heat-related illness”, “Hospitalized patients”, “Ambient temperature”, “Emergency Department”, “Mortality” and “Heat Stroke”. We applied restrictions on language, date of publication and study setting. The language was restricted to English, French and Dutch. Only articles dating from January 1st 1970 until September 30st 2021, those fully terminated and published were included. Expert opinions, letters and in vitro studies were excluded. Articles were first screened based on their title and abstract. If an article possibly contains a source of information about the research question, they were read in total. Selected articles were then added to a separate folder in Mendeley.

Patient data selection

The patients whose data we selected at the ED were subjected to several inclusion- and exclusion-criteria. The timing of arrival at the ED was one of these criteria. Patients whose temperatures were measured before 6:00, between 12:00 and 14:00, and after 22:00 are excluded. We therefore created 2 groups of patients, namely a group admitted in the morning, and a group admitted in the afternoon and evening. Temperatures were measured either temporal, tympanic, under the armpit or rectal. No age exclusion criteria were applied. As it is important to measure the temperature upon entering the ED, only temperatures at the triage post of the ED were included, taking into account the time interval between registration and temperature measurement is less than 1 hour. When a patient had several temperature measurements, the first measurement was, whereas all other measurements of the same patient were ignored. When there was no information about the time of registration, patients were excluded. All of the collected data were entered in an excel file: patient number, time of arrival, time of temperature measurement and measured temperature.

For the patients who were already hospitalized, we respected the same time intervals for collecting data. Since the same patient may be hospitalized for a longer period, different temperature measurements were taken by the nursing staff. The temperature was normally measured daily in the morning between 6:00h and 8:59h and a second time between 9:00h and 12:00h. In the afternoon, two more temperature registrations were taken. The first between 14:00 and 17:59, the second between 18:00 and 21:00. The same patient can therefore have different temperature registrations in the database per time period with a few hours in between. The measured temperatures registered in an excel file were those between 6:00 and 12:00 and between 14:00 and 22:00 hours, creating two groups: morning and afternoon measurements. Temperatures were measured either temporal, tympanic, under the armpit or rectal. No age exclusion criteria were applied. Patient number, hospital unit, date of hospital admission, date and time of temperature measurement and measured temperature were recorded. No distinction was made between fever patterns: endogenous fever (eg. Infectious, inflammatory, intoxications, …) or exogenous fever (heliosis, exertional, ...).

Period of time

We selected data from three days during two periods. We needed to have data from a heat wave and from a control period of normal temperatures as expected for the time of year.

The first period was August 2020 (Klimatologisch-Maandoverzicht-202008-Kmi, n.d.). When we look at the average temperature over the entire month, August 2020 was still much warmer than average (20.9°C, normal: 18.0°C). This made this the second warmest month of August since the start of the observations in 1833, following 1997 (21.2°C). During the first half of this summer month, we registered an intense heat wave. From the 5th to the 16th, the maximum temperature did not fall below 25°C. The 8th was the warmest day with a maximum of 35.9°C, the highest temperature we ever recorded here during an August month. For 8 days in a row, from the 6th to the 13th, the maximum temperature did not fall below 30°C (definition of heatwave) (Fig 3). Only the heat wave of 1976 had a longer consecutive series (15 days). Temperature did not drop below 18,8°C (12 August at 5:00h) during nights. The number of hours of sunshine was higher and the humidity level lower than average for the month of August (Fig 4-5). For our data collection, we decided to use the last three days of the heat wave: 11 to 13 august 2020.
We then decided to compare our data with measured temperatures from a period where the days had normal temperatures to be expected for that time of year. We selected 10 and 20 October, and 5 November 2019. These days were before the covid-19 pandemic hit Belgium, also no other endemism was present.

Fig 3: KMI Average daily temperature, Ukkel, August 2020

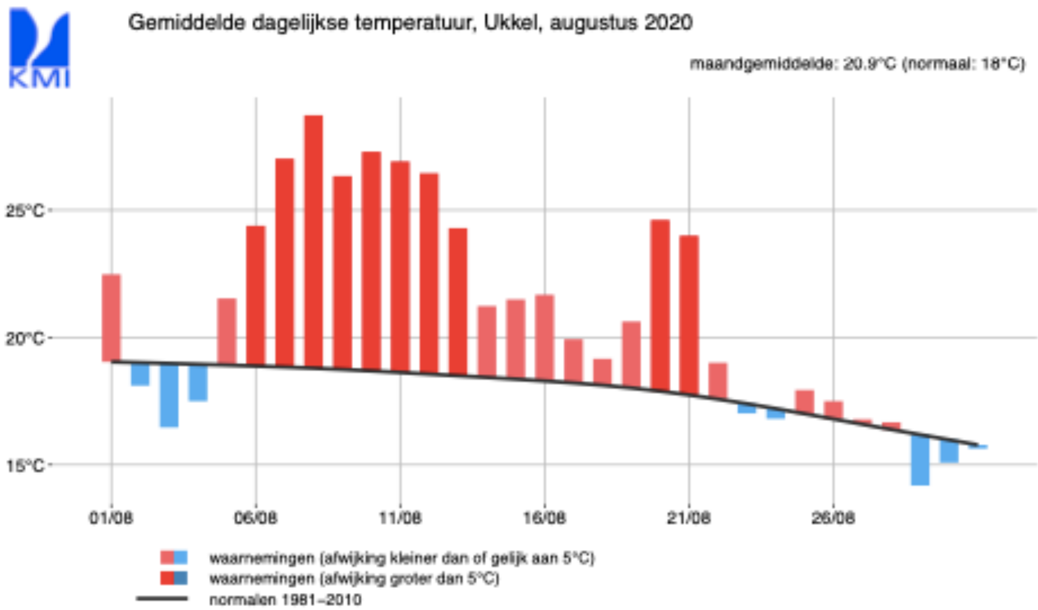


Fig 4: Daily sunshine time, Ukkel, August 2020

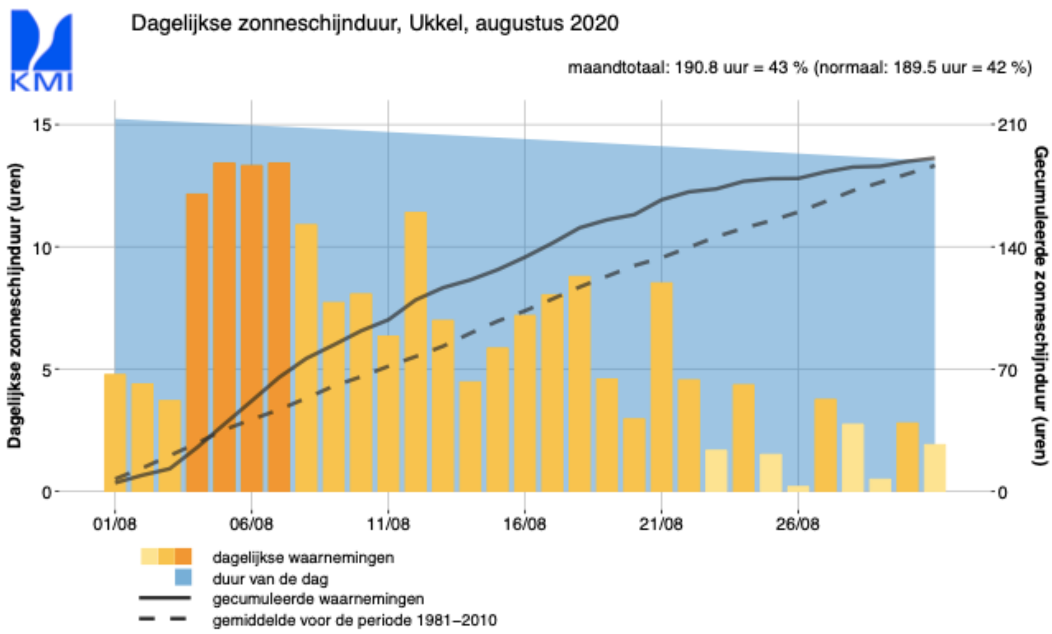
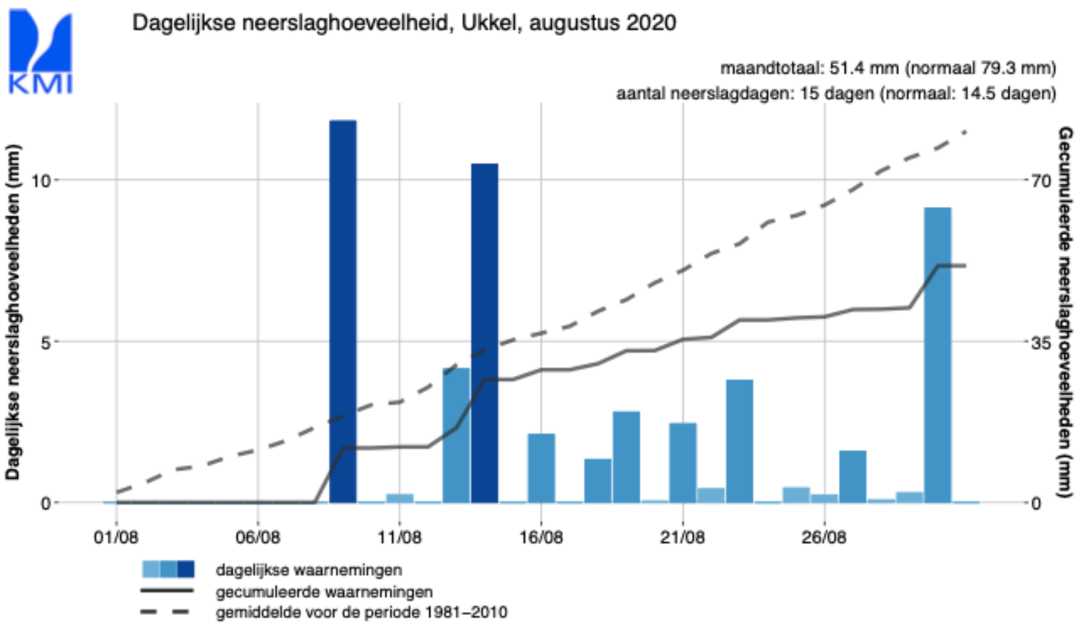


Fig 5: Daily amount of precipitation, Ukkel, August



Test of significance

We hypothesized that there will be a significant temperature difference between the heat wave and the non-heat wave period with a *p-value* ≤ 0.01. This difference can be measured separately in patients who report to emergency departments and the already hospitalized patients, in the morning and the afternoon. We analyzed the results by comparing the average of both groups using an independent sample *T-test*.

3. Results

Results of literature search

A total of 1792 articles were found. Following excluding the duplicates and screening the title and abstract, 22 articles remained. After fully reading the article, the articles essential regarding the research questions were used to distill the necessary information. 7 extra articles were included using the snow ball method reviewing the references of the already included papers (*Fig 6*).

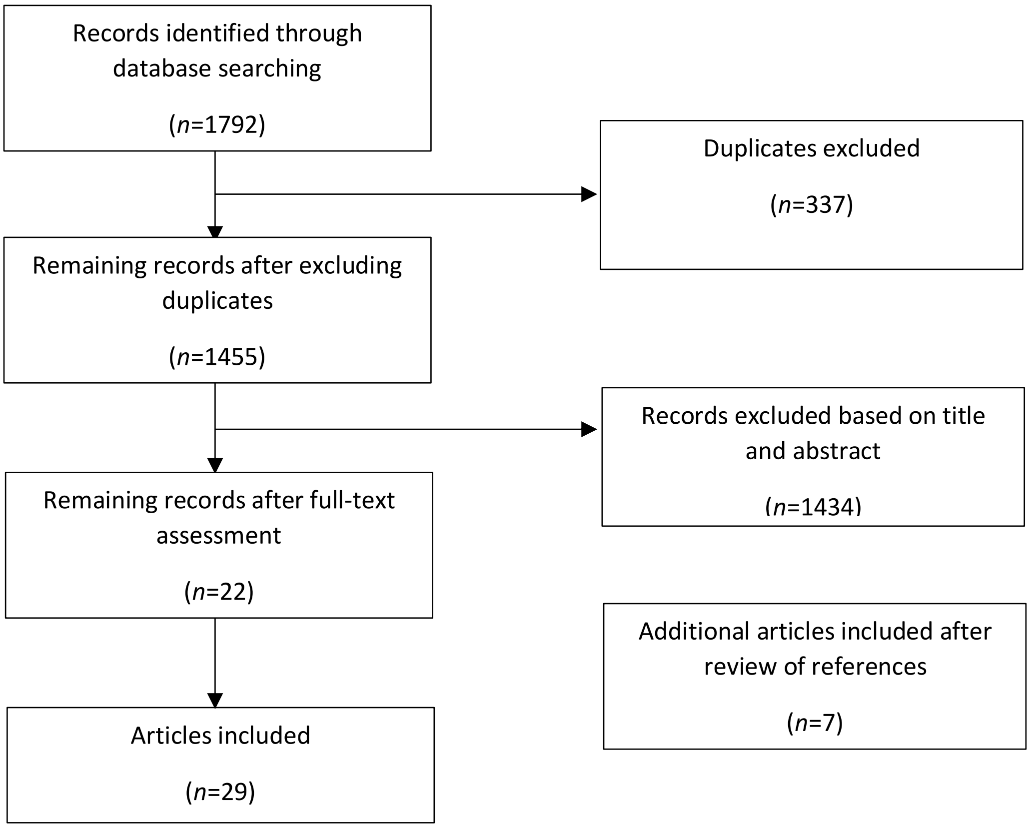
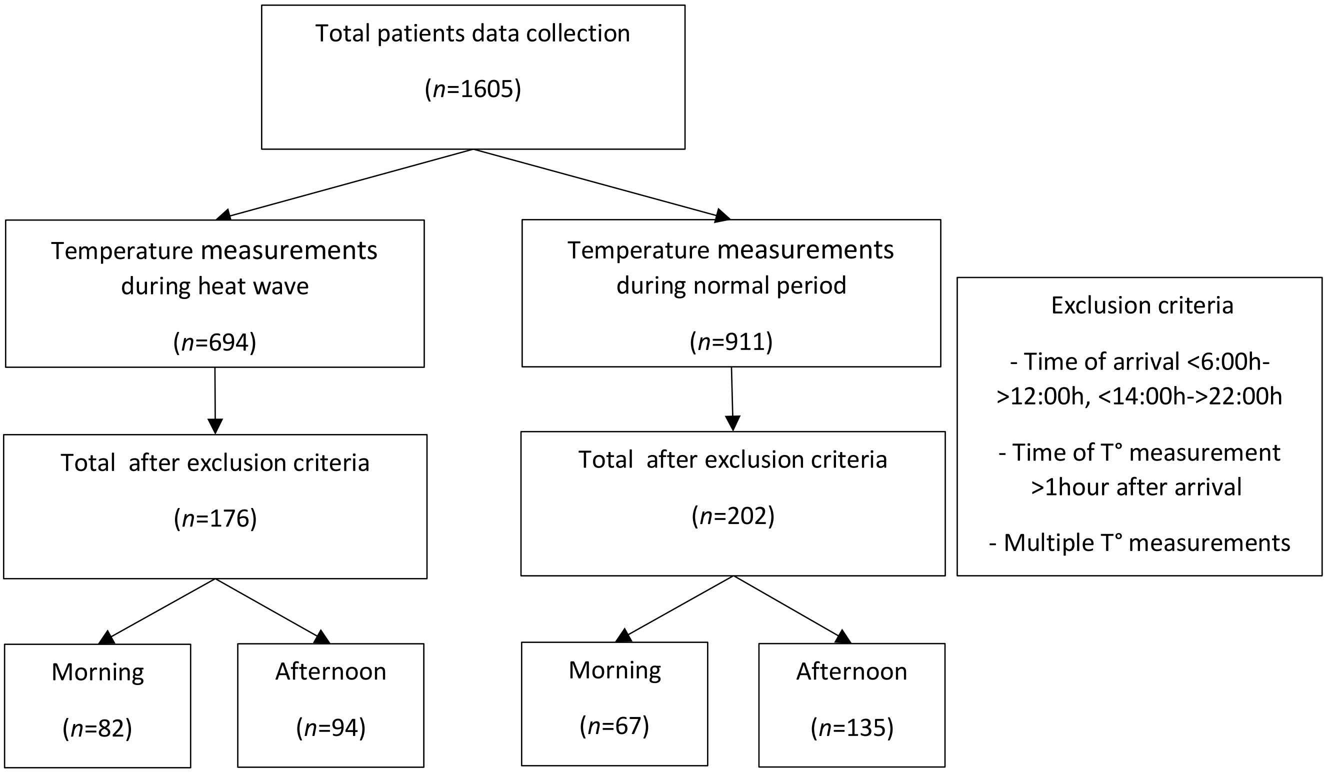


Fig 6: Flow chart of literature search.

Results of temperature measurements in emergency patients

In the period 11-13/08/2020 (heat wave), a total of 694 temperatures were measured at the ED (Fig 7). The age ranged between 0 and 96 years old. After applying the exclusion criteria, 176 temperatures measurements were used. 82 measurements in the morning and 94 measurements in the afternoon. Applying the same protocol for the non-heat wave period, we obtain the following results. On 10/10/2019, 311 temperatures were registered. On 20/10/2019, 254 temperatures were measured. On 5/11/2019, 346 temperature measurements were registered. The age ranged between 0 and 98 years old. After applying the exclusion criteria, 176 temperatures measurements remained for analysis. In the ED and the morning, no statistically significant difference (p>.01) was observed between both groups (heat wave: n = 82; mean T = 36,695 °C, SD = 0,4573 - cold period: n = 67; mean T = 36,709 °C, SD = 0,6637). In the afternoon, however, a statistically significant difference (p<.01*)*was seen between both groups (heat wave n = 94; mean T = 37,191 °C, SD = 0,8417 – cold period: n =135; mean T = 36,842 °C, SD = 0,6116)(*Table 1)*.

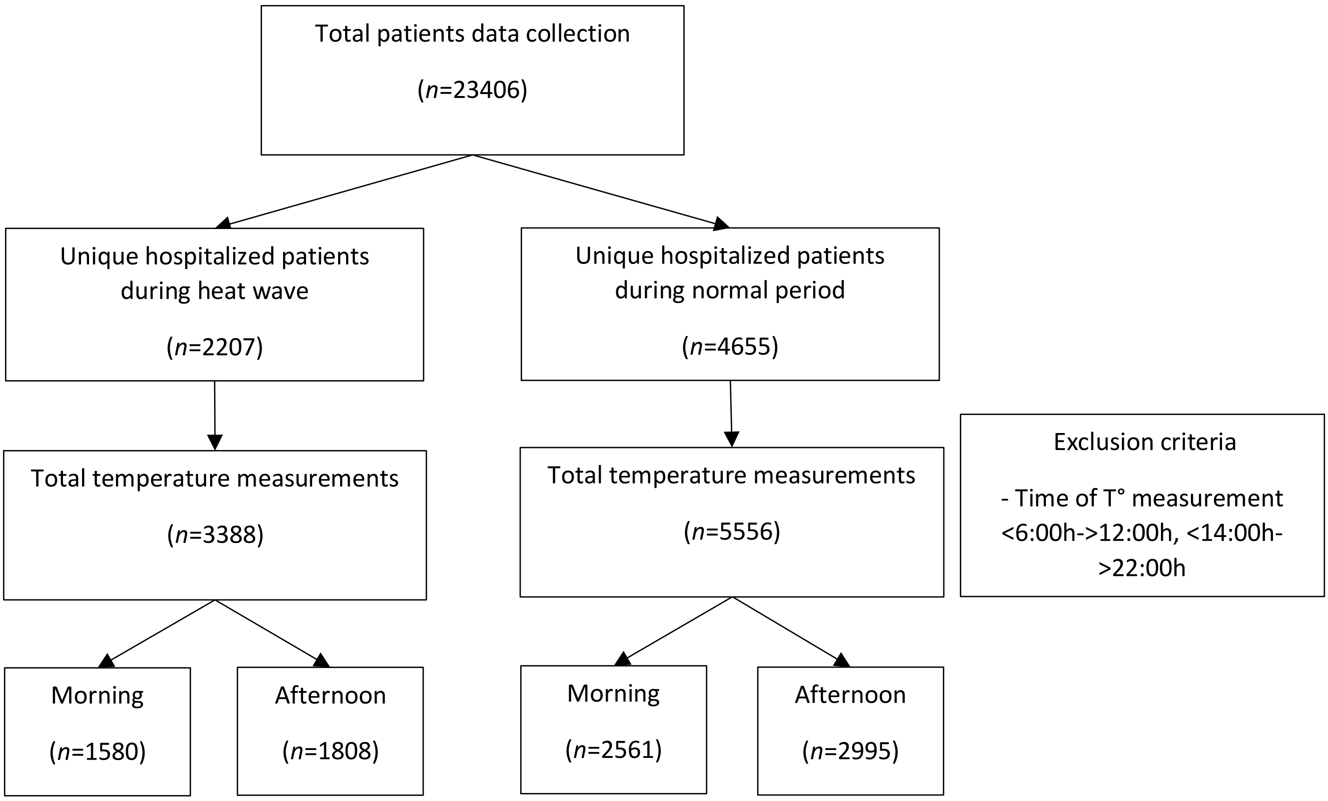
Fig 7: Flow chart patient data selection emergency department.



Results of temperature measurements in hospitalized patients

In the period 11-13/08/2020 (heat wave) a total of 2207 unique hospitalized patients were identified (Fig 8). The age ranged between 0 and 99 years old. After applying the exclusion criteria, 3388 temperatures measurements were used for analysis. 1580 measurements in the morning and 1808 in the afternoon. Applying the same protocol for the cold period, we obtain the following results. On 10/10/2019, 20/10/2019 and 5/11/2019, 4655 unique patients were hospitalized. The age ranged between 0 and 99 years old. After applying the exclusion criteria 5556 temperatures remained for analysis. 2561 measurements in the morning and 2995 in the afternoon. For the hospitalized patients, a statistical difference (p<.01*)* was measured between both groups. In the morning during the heat wave (n = 1579, mean T = 36,699°C, SD = 0,4143) and the cold period (n = 2560, mean T = 36,629°C, SD = 0,4766). Also in the afternoon, a statistical difference (p<.01*)* was observed. During the heat wave (mean T = 36,793 °C, n = 1807, SD = 0,4441) and the cold period (mean T = 36,715 °C, n = 2994, SD = 0,4962)*(Table 2)*.

Fig 8: Flow chart patient data selection University hospital Leuven.



4. Discussion

Limitations

Temperature is commonly measured as part of a routine patient assessment admitted to the ED or while being hospitalized. There are several reasons why a patient can be hyperthermic. No difference was made, neither when admitted to the ED, nor in the hospitalized patients concerning the possible reason for their temperature increase. No standardized measurement method was established before the start of the study for both, the ED and hospitalized patients. Temperature can be measured tympanic, temporal, oral, anal or via the armpit. Each of the methods has a margin of error (Petersen & Hauge, 1997; Stavem et al., 1997). There is a lack of agreement in body temperatures values between tympanic and oral in winter and summer (Lu et al., 2009). Various measuring instruments were used. In addition, thermometers were not calibrated beforehand. This too, can cause errors in temperature measurement (Stavem et al., 1997). Temperature variations were more frequent in elderly. In addition to gender, more sensitive to AT (Gronlund et al., 2014; Holstein et al., 2005; Klenk et al., 2010; Lu & Dai, 2009). Nighttime exposures make an additional important contribution to heat related mortality. The impact is highest on warm nights that were preceded by a hot day (Murage et al., 2017).With patients already hospitalized, no difference was observed between ward patients. Furthermore, no difference was made comparing the infrastructure already present in the various hospital wards. A ward with air conditioning or a ward facing north, for example, can make a difference to the measured results of the patients. When collecting the data, we noticed a big difference in number of patients on the one hand, and the number of measured temperatures on the other hand. There is no equal distribution of the number of measured temperatures between the both mornings and afternoons between the measured periods.

Heat wave management

Despite the above limitations, a difference in temperature was observed in the ED as well as in already hospitalized patients. One could hypothesize that the difference could be even greater in a hospital with few preventive measures, or when checking the different departments separately. We did not request the mortality figures during the measured heat wave to compare with other periods. We know that most of the deaths occur in the first day or two of a period of high temperature (Keatinge, 2003). Few of these deaths are recognizable clinically as being due to heat (Ballester et al., 1997). Heat waves can suddenly present with temperatures that populations have never encountered before and are unprepared for (Argaud, 2007). Exposure to extreme heat can affect many organ systems, which may lead to renal failure, neurological impairments, or cardiovascular failure (Hess et al., 2014). Several causes of hospitalization, such as dehydration and heat stroke, are preventable, and public health interventions, including early warning systems and plans targeting risk factors for these illnesses, could reduce adverse effects of heat in the present and under climate change. There is a >20-fold increase in risk for heat stroke and sunstroke admissions on heat wave days as compared to non-heat wave days (Hopp et al., 2018). Hospitals and doctors may be drastically underestimating the risks of a heat wave. People with heat exhaustion should be given fluids by mouth and sometimes intravenous saline and dextrose, but by far the most important measures are preventive measures. Hot and humid weather adversely affect the perioperative outcome in elderly surgical patients. Patients with poor reserves are at greater perioperative risk during hot and humid climate (Gautam et al., 2011). Also, the number of blood cultures requested rises substantially, leading to increased costs (Johnson et al., 2005; Stéphan et al., 2005). The results have implications for public health and clinical management of disease during heat waves. Knowledge of the specific medical diagnoses that are most likely to occur during heat waves can enable care providers and health systems to be better equipped for the needs of patients during extreme heat events.

By far the most important are the preventive measures. Think ahead. Targeted public health interventions, such as early heat-health warning systems, to intervene earlier during a heat wave could be adapted to mitigate heat-related hospitalizations in the present and future climate change (Hopp et al., 2018). Not all ED's or hospitals in Belgium are equipped for this. A plan of communication with the visitors, staff and hospitalized patients must be foreseen. How can we inform and protect hospitalised? Hospitals need to have clear communication channels available in times of a heat wave to share protective measures. Local authorities can be used for this, the hospital's website, folders, etc. Modifications to infrastructure must be discussed in advance (air conditioning, screens, ...), clothing for staff, transport, etc. Preventive measures such as eating regular meals and drinking enough water can prevent dehydration during heat waves (Keatinge, 2003; Knowlton et al., 2009). Since the only known protective measure against heat in hospital is to withdraw from it, the long-term solution is the widespread installation of air-conditioning (Bouchama, 2004).

Hospital of Leuven

The collected data is from the University hospital of Leuven. This is a hospital in Belgium that complies with the international joint commission. It has a modern infrastructure and it has already its own plan in case of a heat wave. This plan describes actions to tackle impediments and problems caused by periods of very hot weather. In addition the hospital provides a communication plan (Fig 9). This model describes how employees, patients and visitors will be informed and warned about the expected problems and associated actions as a result of the heat wave. Before the summer period and the onset of warm weather, first communication takes place. The heat plan and some important actions for the UZ Leuven employees are framed. A second phase of communication follows when the heat plan comes into effect. The timing of that phase depends on the weather forecasts KMI. Ad hoc initiatives (eg ice cream round for patients) are provided. Communication channels such as Intranet (local server UZ Leuven), illustrative movies, Infuuz (hospital magazine) and the local news site are used to spread the general heat plan guidelines. Several different elements can suffer or have to be adapted during

a heat wave. E.g. appliances, buildings, patients, staff clothing, parking options, transport ... A uniform layout structure with symbols for extreme weather was opted to inform personnel, patients and visitors so they can easily check which theme the warnings concern.

Fig 9: Example heat plan UZ Leuven

5. Conclusion

Due to global warming, external temperatures will become more frequent and longer. It is well known that a heat wave leads to increased morbidity, mortality and costs. Targeted public health interventions, especially for the young and the elderly, can prevent emergency or hospital admissions. In our study, a statistically significant difference was found between the measured temperatures at the ED (except in the morning) and the already hospitalized patients during a heat wave versus a non-heat wave. This study emphasizes the rise in body temperature during a heat wave, independently of other factors that influence body temperature. Knowledge about heat wave-related syndromes can help to be better equipped to the needs of the patients. Preventive measures must be provided in a hospital so that the AT has minimal influence on the CT. Hospitals should focus on preventive measures, whereby air conditioning provides the best temperature control. Further research is needed for UZ Leuven, whereby the different departments are approached separately with regard to orientation and the infrastructure already available. Every hospital should provide his own heat plan, taking into account all the factors that may suffer from the heat.

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Tables

Table 1: Data Temperature measurements at the ED.

Emergency Department					
		n	Mean	SD	Sig.
Morning T	Non-heat wave	67	36,709	0,6637	0,029
	Heat wave	82	36,695	0,4573	
Afternoon T	Non-heat wave	135	36,842	0,6116	0,001
	Heat wave	94	37,191	0,8417	

Table 2: Data Temperature measurements for the hospitalized patients.

Hospitalized patients					
		n	Mean	SD	Sig.
Morning T	Non-heat wave	2560	36,629	0,4766	0,000
	Heat wave	1579	36,698	0,4143	
Afternoon T	Non-heat wave	2994	36,7154	0,4962	0,000
	Heat wave	1807	36,7937	0,4441	

Conflicts of interest

The authors report no conflict of interest.

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