Original Research

Hot Spot: Impact of July 2011 Heat Wave in Southern Italy (Apulia) on Cardiovascular Disease Assessed by Emergency Medical Service and Telemedicine Support

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Abstract

Background: *Heat waves have been reported as being associated with increased rates of hospitalizations and deaths.* **Materials and Methods:** *In July 2011, a heat wave hit southern Italy. We enrolled 9,282 consecutive patients who called the Apulia (southeastern Italy) regional free public emergency medical service (EMS) "118" number (out of 4 million inhabitants) during July 2011. All patients were evaluated with a prehospital electrocardiogram (ECG) thanks to telecardiology support provided by a single telemedicine hub. Local temperatures and relative humidity were recorded and combined in order to calculate the heat index (HI), a more accurate parameter to assess perceived discomfort caused by hot temperatures.* **Results:** *The mean number of calls to the telecardiology hub for prehospital ECG screening in the case of suspected heart disease was increased 48 h after days with an HI ≥44 (402 ± 68 versus 275 ± 52,* $p < 0.001$*, +46%), when the number of calls was directly related to HI values (*$p < 0.01$*). ECG diagnoses of new-onset atrial fibrillation were significantly increased 24 h after days with an HI ≥44 (12 ± 7 versus 8 ± 3,* $p < 0.01$*, +50%). ECG diagnoses of ST-elevation acute myocardial infarction, in contrast, remained substantially unchanged. No significant gender or age (>70 versus <70 years) differences were observed (chi-squared* p *not significant); increased rates of EMS callings were found 48 h after days with an HI ≥44 in hypertensive patients (131 ± 42 versus 78 ± 26,* $p < 0.001$*, +68%) and subjects with prior cardiovascular disease (137 ± 43 versus 89 ± 22,* $p < 0.001$*, +54%).* **Conclusions:** *Increased work burden for EMS assessed with prehospital telecardiology screening accompanies heat waves because of subjects calling for suspected acute heart disease. Prehospital screening with telecardiology support may be of help in identifying subjects who do not require hospitalization in the event of heat waves with increased calls to EMS.*

Key words: *heat wave, cardiovascular disease, telemedicine*

Introduction

Severe and sustained episodes of summer heat (heat waves) have been reported as associated with increased rates of hospitalizations[1] and deaths.[2] Increased mortality during heat waves has been attributed mainly to cardiovascular illness and diseases of the cerebrovascular and respiratory systems,[3] especially among the elderly.[4] A few days after the onset of a heat spell, a sharp increase in the number of heat-related deaths has been observed. Excess emergency department (ED) visits were observed in coincidence with heatstroke.[5]

Modern technologies currently available for at-home assessment of patients calling emergency medical service (EMS) may, however, be helpful in managing the increased work burden caused by heat waves and the increased risk of the adverse health outcome caused by heat waves as well. Telemedicine support and prehospital assessment of suspected acute heart disease are actually recommended by guidelines[6] and scientific statements[7] and implemented in several geographic contexts.[8,9]

We therefore aimed to evaluate the impact of a heat wave on the work burden of a regional EMS supported by a telemedicine hub. Our objectives were to determine if there was an excess of EMS cases with suspected acute heart disease as a result of the hot weather, ascertain the principal reason for electrocardiogram (ECG) examination, and possibly define the underlying cardiac conditions of the susceptible population.

Materials and Methods

All patients who called the Apulia regional free public EMS "118" number from July 1 through July 31, 2011 were enrolled. The number "118" is the Italian public free service for general medical or surgical emergencies, whose aim is an immediate diagnosis of critical diseases in order to avoid emergency room delay-to-diagnosis. Final hospitalization is arranged by teams of physicians and the "118" district central, connected by mobile phone; direct admission to a critical care unit is arranged according to the level of care. Patients are discharged from the ambulance and not transported at all in the case of normal findings.

Telemedicine support provided by a regional telecardiology hub (Cardio-on-Line Europe S.R.L., Bari, Italy) to the EMS of Apulia (southeastern Italy, 19,362 km^2, 4 million inhabitants) (*Fig. 1*) was F1
previously described elsewhere.[10] A cardiologist available 24/7 within the telecardiology hub promptly reads the ECGs recorded by EMS personnel from all over Apulia. In the case of significant diagnoses, the

patients are immediately referred to the nearest coronary care unit or catheterization laboratory for the appropriate treatment.

One hundred sixty-five crews of "118" EMS, 27 first aid points (the first aid point is able to give treatments to citizens who arrive spontaneously or to give treatment for minor problems, such as minor traumas or wounds; if needed, the patient will be transferred by ambulance to the nearest emergency room for adequate treatments), 33 summer first aid points (a summer first aid point is active only in summer months in tourist sites crowded with tourists), and 12 medical vehicles were equipped with a device able to record and transmit by mobile phone a 12-lead ECG (CardioVox P12 Heartline receiving system from Aerotel, Holon, Israel). The regional EMS and telecardiology provider made a preliminary agreement on indications for ECG recording: presence of chest pain or epigastric pain, breathlessness, palpitations, dizziness/fainting, or any suspected acute cardiovascular disease.

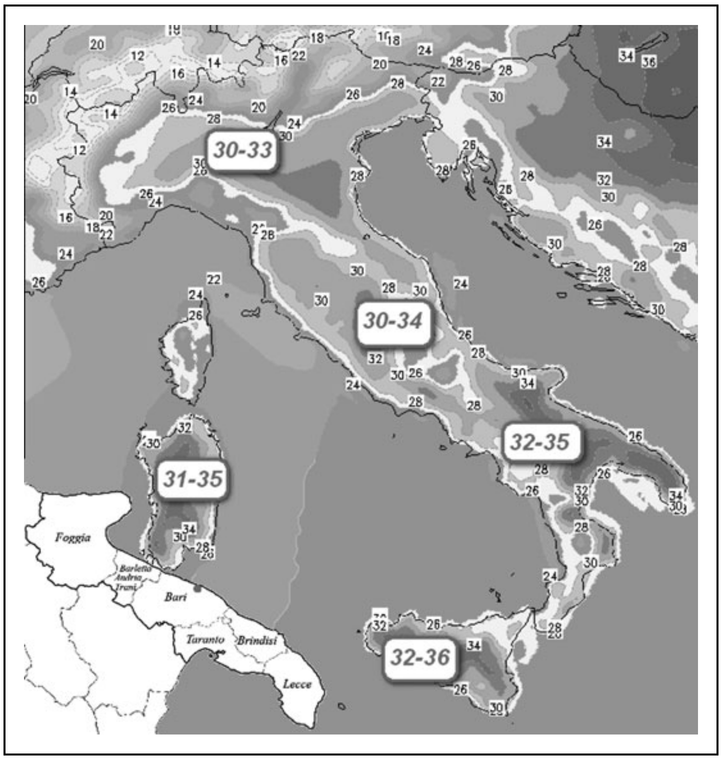


Fig. 1. Heat wave in July 2011 with peak temperatures on July 10 (data obtained from www.meteolive.it). Apulia, Italy, and its administrative districts are shown below, on the left. A single telecardiology serving the entire region is located in the capital city (Bari).

Indications regarding ECG recording, ECG findings, and cumulative by day number of EMS personnel contacts with the telemedicine hub were compiled for the whole month of July 2011, when a heat wave hit southern Italy and Apulia (*Fig. 1*). Local temperatures and relative humidity in Apulia district head cities were recorded and provided by the Regional Environmental Department (Agenzia Regionale Puglia per l'Ambiente) or international weather archives when regionally missing.[11] Temperatures and humidity were combined in order to calculate the heat index (HI), a more accurate parameter to assess perceived discomfort caused by hot temperatures.[12] The HI measures the evaporative heat between a typical human and the environment and is a better measure of the effect of heat on the body than temperature alone.[13] A "heat wave" was considered as an unusual weather condition with an HI above 2 standard deviations over mean levels for that month; means were calculated for the previous 3 years. Four peaks exceeding 2 standard deviation levels can be observed in correspondence with reported "heat waves" (*Fig. 2*). The study was approved by the Regional Health Care Authority. F2

STATISTICAL ANALYSIS

Continuous variables were expressed as mean ± standard deviation values and compared with Student's *t* test or the Mann–Whitney U test as required. Categorical variables were expressed as percentages and compared with the chi-squared test. Correlations between continuous variables were analyzed with Pearson's test or the Spearman test as required. Normal distribution of variables was

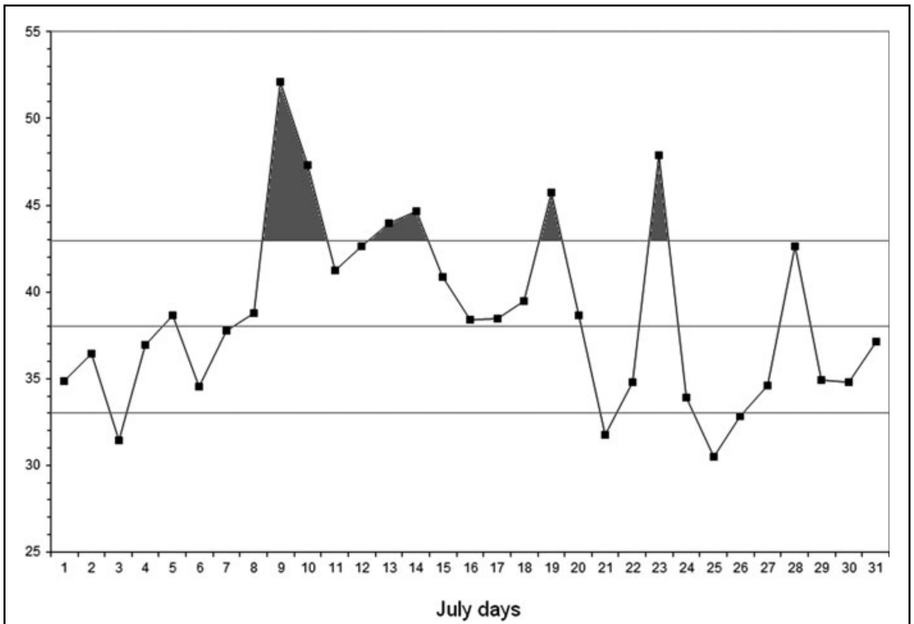


Fig. 2. July 2011 heat index values over mean levels ± 2 standard deviations calculated for the 3 years before. Four peaks corresponding to subsequent "heat waves" can be observed and are highlighted. AU6

checked with the Lilliefors and Shapiro–Wilk test. A p value of <0.05 was considered as statistically significant.

There were 6 experimental subjects (heat wave days) and 24 control subjects (control days). In the study the response within each subject group (calls per day) was normally distributed with a standard deviation of 57. If the true difference in the experimental and control means is 125, we will be able to reject the null hypothesis that the population means of the experimental and control groups are equal with a probability (power) of 99.5%. The Type I error probability associated with this test of this null hypothesis is 0.05.

Results

We enrolled 9,282 consecutive patients who called the Apulia regional free public EMS "118" number from July 1 through July 31, 2011. The mean age of subjects enrolled was 63 ± 20 years, 48% were male, 3% were smokers, 3% had a pacemaker, 29% had a history of cardiovascular disease, 33% were hypertensive, 11% had diabetes, and 12% were obese.

Increased numbers of "118" call rates were observed just after
F3 peaks in HI with a latency of about 48 h (*Fig. 3*). Mean number of calls to the telecardiology hub for prehospital ECG screening in the case of suspected heart disease was increased 48 h after days with an HI ≥ 44 (402 ± 68 versus 275 ± 52, $p<0.001$, $+46\%$); differences were not significant at 24 and 72 h later considering those days with an HI
F4 ≥ 44 (*Fig. 4*). Forty-eight hours after days with an HI ≥ 44, the number of calls was directly related to HI values ($r=0.54$, $p<0.01$); correlations were not significant at 24 and 72 h later considering those days
F5 with an HI ≥ 44 (*Fig. 5*).

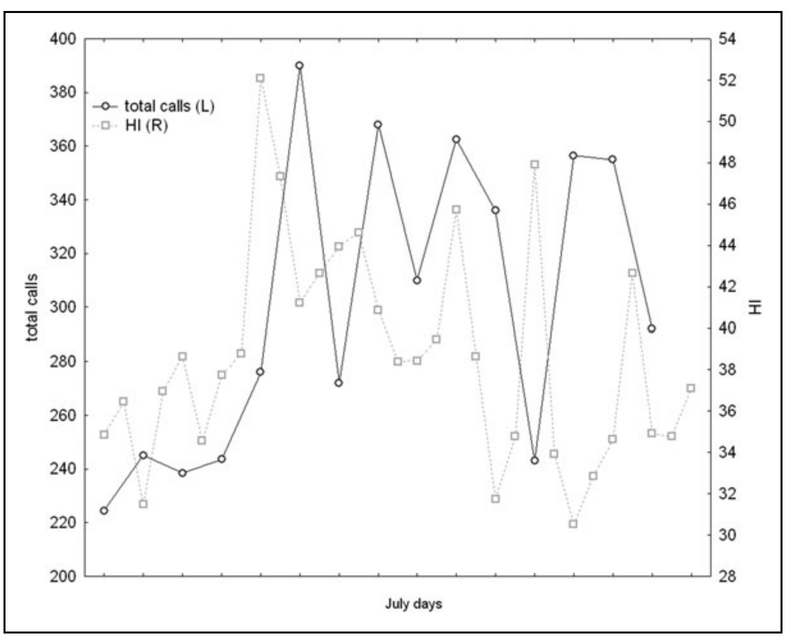


Fig. 3. Emergency medical service calls for suspected heart disease (left [L]) and July 2011 temperatures expressed as mean regional heart index (HI) (right [R]). A heat wave hit on July 9–10 and 23. Coincident increased rates of emergency medical service calls are detectable just after HI peaks.

Symptoms reported by patients in concomitance with heat peaks were mainly fainting (*Fig. 6*). F6

The ECG diagnoses of new-onset atrial fibrillation (AF) were significantly increased 24 h after days with an HI ≥ 44 (12 ± 7 versus 8 ± 3, $p<0.01$, $+50\%$); differences were not significant 48 h later AU3
considering the days with an HI ≥ 44 (*Fig. 7*). ECG diagnoses of F7
ST-elevation acute myocardial infarction, in contrast, remained substantially unchanged.

No significant gender or age (>70 versus <70 years) differences were observed in EMS calling after heat peaks (*Figs. 8* and *9*) (chi F8 F9
squared p not significant); increased rates of EMS calling were found 48 h after days with an HI ≥ 44 in hypertensive patients (131 ± 42 versus 78 ± 26, $p<0.001$, $+68\%$) and subjects with prior cardiovascular disease (137 ± 43 versus 89 ± 22, $p<0.001$, $+54\%$) (*Fig. 10*). F10

Discussion

In this study we describe for the first time the impact of a heat wave on EMS work burden and cases of suspected heart disease assessed by telemedicine support. The heat wave was followed by a peaking rate of EMS calls assessed by prehospital telecardiology support.

Increased rates of hospitalization during heat waves may be explained by several factors. The need to dissipate heat adds stress on the cardiovascular system, which may cause the symptoms of underlying heart disease to worsen (angina, shortness of breath).[14–16] In a study of elderly patients exposed to extreme indoor and outdoor temperatures during heat waves, body temperature increased and blood pressure values decreased proportionally to indoor and outdoor temperatures.[17] Hot weather increases the individual's circulatory rate and acts on blood pressure, particularly in those already consuming cardiovascular drugs.[18,19] When the body's attempts to dissipate heat become overwhelmed and the body's temperature begins to rise, dehydration and electrolyte imbalances may occur.[20] For people with diabetes and renal disease, dehydration and excessive sweating result in increased stress on the kidneys.[21] Serum sodium abnormalities are frequently observed in patients with a nonexertional heatstroke during a heat wave[22]; however, only hypernatremia should be considered as an independent risk factor of death. Increased platelet and red cell counts, blood viscosity, and plasma cholesterol levels were shown during heat stress, and that may be related to observed mortality from coronary and cerebral thrombosis during
heat waves.[19] The level of troponin I is frequently elevated AU4
in patients with nonexertional heat-related illnesses during a heat wave and is an independent risk factor only in high-risk patients, where a severe increase (>1.5 ng/mL) indicates severe myocardial damage.[23]

It is interesting that peaks in EMS calls showed a lag of about 48 h after peaks in HI. This phenomenon is similar to findings from several other prior studies,[24,25] which have already found a 48-h lag.

The presence of a typical lag between heat wave onset and heat-related dispatches (emergency 911 calls) has been

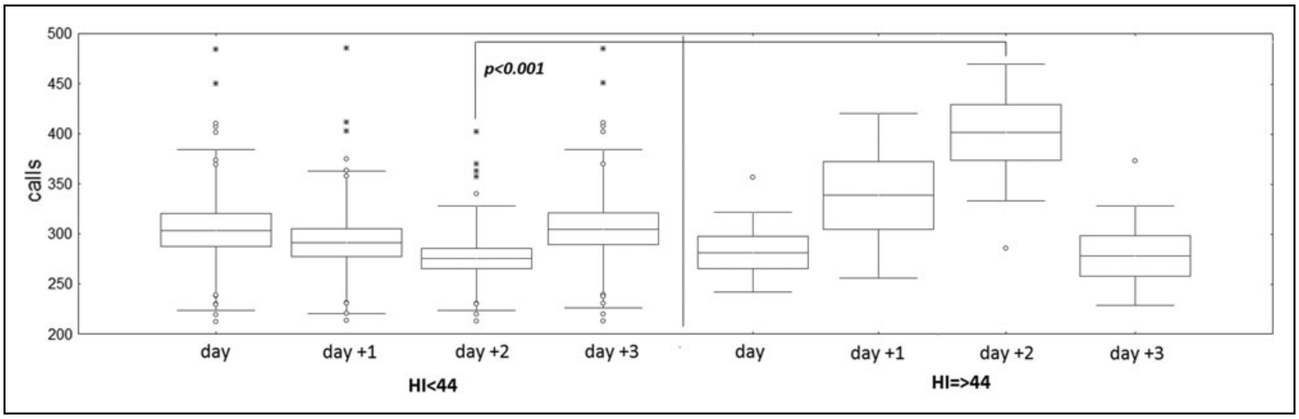


Fig. 4. Mean calls the telecardiology hub for prehospital electrocardiogram screening the the case of suspected heart disease by "118" emergency medical service crews: (**left**) days with a heat index (HI) of <44 and subsequent days and (**right**) days with an HI of ≥44 and subsequent days. Differences were statistically significant at 48 h after days with an HI of ≥44.

previously described by Hartz et al.[26] That is probably due to both the time that climate stressors need to overwhelm the compensatory mechanism of the cardiovascular system and longer decision times (call for medical help) among subjects at higher risk in the case of heat waves (elderly patients).

The lag, however, may be also related to a cumulative effect of hot temperatures; there is evidence that the longer the heat wave duration, the higher the rise in all-causes hospital admission. Heat wave effects were shown to amount to a stable and statistically significant 8.1–11.6% increase in excess deaths per heat wave day[27]; in more than 40 American cities, heat wave mortality risk increased 0.38% for every 1-day increase in heat wave duration.[28] The longest heat waves were associated in Spain with daily mortality.[29] An analysis for 108 communities in the United States during 1987–2000 showed an additional effect linked with heat waves after 4 consecutive heat wave days.[30]

In a study from seven major Korean cities, heat wave definition required at least 2 days of duration to show its effect.[31] In Catalonia, 3 consecutive hot days increased total daily mortality by 19% (cardiovascular and respiratory diseases, mental and nervous system disorders, infectious and digestive system diseases, diabetes, and some external causes such as suicide); about 40% of attributable deaths, however, did not occur during heat wave periods, but later on.[32] Anderson and Bell[33] typically found that heat-related mortality was most associated with a 24–48-h lag; mortality risk increased with the intensity or duration of heat waves. Hertel et al.[34] found that even the effect on respiratory mortality was delayed; the maximum relative risk (RR) was 1.66 at 6 days after the heat wave. During the July 2006 heat wave, daily mortality, morbidity, and HI were correlated with lags of apparent temperature up to 7 days.[35]

The increased frequency and intensity of heat waves, which can cause serious health impacts, seem to be one of the consequences of climate change.[36] According to some authors, extreme heat events are responsible for more deaths in the United States than floods, hurricanes, and tornados combined.[26]

Increased death rates accompanying heat waves have been reported for a long time.[37,38]

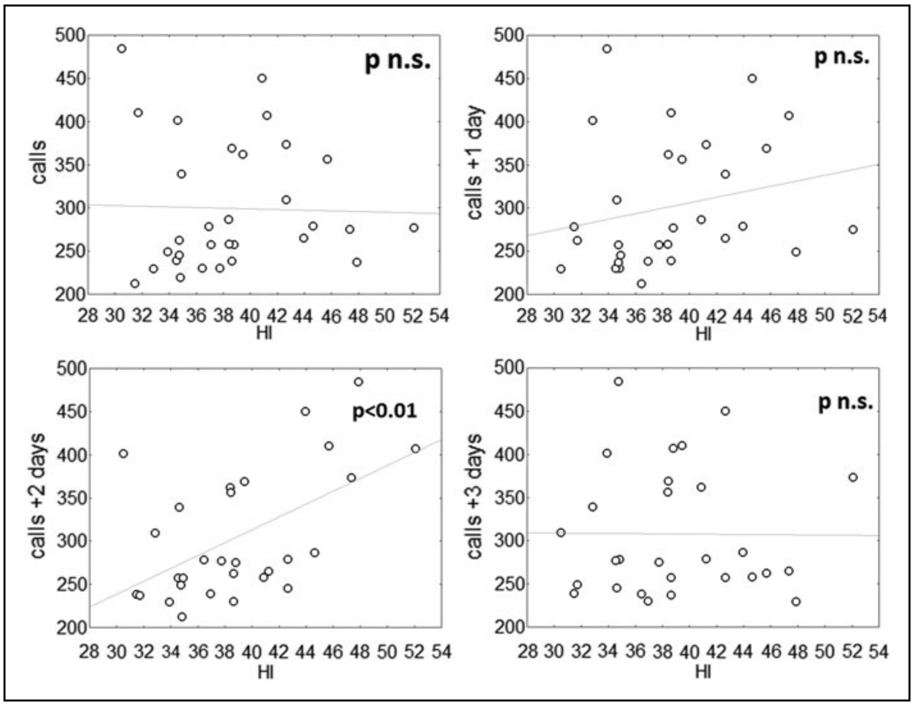


Fig. 5. Correlations between calls to the telecardiology hub for prehospital electrocardiogram screening in the case of suspected heart disease by "118" emergency medical crews and heat index (HI) values. Correlations were statistically significant at 48 h after days with an HI of ≥44. n.s., not significant.

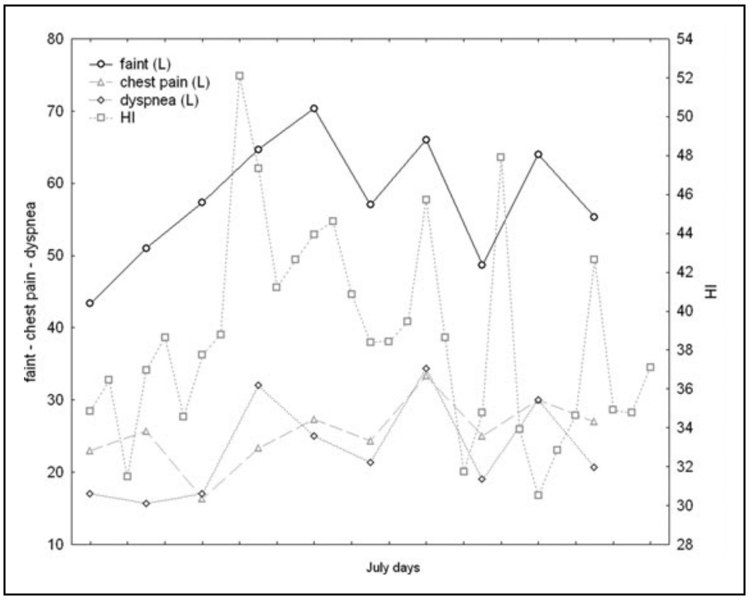


Fig. 6. Symptoms reported by patients calling the emergency medical service for suspected heart disease and July 2011 temperatures expressed as mean regional heat index (HI). Increased rates of reported fainting during the heat wave are seen; a smaller increase is observable also for dyspnea. L, left.

Subsequently, several heat waves have been reported. During the heat wave of 1980, average daily temperatures in Memphis, TN, first rose above the mean on June 25 and remained elevated for 26 consecutive days. There was a statistically significant increase in total mortality rates, death from natural causes, cardiovascular mortality

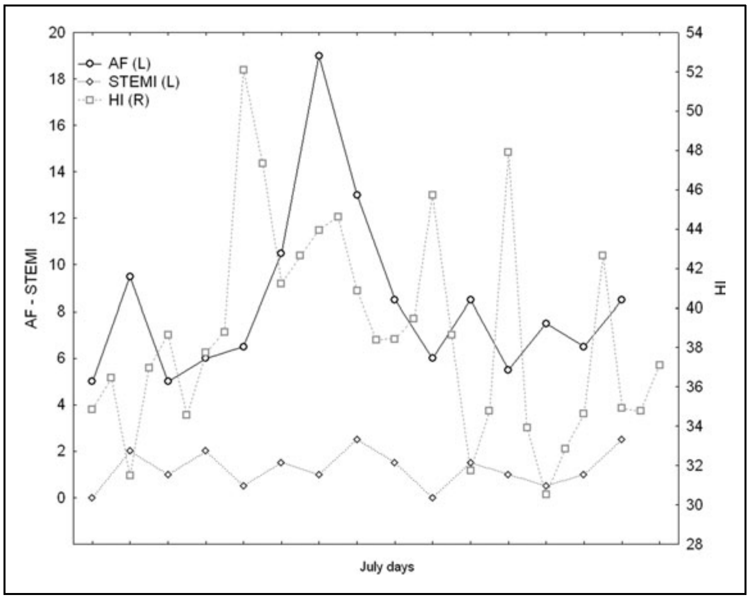


Fig. 7. Main electrocardiogram diagnoses found in emergency medical service calls for suspected heart disease and July 2011 temperatures expressed as mean regional heat index (HI) (right [R]). Increased rates of newly diagnosed atrial fibrillation (AF) were found, whereas diagnosis of ST-elevation acute myocardial infarction (STEMI) remained stable. L, left.

rates, and the rate for persons dead on arrival.[39] Virtually all the excess mortality was in persons over the age of 60 years. Again, in 1980 hospital admissions in St. Louis, MO, and Kansas City, MO, were found to be increased by 5.1% and 1.5% during a heat wave, and deaths from all causes rose by 57% and 64%, respectively.[40] A 26% increase in total mortality and a 98% increase in cardiovascular mortality were associated with the 1999 heat wave in Philadelphia, PA.[41] Data showed an increase in total mortality in four of the five counties examined and an increase in cardiovascular mortality in all five counties. The risk for death for those dying from cardiovascular disease increased significantly for people older than 64 years, for both sexes, and all races.

Cumulative excess nonaccidental mortality during the 2001 heat wave in Moscow was 33%, or approximately 1,200 additional deaths, with short-term displaced mortality contributing about 10% of these.[42] Mortality from coronary heart disease increased by 32%, cerebrovascular mortality by 51%, and respiratory mortality by 80%. In the 75+-years age group, corresponding mortality increments were consistently higher except for respiratory deaths. An estimated 560 extra deaths were observed during the three heat waves of 2002.

In 2003, Shanghai recorded the hottest summer in over 50 years. During the heat wave, the RR of total mortality was 1.13, and the impact was greatest for cardiovascular (RR = 1.19) and respiratory (RR = 1.23) mortality[43]; elderly people (over 65 years) were most vulnerable to the heat wave.

An analysis from heat waves in seven major Korean cities for 2000–2007 found total mortality increased 4.1% during heat waves compared with non–heat wave days[31]; estimated mortality was higher for heat waves that were more intense, longer, or earlier in the summer, although effects were not statistically significant. Estimated risks were higher for women versus men, older versus younger residents, those with no education versus some education, and deaths that occurred out of hospitals in Seoul, although differences among strata of individual characteristics were not statistically significant.

In Québec, Canada, July 2010 was marked by a heat wave unprecedented in recent history.[44] During the heat wave, the crude daily rates showed a significant increase of 33% for deaths and 4% for ED admissions in relation with comparison periods. There were 304 reported deaths from all causes in Montreal residents, of which 106 were probably or possibly heat-related.[45] Major underlying health conditions in heat-related deaths included cardiovascular problems and mental health illness.

During a 2010 heat wave in the city of Harbin in northern China, an overall excess of 41% in total mortality occurred, with a RR of total mortality 1.41.[46]

Heat waves are a public health concern in Australia, and unprecedented heat waves have been recorded in Adelaide in recent years.[47] From January 30 to February 6, 2011, New South Wales was affected by an exceptional heat wave; during the heat wave all-cause ED visits increased by 2%, all-cause ambulance calls increased by 14%, and all-cause mortality increased

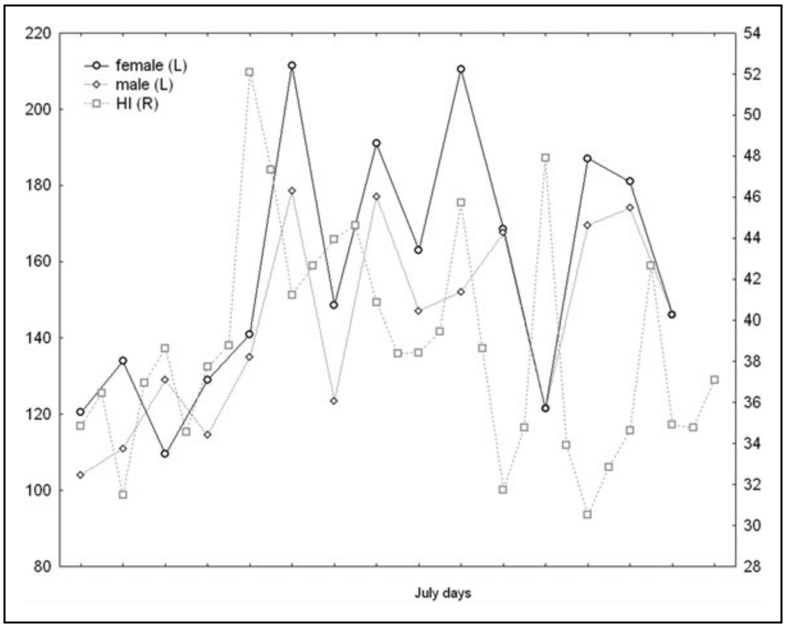


Fig. 8. Emergency medical service calls for suspected heart disease and July 2011 temperatures expressed as mean regional heat index (HI). No statistically significant gender difference is seen. L, left; R, right.

by 13%.[48] Those 75 years of age and older had the highest excess rates of all outcomes.

The largest amount of data come from the 1995 heat wave in Chicago, IL,[1,2,49] that in 2003 in France,[50] and that in 2006 in California.[51]

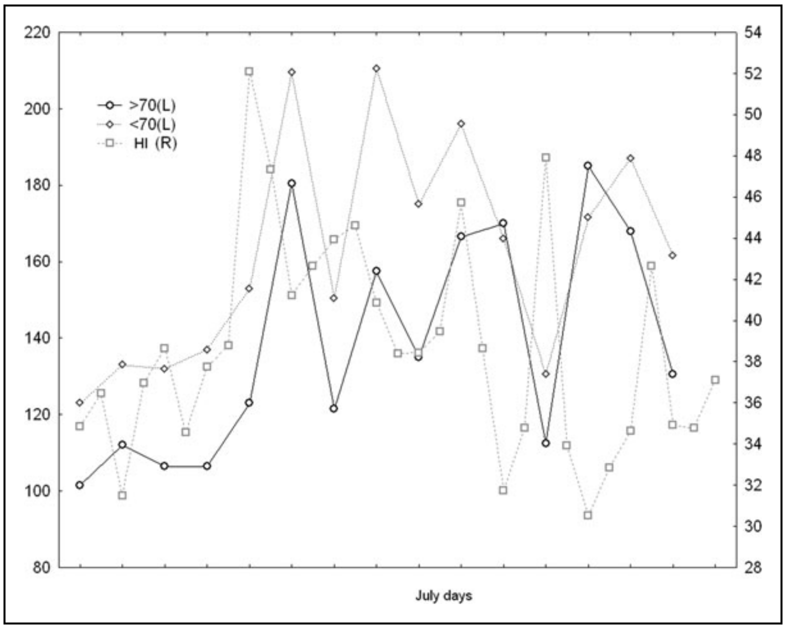


Fig. 9. Emergency medical service calls for suspected heart disease and July 2011 temperatures expressed as mean regional heat index (HI). No statistically significant age difference (in years) is seen. L, left; R, right.

In 1995, the Chicago heat wave resulted in 692 excess deaths from June 21 to August 10, 1995. RR for all-cause mortality on the day with peak mortality was 1.74.[52] During the week of the heat wave, there were 1,072 (11%) more hospital admissions than average for comparison weeks and 838 (35%) more than expected among patients 65 years of age and older.[1] Analysis of comorbid conditions revealed 23% excess admissions for underlying cardiovascular diseases and 30% for diabetes.

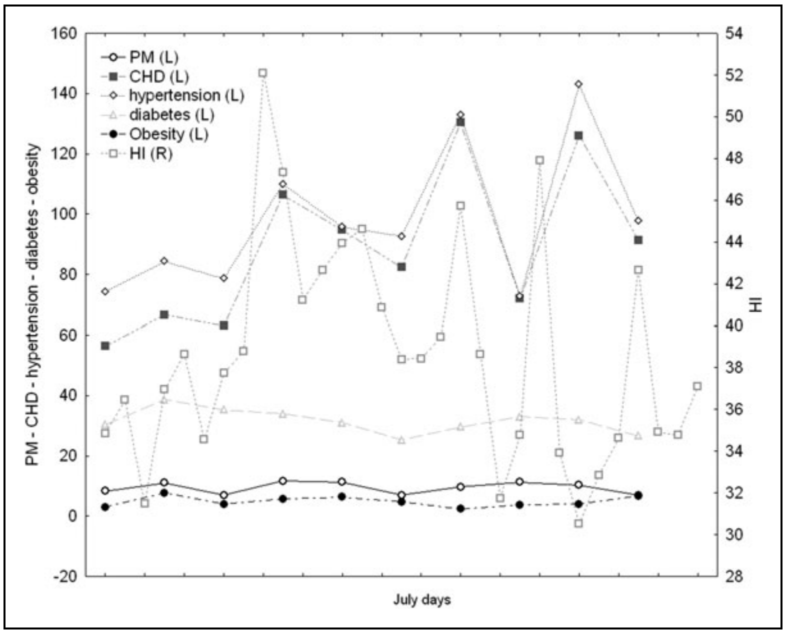
During August 2003, Europe sustained a severe heat wave that resulted in 14,800 heat-related deaths in France.[24,50,53] The consequences were maximal in the Paris area; more than 2,600 excess ED visits, 1,900 excess hospital admissions, and 475 excess deaths were reported despite a rapid mobilization.[54] The excess mortality was marked and increased with age. It was 15% higher in women than in men of comparable age beginning with 45 years of age.[55] Excess mortality at home and in retirement institutions was greater than that in hospitals. Deaths directly related to heat, heatstroke, hyperthermia, and dehydration increased massively. Cardiovascular diseases, ill-defined morbid disorders, respiratory diseases, and nervous system diseases also markedly contributed to the excess mortality. The geographic variations in mortality showed a clear age-dependent relationship with the number of very hot days. No harvesting effect was observed.

In a multicounty analysis from California, during the July 2006 heat wave, there was a 9% increase in daily mortality per 10°F change in apparent temperature for all counties combined.[51] This estimate is almost three times larger than the effect estimated for the full warm season of May–September, during the non–heat wave years. Actual mortality during the July 2006 heat wave was two to three times greater than expected; 16,166 excess ED visits and 1,182 excess hospitalizations occurred statewide in California during the heat wave. ED visits showed significant increases for acute renal failure, cardiovascular diseases, diabetes, electrolyte imbalance, and nephritis.

Quantifying the impact of heat waves on overall mortality, cardiovascular mortality, and cardiovascular morbidity is not easy.

After analyzing mortality risk for heat waves in 43 U.S. cities (1987–2005), mortality was found to be increased 3.74% during heat waves compared with non–heat wave days and 2.49% for every 1°F increase in heat wave intensity.[28] For a 1°C increase in mean apparent temperature a 2.7% increase in mortality (all cause) was observed,[35] and a 6% increase in mortality risk was observed for each degree increase in HI.[56]

Among 95,808 nursing home residents in southwest Germany between 2001 and 2005, mortality risk increased by 26% and 62% at days of 32.0–33.9°C and 34°C and more, respectively.[57] In Castile-La Mancha, for each °C that



AU7 **Fig. 10.** Risk factors and prior history of patients calling the emergency medical service for suspected heart disease and July 2011 temperatures expressed as mean regional heat index (HI). Higher rates are observable in those with hypertension and subjects with prior cardiovascular disease. CHD, congestive heart failure; L, left; R, right.

temperatures exceeded local thresholds, the percentage increase in mortality amounted to increases of approximately 12% over the daily mean, albeit with clear provincial variations.[29]

The influences of temperature on heat-related illnesses seem to vary according to gender, age, and region.[58] Being male was reported as a major risk factor of mortality during heat waves,[59] whereas in a study by Díaz et al.,[60] mortality increased up to 28.4% for every degree the temperature rose above 36.5°C, with particular effect in women over the age of 75 years and circulatory-cause mortality. No significant gender differences were found in our study.

Although the short-term effects of high environmental temperatures on mortality have been well documented,[2,61] there is less evidence about the effects of high temperature on morbidity. In 12 U.S. cities, there was an association between hot weather and a rise in admissions for heart diseases in the 65-year age group.[62] In Denver, CO, high temperatures were associated with an increase in admissions for acute myocardial infarction and congestive heart failure.[63]

Despite this prior evidence, in our study an increased number of "118" calls was not matched with an increase in acute myocardial infarction or severe cardiovascular disease diagnosed at prehospital assessment with telecardiology support. This apparent contrast could be explained by considering several points.

Our study did not focus on mortality and was exclusively aimed at evaluating the increased workload for EMS supported by a telecardiology service during a heat wave, although heat waves probably impact mainly on cardiovascular mortality rather than on morbidity. Empana et al.[64] thus found increased rates of out-of-hospital cardiac arrest attended by the medical mobile intensive care units during the 2003 heat wave in France but without significantly increased rates of myocardial infarction. Kovats et al.[65] also described a contrasting pattern of mortality and hospital admission during heat waves in Greater London: the impact of hot weather on mortality is not paralleled by similar magnitude increases in hospital admissions, which supports the hypothesis that many heat-related deaths occur in people before they come to medical attention.

The temperature above which hospital admissions soar, however, coincides with the temperature limit above which mortality sharply rises. The pattern of hospital admissions is completely different from that of mortality; the rise in hospital admissions due to all causes and age groups is clearly smaller than that detected for mortality.[66] These results suggest that people die rapidly from circulatory diseases before they can be admitted to the hospital.

On another hand, several studies have remarked on the greater impact of heat waves on respiratory disease rather than on cardiovascular disease. The 2003 Germany heat wave effect on mortality varied based on underlying disease; regression analysis showed an association between heat and overall mortality and greatest associations for respiratory mortality.[67] In a large study from Essen, Germany, periods with sustained heat especially affected respiratory mortality, whereas for cardiovascular and neoplastic mortality no distinct influence could be shown.[34]

In a study conducted in 12 European cities, for respiratory admissions there was a positive association that was heterogeneous among cities.[68] In contrast, the association between temperature and cardiovascular and cerebrovascular admissions tended to be negative and did not reach statistical significance.

During the 1995 heat wave in Chicago, the number of hospitalizations exceeded the average for non–heat wave weeks by 1,072, but no morbidity displacement was observed to supersede this excess.[1,2] Studies of heat waves tend to show comparatively smaller increases in hospital admissions than in mortality,[1,66] but the results of time series studies are not consistent.

The only significant finding in our study on cardiovascular morbidity was an increased rate of diagnosis of new-onset AF in coincidence with a heat wave. This finding contrasts with prior observations that found increased rates of admission for AF during cold days[69] or in winter periods.[70,71]

This apparent contrast may be probably explained by extreme conditions typical of heat waves possibly related to AF onset, such as dehydration, electrolyte anomalies,[72] hemodynamic stress, and catecholamine release consequent to hypotension.[73] Hypovelemia induced by dehydration is a well-known trigger of adrenergic activation,[74] and adrenergic hypertone is related to AF onset.[75] Moreover, autonomic tone variations possibly induced by heat may lead to AF.[76,77] Heatstroke is linked with an inflammatory activation,[78] and inflammation may be associated with new onset of AF.[79]

Understanding the health impacts of heat waves is important, especially given anticipated increases in the frequency, duration, and intensity of heat waves due to climate change. Initiatives were taken with the aim of reducing health consequences of heat waves, and results were encouraging. Following the 2010 heat wave, the Montreal heat response plan and heat surveillance system were updated to include initiatives to better communicate preventive measures to the vulnerable populations and to intervene earlier during a heat wave.[45] Thanks to these initiatives, the impact of heat waves was significantly blunted. Data on nine French cities from the 2006 heat wave show that, unlike the 2003 heat wave, no additional heat wave effect was observed.[80] The absence of a specific heat wave effect may be partly explained by the prevention plans. The excess mortality during the 2006 heat wave in France, which was markedly lower than that predicted by the model, may be interpreted as a decrease in the population's vulnerability to heat, together with, since 2003, increased awareness of the risk related to extreme temperatures, preventive measures, and the setup of the warning system.[81]

The implementation of a regional heat-health warning system was associated with a decrease of the excessive heat effect on mortality also in Tuscany, Italy.[82]

However, an important residual risk remains that needs to be more vigorously addressed by public health authorities in light of the expected increase in the frequency and severity of heat waves and the aging of the population. Because a warmer climate is predicted in the future, the incidence of heat waves should increase, and more comprehensive measures, both medical and social, should be adopted to prevent the effects of extreme heat on the population, particularly the elderly. From such a perspective, prehospital immediate assessment with telecardiology support may be of help in reducing time of diagnosis in the case of real acute cardiovascular disease or reducing unnecessary ED visits in the case of heat waves.[9,10,83–85] Other authors indeed have already suggested that simple preventive measures before hospital admissions, such as prehospital assessment with telecardiology support, may be able to reduce the mortality that mostly occurred at home and in nursing homes.[54]

Further randomized studies on larger populations, however, are needed in order to evaluate the possible efficacy of telemedicine in managing increased work burden for EMS during heat waves, in promptly diagnosing cases needing urgent hospitalization, or in avoiding unnecessary urgent cardiologist consultations.

LIMITATIONS

The main limitation of the study is the lack of data regarding subsequent hospitalization and final diagnosis of hospitalized patients. That does not allow any analysis on mortality or diagnostic pathways.

No data are available on markers of pollution or microparticulate material in the air.

Exposure was not measured as HI for each individual but used at a community level. The estimated exposure does not address activity patterns such as time indoors versus outdoors, the limited time frame (1 month) to establish baseline rates for comparison, and multiple calls from the same person.

AF cases were considered as new onset as reported by patients; some cases of presumed new-onset AF could be therefore permanent AF with inadequate rate control in patients who were more vasodilated due to the heat, resulting in activation of the sympathetic nervous system.

Conclusions

Increased work burden for EMS assessed with prehospital telecardiology screening accompanies heat waves because of subjects calling for suspected acute heart disease. Despite the increased number of calls, the diagnosis of severe acute cardiac disease remains substantially unchanged. Prehospital screening with telecardiology support could possibly be of help in the case of heat waves and consequent peaks of calls to the "118" EMS number in reducing the workload for EDs.

Disclosure Statement

No competing financial interests exist.

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AU1 Proved academic degree for co-author.
AU2 Spell out U.O.
AU3 at 48 and 72 h meant, rather than 48 h later?
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