AIR-CONDTIONING IN NURSING HOMES TILL DEATH DO US PART?

PG Luscuere[1] and V Borst[2]

[1]Delft University of Technology, Faculty of Architecture, Delft, The Netherlands
[2]Verpleeghuis De Riethorst, Geertruidenberg, The Netherlands

ABSTRACT
Heat wave periods coincide with raised levels of mortality in general and particularly among in-patients in nursing homes. There are several studies which confirm this phenomenon, among them one in The Netherlands (Borst, Schols and Mackenbach, 1997; also Mackenbach, Schols and Borst, 1997). This study showed the correlation between mortality rates and the weekly average of maximum daily ambient air temperatures at intervals of 5 ºC. As mortality rates were more evidently raised in hot periods the correlation with specifically the hot period (summer 1994) was analysed in more detail. The correlation is striking, with a correlation factor of R^2= 0.8988. This result generates the question as to what extent nursing homes should be equipped with air-conditioning even in moderate climates, and provides a start towards a quantification of indoor temperature limits in heat wave periods.

INDEX TERMS
Mortality, Nursing homes, Heat wave, Air-conditioning

INTRODUCTION
Several researchers in different countries have shown significant increases in mortality rates among the elderly during heat wave periods (see all references). Several of these studies were specifically directed at nursing homes, where a group exists of in-patients who often are unable, or merely do not have a choice, to move to air-conditioned areas, if any are available. One study (Marmor 1978) describes a comparison between mortality rates in 11 air-conditioned and 9 un-air-conditioned homes in New York City, USA, during each of four heat waves in 1972 and 1973. The number of deaths in un-air-conditioned nursing homes was significantly greater than the number of deaths expected on the basis of mortality during cooler control periods, whereas deaths in air-conditioned nursing homes were not significantly different from expected. The relative death rates and risk ratios for all four heat waves combined were approximately doubled for the un-air-conditioned nursing homes in comparison to the air-conditioned ones.

Another article (Sullivan-Bolyai , Lumish , Smith et al., 1979) describes the effects of a sudden air-conditioning failure during a heat wave in a nursing home in Florida, USA. Several patients died, and physical examinations and laboratory studies failed to reveal evidence for any etiologies other than heat. The article states that heat waves increase mortality from all causes, not just from such heat-related illnesses as heat stroke and dehydration. A third article (Lye and Kamal, 1977) describes the correlation between total mortality within a department of geriatric medicine and average weekly peak temperature during a heat wave in 1976 in Manchester, U.K. Figure 1, redrawn after Lye and Kamal

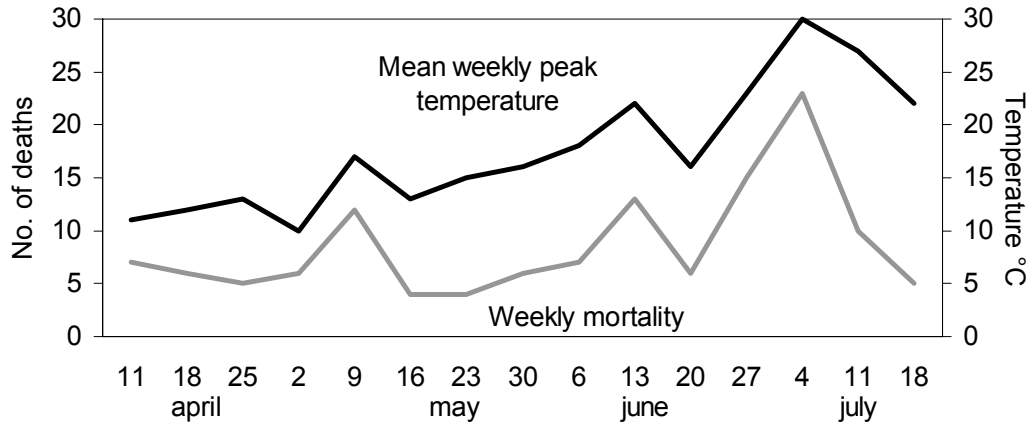


Figure 1. Total mortality within a department of Geriatric Medicine and Average Weekly Peak Temperatures (ºC), redrawn after Lye and Kamal (1977).

(1977), speaks for itself. Several other articles could be discussed (see references), but we think that these short abstracts are sufficient to make our point: Heat is a risk factor; in-patients in nursing homes are a vulnerable group. They should be protected from extreme climatic conditions, if not only because they often do not have the chance to withdraw from the exposure to heat.

RESEARCH IN THE NETHERLANDS

The Netherlands has a cool moderate climate, where temperatures seldom occur below –10 ºC or above +30 ºC. Research into heat wave related deaths is consequently rare. One study regarding this topic was carried out by Borst, Schols and Mackenbach (1997), in which data from two years including heat wave periods in The Netherlands during 1993 and 1994 were examined. During these heat wave periods a rise in death rates was observed, leading to this retrospective analysis. Death rates from approximately 90 % of all nursing homes in The Netherlands (total population about 50,000) for 1993 and 1994 were correlated with climatic data (weekly average of maximum daily ambient air temperatures, or WAM) from that period. For this purpose temperature intervals of 5 ºC were taken, ranging from 0-5 to 25-30 ºC. After eliminating influenza periods mortality rates and relative risks could be calculated for all temperature ranges, showing raised levels in both lower and higher temperature ranges. Far away the biggest rise (approx. 50%) was in the 25-30 ºC range. No compensation was found for a period of seven weeks following the heat wave, which was included in 1994. For further details we refer to the two relevant published articles.

AN ENGINEER'S VIEW

As The Netherlands has a cool moderate climate, air-conditioning is traditionally often seen as luxury, especially in health care facilities, where the basic objectives in building guidelines are: sober and efficient. Very few nursing homes are consequently equipped with air-conditioning. That section of the research by Borst which refers to the warm periods is interesting from a designer's point of view. First of all, the fact that within the two years

Contact authors email: luscuere@wxs.nl

observed several weeks with a WAM-value in the range 25-30 ºC occurred was uncommon; it meant that several weeks of heat wave really did occur. From an indoor climate design point of view a WAM-temperature range of 25-30 ºC, however, is very wide, probably from daily temperatures ranging between 20 and 35 ºC. It completely overlaps standard design temperature (approx. 22 ºC) and the maximum outdoor design temperature (28 ºC) up to and including outdoor maximal values (35 ºC) very rarely occurring in The Netherlands. This observation immediately raises questions about what these specific heat wave weeks had looked like with regard to the outdoor temperatures and how the death rates correlated with these individual weeks. The result of the two years' study, however, was condensed into one figure only (50% rise in mortality for all weeks within the 25-30 ºC range). Other questions raised were: what was the distribution of the WAM-data over the 25-30 ºC range; how are the weekly averages composed (several comparable maximal values, or one extreme raising the average of the week as a whole)?
Several of these questions were also raised and discussed in the study of Borst, but as the study was aimed at all data over the two year period, the detailed data required to answer these questions for only the heat wave period was not available.

RAISING THE LEVEL OF DETAIL

The raw data which was used for the research of Borst was still available, and contained daily climatic data (from which corresponding WAM values could be calculated) as well as weekly mortality figures, see figure 2.

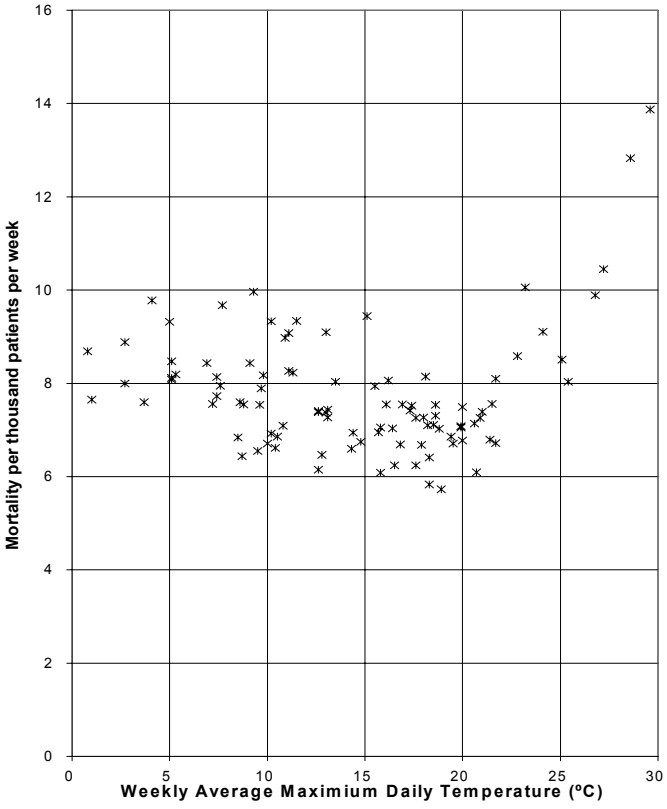
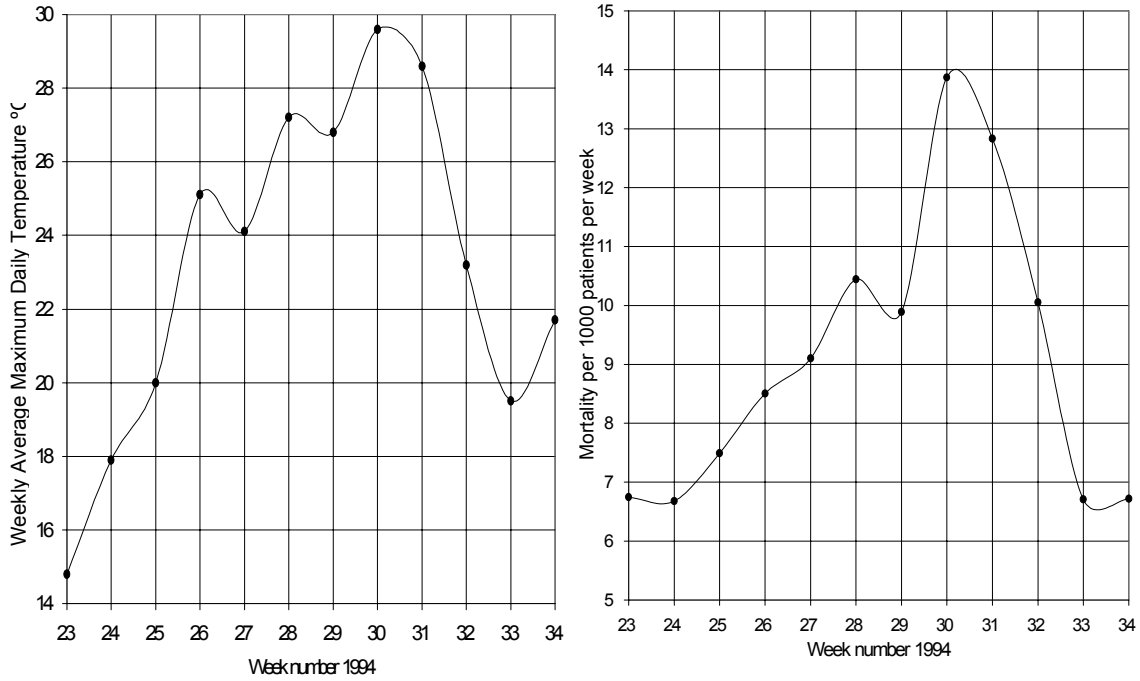


Figure 2. Mortality of nursing home patients in The Netherlands versus Weekly Average of Maximum Daily Ambient Air Temperatures (ºC) in 1993 and 1994.

These data were further structured and analysed on a weekly basis. It seemed that 1993 contributed only one week to the 25-30 ºC interval, whereas 1994 contributed 5 weeks of

which 4 were consecutive. These weekly data seemed to be evenly distributed over the period under investigation, with a gradual build-up of the WAM-value from approx. 15 ºC to the maximum of nearly 30 ºC and a quick descent to 20 ºC. As this period was of prime interest for this complementary study, 1993 was excluded. The remaining data from 1994 were further limited to approximately the larger period in which all of the warm weeks were incorporated, the period June, July and August, totalling 12 weeks. The Weekly Average of Maximum Daily Ambient Air Temperatures (WAM) data (ºC) were correlated in the following way:

1. WAM vs. week number (showing sequential temperature profile), figure 3.
2. Mortality vs. week number (showing sequential mortality profile), figure 4.
3. Mortality vs. WAM-value (showing combined correlation), figure 5.



Figures 3 (left) and 4 (right). Weekly Average of Maximum Daily Ambient Air Temperatures (ºC) and Mortality per thousand patients per week set out over time (actual week numbers from June/July/August in 1994).

The correlation for the June/July/August period is striking (see figure 5), with a correlation factor of $R^2 = 0.8988$. Detailed observations of daily data showed steadily increasing or decreasing daily maxima, thereby excluding incidents with (daily) extreme values. Finally the non-compensatory effect was clearly shown by comparison of 3 and 4, showing instant (weekly) increased mortality rates every time a sequential fall in temperature was followed by a rise.

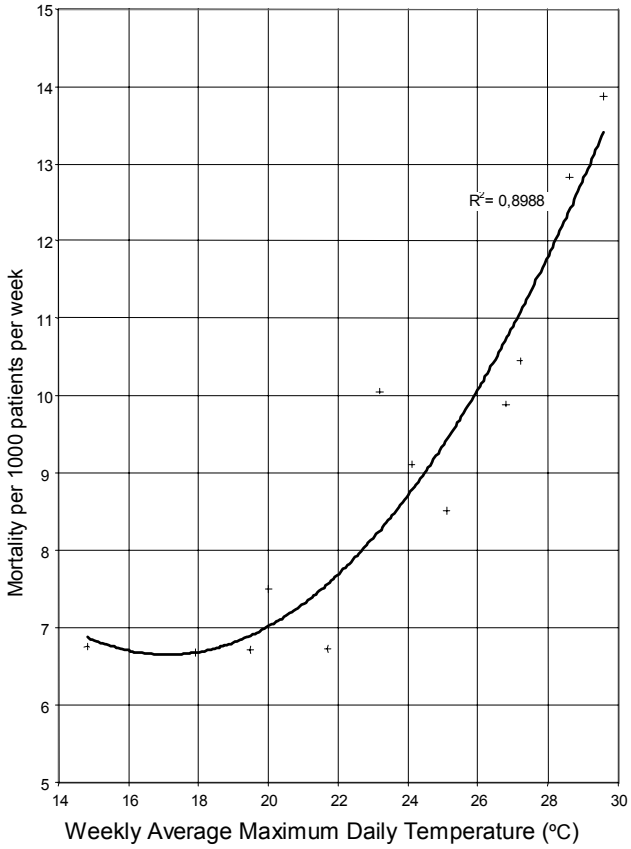


Figure 5. Correlation of Mortality per 1000 patients per week as a function of the Weekly Average of Maximum Daily Ambient Air Temperatures (ºC), The Netherlands, June/July/August1994.

DISCUSSION

This correlation generates the question whether, or to what extent, nursing homes should be equipped with air-conditioning, especially in those countries where traditionally no budgets are allowed for cooling. Except in e.g. comfort cooling, where a defined level of overheating can be acceptable, we find ourselves confronted here with a situation where any level of overheating clearly correlates with a certain level of deaths. From an ethical point of view we cannot define any level of acceptable over-mortality as a result of withholding from nursing home patients normal day to day cooling facilities such as are normally applied in e.g. offices. The conclusion therefore should be to define a zero hour tolerance for overheating exposure for these people. In addition to the correlation study several recommendations can be made with regard to hot-weather protocols in nursing homes. This, however is outside the scope of this paper.

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