

## Commentary

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### Why do older patients die in a heatwave?

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#### Introduction

More than 11 000 people were registered as dying in France during the first two weeks of August, 2003.<sup>1</sup> This confirmed a significant increase in mortality compared with a similar period in recent years. The majority of excess mortality appears to have occurred in older, frail individuals who were thought to have tolerated poorly the extremes of heat experienced in France at that time.<sup>2</sup> Some potential mechanisms underlying this increase in death rate are discussed in this article.

#### Risk factors in the elderly

A diagnosis of heat stroke requires a core body temperature of  $>40^{\circ}\text{C}$  and central nervous system dysfunction to be present. Symptoms of altered consciousness and disseminated intravascular coagulopathy are frequently profound in the setting of hyperthermia. Subsequent multi-organ dysfunction and failure contributes to mortality in heat stroke.<sup>3</sup>

However, many of the physiological changes in renal function and water and electrolyte homeostasis which occur with increasing age could be pertinent to the excess mortality noted in older patients in extremely hot weather. Older subjects have a lower threshold for the development of renal failure, and diminished renal tubular conservation of sodium and water during periods of dehydration. This occurs for a number of reasons. Firstly, the exponential fall in sodium excretion that occurs in younger subjects who are placed on a low sodium diet or deprived of sodium, is

both delayed and prolonged in older subjects.<sup>4</sup> Moreover, an age-related decline in plasma renin and aldosterone levels predisposes to natriuresis, diuresis and salt depletion in older patients, even when they are water- and salt-deprived.<sup>5–9</sup> There is also a linear decline in glomerular filtration rate (GFR) at an average rate of  $8\text{ ml/min/1.73 m}^2/\text{decade}$  in most patients without renal disease, starting at the age of 40 years.<sup>10,11</sup> Total body water decreases with increasing age, and this is associated with an increase in fat and a decrease in lean body mass.

A further contributor to risk in hot weather occurs when older subjects are unable to obtain sufficient volumes of water for themselves, due to infirmity or impaired thirst during such periods of excessive insensible loss of fluid. Older patients are prone to hypernatraemia in these circumstances. In this situation, hypernatraemia is associated with hyperviscosity, and increased risk of coronary and cerebral thrombosis<sup>12</sup> and central nervous system dysfunction.<sup>13</sup>

Older people are also at increased risk of hyperkalaemia, even in the absence of renal disease.<sup>14</sup> There are many factors that contribute to this, including the aforementioned age-related decline in plasma renin and aldosterone levels,<sup>5–9</sup> and the reduction in GFR with increasing age.<sup>10,11</sup> Moreover, there is a decline in the aldosterone response of older subjects to an experimental rise in serum potassium levels.<sup>15</sup> The ability of the ageing kidney to correct an acid load is blunted, and therefore hyperkalaemia is more common in older patients with acidosis.<sup>16</sup>

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Hyperkalaemia can have serious consequences in older patients. A reduction in the resting membrane potential will lead, if uncorrected, to life-threatening cardiac rhythm disturbances. Hyperkalaemia is very likely to occur in the context of pre-renal failure due to diminished fluid intake in dehydrated, frail older individuals.

Indeed, all of the above age-related physiological changes may be exacerbated by concomitant cardiorenal disease and/or various commonly used medications, such as diuretics, angiotensin converting enzyme inhibitors, digoxin, beta-blockers and other antihypertensives. Moreover, patients taking anticholinergic drugs and phenothiazines, as well as those with peripheral neuropathy, are at increased risk of heat-related morbidity due to inability to sweat and/or altered reflex regulation of body temperature.

Thus, we postulate that many of the older patients who succumbed in the recent heatwave were dehydrated, hypernatraemic and hyperkalaemic, with evidence of renal failure. Resultant thrombo-embolic disease and malignant cardiac arrhythmias, as well as the consequences of heat-induced sepsis-like shock, would be the most probable causes of death in this scenario. This heat-related mortality may continue to rise significantly in the future as a result of global warming.<sup>17</sup>

## Prevention

What can be done to reduce such mortality? Simple measures which could be implemented in the homes of frail, at-risk older people are likely to be effective. These include the maintenance of adequate fluid intake, accompanied by a focus on reduction of insensible fluid loss by tepid sponging, antipyretics (where indicated), and moving the individual to a cooler environment during periods of intense heat, where feasible. Adjustment of dosages of medications such as diuretics may help maintain reasonable fluid balance. Monitoring of serum electrolytes, urea and creatinine would complement regular clinical assessment and help identify electrolyte abnormalities and renal failure at an early stage. Intercurrent illnesses such as infections should be treated promptly, and when deterioration is accompanied by diminished fluid intake, early transfer of such individuals to an acute care facility for enteral or parenteral fluid replacement would reduce the likelihood of progression to established renal failure and/or life threatening electrolyte derangement. A responsive and well-resourced primary care service alert to the dangers of extremes of heat to vulnerable

older people could minimize the likelihood of such serious consequences.

Adequate social programmes are a further important consideration. In previous heatwaves, while mortality among the poor was disproportionate to that of the rich, groups who would meet in public places were at less risk than those who remained indoors for fear of crime or other reasons.<sup>22</sup> Primary care services and regional heat plans that would alert older patients to impending heatwaves and thus anticipate and correct fluid and electrolyte imbalances, should in turn lead to a reduction in morbidity and mortality.

In a recent BMJ editorial, Keatinge emphasized the importance of simple preventative measures such as the above, but he also highlighted the need to institute them in an anticipatory fashion.<sup>18</sup> Some debate exists regarding the potential benefits of measures such as opening windows<sup>19,20</sup> and the use of fans,<sup>20,21</sup> and any benefits depend on factors such as heat production and air humidity.<sup>22</sup>

In summary, identification and targeting of at-risk individuals should be achieved by heightened awareness of the physiological pitfalls of older people. The combined efforts of general practitioners, health visitors, relatives, neighbours and carers (formal and informal) and many simple preventive measures as outlined above may help reduce mortality and morbidity.

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