Hydration, morbidity, and mortality in vulnerable populations

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Both acute and chronic fluid deficits have been shown to be associated with a number of adverse health outcomes. At the extreme, deprivation of water for more than a few days inevitably leads to death, but even modest fluid deficits may precipitate adverse events, especially in young children, in the frail elderly and in those with poor health. Epidemiological studies have shown an association, although not necessarily a causal one, between a low habitual fluid intake and some chronic diseases, including urolithiasis, constipation, asthma, cardiovascular disease, diabetic hyperglycemia, and some cancers. Acute hypohydration may be a precipitating factor in a number of acute medical conditions in elderly persons. Increased mortality, especially in vulnerable populations, is commonly observed during periods of abnormally warm weather, with at least part of this effect due to failure to increase water intake, and this may have some important implications for those responsible for forward planning in healthcare facilities.

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INTRODUCTION

Deprivation of water for more than a few days inevitably leads to death, although there are occasional reports of much longer survival without access to water in exceptional situations, highlighting individual differences in susceptibility to the effects of absence of water intake.¹ Such extreme conditions, however, are seldom encountered in daily living for most of the population. It is normal for small fluctuations in body water content to occur throughout the day with no perceptible effect on health or performance. Losses incurred due to sweating, respiratory loss, vomiting, and in urine and stools are replaced through the intake of fluids and foods at more or less regular intervals throughout the day.

HYDRATION, MORBIDITY, AND MORTALITY IN VULNERABLE POPULATIONS

It is important to distinguish between the effects of chronic hypohydration, which is likely to be mild as severe hypohydration would likely be corrected, and those of acute hypohydration, which may be severe. There is some evidence that chronic mild dehydration may be a common condition in some population groups, especially elderly individuals. There may be an association, although not necessarily a causal one, between a low habitual fluid intake and some chronic diseases, including urolithiasis, constipation, asthma, cardiovascular disease, diabetic hyperglycemia, and some cancers.² This raises questions as to the strength of the association, if any, between fluid intake and hydration status. Fluid intake is commonly used as a proxy measure for hydration status because it is convenient and easy to measure, whereas the measurement of hydration status presents some difficulties. However, the two may not be closely associated.³ Urine output, rather than fluid intake, is likely to be a better index of hydration status, with a low daily urine volume likely being an indication of poor hydration status.

Acute hypohydration is recognized by many clinicians as a precipitating factor in a number of acute medical conditions in elderly persons.⁴ The risk of infection in elderly individuals has also been linked to poor fluid status, and the mortality rate can be as high as 50% in the absence of early diagnosis.⁴ According to analyses of the causes of deaths of care home residents in England and Wales between 2005 and 2009, carried out by the Office for National Statistics, dehydration was responsible
for 667 deaths during this period compared with 157 deaths that were ascribed to malnutrition. Such statistics, however, cannot say whether dehydration was a major factor that contributed to death. These individuals may have died because of dehydration, as indicated by the death certificate, or they may have died and been hypohydrated.

There is some evidence of impairments of cognitive function at moderate levels of hypohydration, but the methodology in many of these studies is poor, both with regard to the assessment of hydration status and to the functional tests applied. Even short periods of fluid restriction leading to a 1–2% loss of body mass lead to reductions in the subjective perception of alertness and ability to concentrate as well as increases in self-reported tiredness and headache. In elderly persons with already impaired function, this may lead to a spiral of further reductions in fluid intake, and there is some evidence of an association between impairment of normal functional status, as assessed by the Barthel index and water turnover. Water turnover, assessed by use of a deuterium tracer, was found to be lower in residents of a care home than in those living in the community. Within the care home residents, individuals with a Barthel index score between 11 and 14 (moderately disabled) seemed to have a slower daily water turnover rate and lower daily urine output volumes than either those with a Barthel index score ≤10 (severely disabled) or those with a Barthel index score between 15 and 20 (relatively normal ability). This suggests that the most vulnerable individuals may receive more attention from staff, whereas those with moderate levels of impairment may be at greater risk.

Courtney et al. assessed the relationship between clinical care indicators (CCIs) and quality of life (QoL) in 82 residents of four Australian residential care facilities. Standard analytical tools were used for CCIs, covering 23 different areas of care, and QoL, which was assessed as a profile of six domains (physical, psychological, independence, social relationships, environmental, and spiritual). The study showed, perhaps not surprisingly, that that poorer scores in the CCIs adversely influenced QoL. All QoL domains were affected to some degree, with the greatest impact on the social and spiritual domains. Poorer status in hydration, falls, and depression were the three factors most strongly associated with lower QoL scores, suggesting that those three indicators could represent key areas for clinical management in residential aged care. It is important to recognize that this study does not show that improving the quality of care in these three areas will necessarily improve QoL of elderly individuals living in care. However, improving hydration status does seem to be a low-cost intervention that deserves further investigation.

**INCREASED MORTALITY DURING HEAT WAVES**

Although there is limited published information, dehydration is commonly believed by geriatricians to be an acute precipitating factor in hospital admissions of the elderly, and added heat stress may increase symptoms in susceptible individuals. Epidemiological evidence from patterns of morbidity and mortality suggest that all-cause mortality is increased when high temperatures persist for more than a few days. The limitations of this evidence must be recognized, and it seems likely that the number of heat fatalities is underreported. In the last decade or so, a very substantial number of papers have been published with analysis of patterns of morbidity and mortality during periods of exceptional weather, with the primary focus of most of these studies being on very high, rather than low, environmental temperatures. Some of these reports have analyzed single events. For example, the city of Chicago experienced a heat wave July 12–July 20, 1995, that was reported to result in more than 600 excess deaths, 3,300 excess emergency department visits, and a substantial number of intensive care unit admissions for near-fatal heatstroke. Others have looked at repeated episodes in specific geographic regions. In 2003, much of Western Europe was affected by a heat wave, and the estimated total excess mortality was estimated at 25,000–70,000. Between August 1 and 20, 2003, the mean temperature in France exceeded the seasonal norm by 11–12°C. Fouillet et al. examined mortality records from official sources and compared death rates with those from 2000 to 2002 for the same period. They estimated that there were 11,731 excess deaths in individuals aged >75 years, 2,930 excess deaths in adults aged 35–74 years, and 25 excess deaths in infants aged <12 months. For the same period, excess mortality in other countries in Western Europe was estimated at 1,316 in Portugal, 6,595–8,648 in Spain, 3,134 in Italy, 2,139 in England and Wales, 1,400–2,200 in the Netherlands, and 975 in Switzerland.

Analysis of morbidity and mortality data from northeastern Germany revealed that during the two major heat waves that occurred between 1990 and 2006, health risks were higher for older people. However, during the two main heat waves that occurred, the highest mortality rates were observed in the city of Berlin. In addition, within Berlin, the highest rates were in the most densely built-up districts.

A more comprehensive analysis was provided by the EUROHEAT project, which involved nine European cities (Athens, Barcelona, Budapest, London, Milan, Munich, Paris, Rome, and Valencia) with a total population of approximately 25 million citizens. Data for daily mortality, meteorological conditions, and air pollution were analyzed for each city between 1990 and 2004, and
the summer of 2003 was analyzed separately to assess the impact of the exceptionally hot conditions. Other smaller heat waves were also assessed. Considering all years except 2003, the increase in mortality during heat-wave days ranged from +7.6% in Munich to +33.6% in Milan for respiratory causes. The effects of heat waves increased with age, and a statistically significantly higher impact was observed among women aged 75–84 years in Mediterranean cities. The increase was up to three times greater during episodes of long duration and high intensity.

A large survey comprising 1,497,655 emergency hospital admissions in five regions of New South Wales, Australia, also examined the health impact of heat waves. The researchers found that on days of extreme heat, the risk of emergency hospital admission due to heat-related injuries, dehydration, and other disorders of fluid, electrolyte, and acid-base balance increased more than the risk of admission from other causes. Individuals were more susceptible to extreme heat if they had underlying mental and behavioral disorders; diseases of the nervous and circulatory system, especially cardiac disease; diseases of the respiratory system, especially asthma and chronic obstructive pulmonary disease; or neoplasms and renal disease, especially renal failure.

There is evidence that elderly persons are the most vulnerable to periods of extreme heat; however, this effect is seen across the whole age range. Young children and those with predisposing illness or other factors may also be particularly susceptible. It has been suggested that at least part of the mortality observed during a heat wave is the result of a harvesting effect, also referred to as short-term forward mortality displacement, whereby sustained periods of heat have the greatest effect on those who are so ill that death is hastened. If this is indeed the case, there should be a compensatory decrease in overall mortality during the subsequent weeks after a heat wave. In some surveys, however, no such effect has been established, suggesting there is not simply an elimination of the most susceptible individuals.

Epidemiological surveys cannot establish causal relationships, and there seem to have been few attempts to analyze the effectiveness of the preventive measures implemented in the aftermath of major heat waves. Nonetheless, and even though some of the evidence is not entirely consistent, prudence suggests it may be wise to ensure that those individuals at particular risk make an effort to maintain good hydration status when unusually hot weather conditions are forecast, as well as attempt to minimize exposure to the outdoors environment and seek cool indoor shelter where possible.

Dehydration as a result of abnormal weather conditions may, therefore, have some important implications for those responsible for forward planning in healthcare facilities. It may also have an economic impact. An analysis of the potential economic impact was reported by Warren et al. These authors examined Medicare records in the United States for the calendar year 1991, and extracted data for older adults aged 65–99 years. They recorded age, race, sex, costs reimbursed, and dates of admission, discharge, and death. They also looked at up to five recorded diagnoses and classified patients as follows: admitted for dehydration (the principal diagnosis), with dehydration (one of the secondary diagnoses), or without dehydration (not one of the recorded diagnoses). They reported that 1.4% of admissions were recorded with dehydration as the principal diagnosis, which amounted to 146,960 hospitalizations with a total cost reimbursement of $446 million. A further 6.7% of admissions included dehydration as any diagnosis, amounting to a further 731,695 hospitalizations. Both early (within 30 days) and late (31–365 days) mortality risk were substantially elevated in patients with dehydration, irrespective of the recorded cause of death. This interesting analysis seems not to have been repeated to assess whether the pattern persists.

**CONCLUSION**

In summary, it seems that both acute and chronic dehydration carry an increased risk of morbidity and mortality, especially for vulnerable individuals.

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