Alternative water sources and reuse: what are the public health issues?

National water-recycling guidelines will address both health and environmental risks

SEPARATING DRINKING WATER from sewage may seem obvious now, but the idea that sewage could affect health was not understood until the 19th century. Dr John Snow (1813–1858) was one of the first to make the connection when investigating a cholera outbreak in London. He noted that most of the people who were sick had consumed water from a pump in Broad Street, Soho, that was contaminated by sewage. When the pump's handle was removed, the spread of cholera dramatically stopped. But it was not until the early 1900s that adequate separation of water supplies from sewage routes was achieved (at least in developed countries), resulting in substantially fewer cases of waterborne disease.

In Australia, in 2004, we are 6 years into another drought, and water shortages and increasing climate variability are behind efforts to reduce water consumption and find other, sustainable ways of utilising all available water. While current efforts concentrate on reducing per-capita water use through more efficient appliances and water restrictions, other, longer-term strategies are also needed. These pressures are leading the community to consider alternative sources of water for some household uses. At present, potable-quality water is supplied for all household purposes. But more than 50% of this water is used for gardens, toilets and laundry, where water of lesser quality would suffice. The domestic use of alternative water sources — rainwater, stormwater, greywater and sewage — has the potential to expose large populations to pathogens and chemical contaminants unless the water is appropriately treated and managed. These treatments can be complex, and, to further confound the issue, permissible applications vary by jurisdiction. There are also many gaps in the regulations for urban domestic uses.

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Reports of health outcomes from reusing water predominately concern sewage reuse. These studies focus on the health of wastewater workers,[1] farm workers and surrounding communities.[2] Many of the studies are poorly designed and examine reuse of untreated sewage,[3] which means they are of limited relevance to Australia. Because of the paucity of relevant studies on the health effects of other water sources, water quality is used as a proxy health-risk measure. Furthermore, much of the information on urban use of alternative water sources is in literature that is not readily accessible and often not peer reviewed. Thus, there is a pressing need for more rigorous scientific evidence to inform regulation.

Rainwater collected from roofs is mixed with debris (eg, leaves and animal droppings) from the roof or from the guttering, and possibly contaminated by dead insects, trapped animals and leaf litter in the tank itself. Additionally, heavy metals from roofing materials, airborne pollutants from traffic emissions and industrial exhaust, or agricultural chemicals can contaminate rainwater supplies.[4] It is widely accepted that rainwater can safely be used for bathing, laundering and watering the garden,[5] and only in situations where a treated reticulated water supply is not available is it endorsed as a primary source of drinking water. Rainwater is generally considered safe to drink for most members of the community if it is clear, has low odour and taste, and the tank and roof are well maintained.[5]

Stormwater is rain that drains into the stormwater system from roofs, roads, footpaths and other ground surfaces and is channelled, untreated, directly to local waterways. The water carries rubbish, animal faeces, motor oil, petrol, tyre rubber, soil and debris. Use of this water has been limited to date, partly because of its seasonal variability in volume and the need for large-scale storages. However, in New South Wales, it has been proposed that stormwater from local residences be redirected to irrigate local sports fields, wetlands[6] and parks.[7]

Greywater is sourced from kitchen, laundry and bathroom drains but excludes toilet water. Some guidelines exclude wastewater from the kitchen, as it can contain higher levels of wastes.[8] Greywater may contain urine and faeces from nappy washing and showering, in addition to kitchen scraps, soil, hair, detergents, cleaning products and fats and oils. Greywater contaminants can include substances such as boron and phosphates, and the water is often alkaline and saline.[9] Treated greywater may potentially be used for toilet flushing, laundering and subsurface garden watering. However, reusing greywater for gardens can detrimentally alter the properties of soil and gradually kill plants sensitive to phosphorus, including Australian native flora.

Sewage is water entering the sewerage system. It has all the contaminants of greywater, in addition to high concentrations of faecal material. This water can be reclaimed after rigorous treatment at a sewage treatment plant and piped to individual households, as part of a dual-reticulated water-supply system (additional to and separate from normal tap water), for uses such as toilet flushing, garden watering and washing of cars and outdoor surfaces. It may also be used for irrigating sports fields and public parks, as well as for fire control, sewerage flushing, dust suppression, topping up of ornamental ponds or irrigating agricultural crops. A number of such systems are currently in place across Australia and are the focus of long-term assessment.[10-14]

Some new urban developments are planning to incorporate alternative water sources, such as reclaimed sewage water at Rouse Hill in Sydney,[10] but there are questions about the potential impact on public health, particularly if long-term regulation and governance issues are not adequately addressed. With the exception of good-quality rainwater, all of the above water types are unsuitable for drinking. However, if they are supplied to thousands of individual households, incidents of accidental ingestion are bound to occur. In addition, errors in plumbing installation may result in the

non-potable water being "cross-connected" to potable water taps. Regulatory oversight, awareness by health professionals of the potential for waterborne diseases, and continuing surveillance programs will be required to monitor and minimise these risks.

Recognising the need for better guidance for regulators and water suppliers, the Environment Protection and Heritage Council and the Natural Resource Management Ministerial Council have initiated the development of national guidelines for water recycling. These guidelines are intended to provide a unified approach across Australia, and will address both health and environmental risks, and be developed in collaboration with the National Health and Medical Research Council. In keeping with recent revisions to the Australian Drinking Water Guidelines,[15] a risk-management approach will be adopted, emphasising the multiple-barrier principle and ongoing monitoring of the effectiveness of systems to protect public health.

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Database support for cardiac rehabilitation

RCT evidence for rehabilitation is strengthened by an observational cohort study

THE STUDY BY SUNDARARAJAN et al[1] (*page 268*) is a novel data linkage study and is best described as a cohort study. The study showed 35% lower mortality in patients with cardiovascular disease who had undergone cardiac rehabilitation when compared with patients who had not undergone cardiac rehabilitation. However, even the best cohort studies can give only limited inference on treatment effects. For example, observational studies suggested that women who used hormone replacement therapy (HRT) had a lower incidence of cardiovascular events than did non-users.[2] However, not only did prospective randomised controlled trials (RCTs) fail to confirm the protective effect of HRT,[3] they suggested that such treatment might actually cause cardiovascular disease.[4] The apparent impressive protection of HRT suggested by observational databases may have been accounted for by socioeconomic differences between the users and non-users of HRT. Thus, RCTs have assumed the strongest evidence in suggesting a relationship between treatment and outcome.

So why does the database linkage study by Sundararajan et al[1] appeal at all? Perhaps it is because the evidence base for cardiac rehabilitation programs fails to convince all medical practitioners, despite "level 1" evidence existing from other studies.[5]

Even the best RCTs have intrinsic limitations. The first is that most trials exclude older, sicker patients with multiple comorbidities and those who might not cooperate with the trial protocol. This often results in a clinical trial of low-risk patients, which may miss a beneficial effect of treatment.

The second limitation of RCTs, more common in single-centre studies, is publication bias. It is hard work to prepare a study for publication — even harder for a negative study than for a positive one. As a result, investigators are less likely to submit negative studies and journal editors are less likely to accept them for publication. Publication bias is likely to exist in most, if not all, areas of published research.

So, what are the limitations of the evidence specifically regarding cardiac rehabilitation? The Cochrane Library review of exercise-based rehabilitation for coronary heart disease reviewed 51 RCTs of 8440 patients.[5] Total cardiac mortality was reduced by 31% (random effects model odds ratio [OR], 0.69; 95% CI, 0.51–0.94) and 26% (random effects model OR, 0.74; 95% CI, 0.57–0.96) in the exercise-only and comprehensive cardiac rehabilitation groups, respectively. Neither intervention had any effect on the