Accepted for publication by Occupational and Environmental Medicine 28 Nov 2003

Excess risk of kidney disease in a population living near industrial plants

S Hodgson (MSc)[1], M J Nieuwenhuijsen (PhD)[2], A Hansell (MBBS)[1], S Shepperd (D.Phil)[1], T Flute (BSc)[3], B Staples (MBBS)[4], P Elliott (FRCP)[1], L Jarup (PhD)[1]

[1]Small Area Health Statistics Unit (SAHSU), Imperial College London, UK.

[2]Dept Environmental Science and Technology, Imperial College London, UK.

[3] Halton Primary Care Trust & Warrington Primary Care Trust.

[4] Formerly Consultant Environmental Health, North Cheshire Health Authority.

Correspondence to: Lars Jarup, SAHSU, Department of Epidemiology & Public Health, Faculty of Medicine, St Mary's Campus, Imperial College London, Norfolk Place, London W2 1PG

The Authors would like to thank the Medical Research Council for PhD studentship support of S Hodgson.

Accepted for publication by Occupational and Environmental Medicine 28 Nov 2003

Abstract

Runcorn has been a site of chemical industry activity for over a century, where tons of toxic chemicals are released annually to air and water. We found excess kidney disease mortality (nephritis, nephrotic syndrome and nephrosis) in the population living within 2km of the industrial plants (Standardised Mortality Ratio (SMR) in males 131 (95% Confidence Interval (CI) 90-185) and females 161 (95% CI 118-214)) compared to a reference population (North West England)). Risk of hospital admissions for kidney disease in Halton (comprising the towns of Runcorn and Widnes) was higher than in the less industrial, nearby town of Warrington. The standardised Admission Ratio (SAR) in Halton was 115 (95% CI 107-124) for males and 126 (95% CI 117-137) for females; and in Warrington 91 (95% CI 85-97) for males and 84 (95% CI 78-91) for females compared to the Warrington and Halton area as a whole. The excess risk of kidney disease in the Runcorn area requires further investigation.

Accepted for publication by Occupational and Environmental Medicine 28 Nov 2003

Main Messages

- There is a significant excess of kidney disease and kidney disease mortality in people living near to several polluting sources in Runcorn.
- These excesses may be associated with exposure to kidney toxicants emitted by these plants over the last century.
- Morbidity and mortality ratios were more pronounced in females than males, suggesting that occupation in not a substantial confounder.

Introduction

A commentary published in the Lancet in January 1880 describes how the town of Runcorn is *'exposed to the irritating vapour cast off so freely by the large chemical works in its vicinity'(1)*. Today, over a century since this report, Runcorn is still exposed to many toxic chemicals released from over a dozen industrial plants in the area. Emissions data from the UK Environment Agency Pollution Inventory (2) show that substantial amounts of nephrotoxic chemicals, including 125 tons lead, 4 tons mercury, and over a ton of arsenic and chromium were released to air from 16 plants[1] in the Runcorn area between 1998-2000. All these substances have toxic effects on a range of human organs, including the kidneys (3). Three sites are responsible for the majority of nephrotoxic emissions, with mercury being the major nephrotoxin released in Runcorn. It should be noted that current emissions are much lower than those experienced in the past, as shown by metals in sediment from the Mersey estuary over the last century (4).

In collaboration with the former North Cheshire Health Authority (now Warrington and Halton Primary Care Trusts), we undertook preliminary investigations into the health of the population living in the vicinity of these industrial plants in Runcorn. The aim of this study was to determine if there was an excess risk of kidney mortality and morbidity in people living near these industrial plants. Kidney morbidity and mortality was the main concern because of the nephrotoxicants known to be released in the area, and because of the findings of previous investigations (5).

[1] Located on 8 sites (figure 1)

Methods

Mortality was investigated using routinely collected data supplied by the Office for National Statistics (ONS) and analysed using the SAHSU Rapid Inquiry Facility (RIF)(6). Distance from the industrial plants was used as a proxy for exposure.

Standardised Mortality Ratios (SMR) adjusted for socioeconomic deprivation (7) were calculated for deaths from nephritis, nephrotic syndrome and nephrosis (ICD9 580-589) over the years 1981-1999 for populations living in enumeration districts with population weighted centroids falling within 0-2km and 2.01-7.5km of the installations, using the postcode of residence mapped onto those enumeration districts to locate the cases (6) (Figure 1). Expected figures were derived from the North West region population. Enumeration districts are the smallest unit of the national Census and can be aggregated to electoral ward boundaries.

Morbidity was assessed by North Cheshire Health Authority (NCHA), who investigated kidney disease at electoral ward level using routinely collected local hospital admissions data (Patient Information System (PINS), Central Patient Activity Database (CPAD) and Commissioning Minimum Datasets (CMDS)). These data were available from 1990 to 1999, and were used to calculate district age Standardised Admission Ratios (SAR) for non-malignant renal disease as well as kidney cancer (ICD9 580-583 (except 581.8, 582.8 and 583.8), 585-587, 189.0; ICD10 N00-N06, N10, N11.8, N11.9, N15.8, N18, N19, N26, C64) using the population of Warrington and Halton as a reference. Where several hospital episodes involved the same person, that person was counted only once.

Ethical approval for use of routine data has been granted to SAHSU by St Mary's Local Research and Ethics Committee.

Results

There were 451 deaths from nephritis, nephrotic syndrome and nephrosis in the population living within 0-7.5 km from the industrial plants. There was excess SMR within 7.5km which was higher at 0-2km than 2.01-7.5km, although confidence intervals overlapped (Table 1).

A similar pattern was seen for kidney morbidity (2804 individuals admitted to hospital) when mapped by electoral ward across North Cheshire. (Figure 1). When the ward data were pooled to town level there were excess risks of kidney morbidity in Runcorn and Widnes with SAR of 122 (95% CI 110-136) in males, 136 (95% CI 122-151) in females in Runcorn; and 108 (95% CI 97-120) in males, and 117 (95% CI 104-132) in females in Widnes, in contrast to Warrington (SAR of 91 (95% CI 85-97) in males and 84 (95% CI 78-91) in females), which has far fewer sources of pollution.

Discussion

By using distance from point sources as a proxy for exposure to pollutants from industrial plants we have observed a significant excess of kidney mortality in people living nearest to several polluting sources after adjustment for socio-economic deprivation. Similarly, kidney morbidity appears to be highest in the areas closest to the industrial plants. These trends may be associated with exposure to kidney toxicants, which have been emitted by these plants over the last century.

Ecological analyses and disease mapping are relatively crude methods for establishing health risks associated with point source pollution, especially in this area where historical land contamination and industrial landfill sites may contribute to chemical exposure via pathways other than inhalation. However we have observed a consistent pattern in kidney disease morbidity and mortality from two independent data sources.

Exposure will be affected by occupation (in this area the industrial plants provide a major source of employment) and diet. However, both morbidity and mortality ratios in females were more pronounced than in males (who are much more likely to be occupationally exposed) suggesting that occupation is not a substantial confounder.

Conclusions

We found an excess risk of kidney mortality and morbidity in areas with potential exposure to renal toxicants released from near-by industrial plants. Further work is planned (including more detailed exposure assessment, exploring different exposure pathways) to investigate whether the excess risks are causally related to chemical pollution in the area.

Accepted for publication by Occupational and Environmental Medicine 28 Nov 2003

Acknowledgements

The Small Area Health Statistics Unit is funded by a grant from the Department of Health, Department of the Environment, Food and Rural Affairs, Environment Agency, Health and Safety Executive, Scottish Executive, Welsh Assembly Government and Northern Ireland Department of Health, Social Services and Public Safety. We thank the Office for National Statistics (ONS) for provision of mortality data. The views expressed in this publication are those of the authors and not necessarily those of the funding departments, data providers or of ONS.

The morbidity analysis was undertaken by the North Cheshire Health Surveillance Project. Funding was provided by local industry.

Accepted for publication by Occupational and Environmental Medicine 28 Nov 2003

Contributors

S Hodgson, Anna Hansell, L Jarup, M J Nieuwenhuijsen and P Elliott designed, analysed and interpreted the SAHSU study; S Shepperd contributed to the exposure assessment and analysis. T Flute and B Staples designed, analysed and interpreted the NCHA study. S Hodgson wrote the initial draft of the report, which was revised by A Hansell, L Jarup, M J Nieuwenhuijsen and P Elliott.

References:

1. Anonymous. The sanitary state of Runcorn. The Lancet Jan 24, 142-143. 1880.
2. Environment Agency website. http://216.31.193.171/asp/introduction.asp. 2002.
3. WHO. Principles and Methods for the Assessment of Nephrotoxicity Associated with Exposure to Chemicals. [119]. 1991. WHO.
4. The Environment Agency. The State of the Environment in the North West of England. 1998.
5. Staples, B., Howse, M., Mason, H., Bell, G. Land Contamination and Urinary Abnormalities: Cause for Concern? Occupational and Environmental Medicine 2003;60:463-467.
6. Aylin, P., Maheswaran, R., Wakefield, J., Cockings, S., Jarup, L., Arnold, R., Wheeler, G., and Elliott, P. A National Facility for Small Area Disease Mapping and Rapid Initial Assessment of Apparent Disease Clusters Around a Point Source: the UK Small Area Health Statistics Unit. Journal of Public Health Medicine 1999;21(3):289-98.
7. Carstairs, V. and Morris, R. Deprivation and Health in Scotland. Health Bulletin 1990;48(4):162-75.

Table 1: Relationship between proximity to chemical installations and risk of mortality from nephritis, nephrotic syndrome and nephrosis (ICD9 580-589).

Distance from point source			Adjusted for age (sex)				Adjusted for age (sex) deprivation			
	Sex	Person years	Obs	Exp	SMR	95% CI	Obs	Exp	SMR	95% CI
0-2km	Males	390,699	32	23.9	134	92 – 189	32	24.4	131	90 - 185
	Females	406,581	47	29.3	160	118 – 213	47	29.2	161	118 - 214
	Males and females	797,280	79	53.2	149	118 – 185	79	53.6	147	117 - 184
2.01-7.5km	Males	2,941,656	166	152.0	109	94 – 127	166	154.4	108	92 - 125
	Females	3,041,976	206	182.5	113	98 – 129	206	185.9	111	97 - 127
	Males and females	5,983,632	372	334.5	111	100 – 123	372	340.3	109	99 - 121

Figure 1: Standardised admission ratios for kidney disease in the North Cheshire area (shaded areas); 0-2 and 2.01-7.5 km Rapid Inquiry Facility (RIF) exposure areas used in the mortality analysis (circled areas) and location of point sources (16 sources on eight sites).

