Environmental Health

The Journal of the Australian Institute of Environmental Health

...linking the science and practice of Environmental Health

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Call for Papers

The Journal is seeking papers for publication.

Environmental Health is a quarterly, international, peer-reviewed journal designed to publish articles on a range of issues influencing environmental health. The Journal aims to provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region.

The Journal publishes articles on research and theory, policy reports and analyses, case studies of professional practice initiatives, changes in legislation and regulations and their implications, global influences in environmental health, and book reviews. Special Issues of Conference Proceedings or on themes of particular interest, and review articles will also be published.

The Journal recognises the diversity of issues addressed in the environmental health field, and seeks to provide a forum for scientists and practitioners from a range of disciplines. Environmental Health covers the interaction between the natural, built and social environment and human health, including ecosystem health and sustainable development, the identification, assessment and control of occupational hazards, communicable disease control and prevention, and the general risk assessment and management of environmental health hazards.

Aims

- To provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region
- To promote the standing and visibility of environmental health
- To provide a forum for discussion and information exchange
- To support and inform critical discussion on environmental health in relation to Australia's diverse society
- To support and inform critical discussion on environmental health in relation to Australia's Aboriginal and Torres Strait Islander communities
- To promote quality improvement and best practice in all areas of environmental health
- To encourage contributions from students

Papers can be published under any of the following content areas:

Guest Editorials

Guest Editorials address topics of current interest. These may include Reports on current research, policy or practice issues, or on Symposia or Conferences. Editorials should be approximately 700 words in length.

Research and Theory

Articles under Research and Theory should be 3000-5000 words in length and can include either quantitative or qualitative research and theoretical articles. Up to six key words should be included. Name/s and affiliation/s of author/s to be included at start of paper and contact details including email address at the end.

Practice, Policy and Law

Articles and reports should be approximately 3000 words in length and can include articles and reports on successful practice interventions, discussion of practice initiatives and applications, and case studies; changes in policy, analyses, and implications; changes in laws and regulations and their implications, and global influences in environmental health. Up to six key words should be included. Name/s and affiliation/s of author/s should be included at start of paper and contact details including email address at the end.

Reports and Reviews

Short reports of topical interest should be approximately 1500 words. Book reviews should be approximately 700 words and Review Articles should not exceed 3000 words in length.

Correspondence

Associate Professor Heather Gardner
Editor, *Environmental Health*
PO Box 68, Kangaroo Ground, Victoria, 3097, AUSTRALIA
Guidelines for Authors can be obtained from the Editor
Telephone: 61 3 9712 0550
Fax: 61 3 9712 0511
Mobile: 0417 580 507
Email: gardner@minerva.com.au

Environmental Health

Call for Papers

Sustainability in Environmental Health

Papers are sought for the **Special Issue, Sustainability in Environmental Health,** *Environmental Health*, Volume Three, Number One, to be released in March/April 2003. Final date for submission of papers for the special issue is Tuesday 14 January 2003.

Details of the journal, and Guidelines for Authors, including the aims and sections under which articles can be published are in this issue, can be seen at www.aieh.org.au, and are available from the Editor, Associate Professor Heather Gardner.

Email: gardner@minerva.com.au,
Telephone: 61 3 9712 0550,
PO Box 68, Kangaroo Ground,
Victoria, 3097, Australia.

Papers, reports, commentaries, and reviews on all aspects of environmental health, national and international, are always welcome.

Richards begins her paper with the words, "The momentum that appears to be building in relation to the development of a professional certification scheme for environmental health practitioners requires the several strands of the multi-disciplinary environmental health profession to engage in ... opportunistic surveillance". Richard's paper is a commentary on Tenkate and Smith's article in *Environmental Health* (2002), "Development of a professional certification scheme for environmental health practitioners", but it takes the proposal to the next stage and argues that "the success of the certification scheme depends...on graduating students possessing the skills and knowledge that will permit them to engage in statutory decision-making with sufficient competence to allow their decisions, and the decision process they used, to remain substantially intact under the rigorous scrutiny of our administrative-legal system".

Peng Bi and Kevin Parton of the Centre for Healthcare Related Infection Surveillance and Prevention, Brisbane and the Faculty of Rural Management, University of Sydney, combine to determine the impact of climate variation on the transmission of Ross River virus infection in a comparison study on the incidence of the disease and climate variability across different meteorological regions of Queensland between 1985 and 1996. The results showed that the incidence of RR virus infection in autumn in the northern coast region was higher than that in central and southern coast region.

Continuing with the theme of communicable disease, Chen and Heyworth report on what university residential college students know about three infections, to which they are perhaps particularly susceptible, bacterial meningitis, infectious mononucleosis and influenza. It was concluded from the cross-sectional study that the residential college community could benefit from public health campaigns to educate them about relevant infections, including meningitis and glandular fever.

The effects of global climate change are suggested by Arya to exacerbate the current difficulties in maintaining the efficacy of various types of pharmaceuticals. The majority of the issues he outlines would operate in high temperatures and poor storage conditions even without climate change, but future climate change would exacerbate these effects. To address these he offers a strategy for developing countries.

Norwalk-like virus (NLV) can spread rapidly at recreational camps for school children. The paper by Harper, Adams, Cowell and Langley highlights the rapid and efficient transmission of NLV, and how the outbreak continued despite disinfection of the premises and chlorination of water supplies, that were found not to meet NHMRC Australian Drinking Water Guidelines. The checklists for environmental health assessment of recreation camps and guidelines for investigation of outbreaks involving children developed by the Public Health Unit, Queensland Health have obvious relevance.

Particularly important for the practice of environmental health officers (EHOs) is a paper on something that has emerged from changed social ideas on what is beautiful. Infection control of blood borne diseases in the expanding practice of body piercing and tattooing has become critical as more and more commercial premises supply these services to customers. Oberdorfer and Wiggers researched two complementary areas: the inspection practices of local

councils and public health units in monitoring, enforcing and promoting skin penetration guidelines in New South Wales, and the knowledge and attitudes of EHOs on infection control as they have responsibility for ensuring premises involved in skin penetration services comply with guidelines and thereby improve their infection control. Hellard takes up the issue of the transmission of hepatitis C virus in her commentary. Her commentary is timely as the Australian Institute of Environmental Health (AIEH) and the Macfarlane Burnet Institute have recently completed the draft report of the Hepatitis C Research Project on hepatitis C and commercial body piercing in Victoria.

The paper by Bowman, Cleave and Barbis on Victoria's responses to Legionnaires' Disease is particularly important as, since its detection at the US veterans' convention in Philadelphia in 1976 where 30 American Legionnaires died, there have continued to be outbreaks across the world, the most recent being in Barrow-in-Furness with 45 people infected.

NSW Waterscape 2002 Conference

In this issue, we are fortunate to have an article based on the paper presented to the Australian Water Association's NSW Branch, *NSW Waterscape 2002* Conference in Sydney in May. Laginestra analyses various approaches to treating sewage, landfill sites, and various industrial applications and argues that soil beds are the most ecologically sustainable for odour control. The Conference was held over two days in the lead up to Environment Week and had themes covering environmental health, effluent reuse, a sustainable water supply, trade waste, odour control, marine science, and integrated modelling. We hope to publish more of these papers in the future.

AIEH Conferences

There are of course a number of AIEH Conferences on the horizon, not least of which is the Institute's 29th National Conference, *Environmental Health – The Living Profession*, in Sydney on 20 - 25 October. The Victorian Division's Conference is on 5 & 6 September at Pinnacle Valley, and the Queensland Division's, *Environmental Health in the Smart State – Innovations in the 21st Century*, is to be held on 15-20 September.

The National Conference has brought together an impressive array of speakers on environmental health. Prominent among these are Dr Karl Krusznelnicki, Peter Heyward, Department of Foreign Affairs and Trade, and Graeme Richardson, the former Minister for the Environment in a federal Labor ministry. Among other areas there is too a very strong Indigenous session.

References

Tenkate, T.D. & Smith, J.C. 2002, 'Development of a professional certification scheme for environmental health practitioners', *Environmental Health*, vol. 2, no. 1, pp. 81-85.

A Time to Review Training in Statutory Decision-making

Eve Richards

TAFE Tasmania

The proposed professional certification scheme for environmental health practitioners has implications for those who are involved in the education and training of students who may enter the environmental health profession as officers. It also has implications for those who have the responsibility for assessing the suitability of courses for certification. The success of the certification scheme depends, amongst other matters, on graduating students possessing the skills and knowledge that will permit them to engage in statutory decision-making with sufficient competence to allow their decisions, and the decision process they used, to remain substantially intact under the rigorous scrutiny of our administrative-legal system. This article, by carrying out a legislative exercise, will encourage stakeholders in the certification process to commence a review and assessment of the training requirements for statutory decision-making.

Key Words: *Professional Certification; Statutory Decision-making*

The momentum that appears to be building in relation to the development of a professional certification scheme for environmental health practitioners (Tenkate & Smith 2002) requires the several strands of the multi-disciplinary environmental health profession to engage in what the classical organisation theorist James D. Thompson refers to as opportunistic surveillance (1967, p. 151). Opportunistic surveillance is monitoring behaviour that scans the environment for opportunities rather than waiting for problems to present themselves for action. It will become apparent in this article that problems may arise in the future if members of the environmental health profession do not respond now to this proposed development.

The introduction of a certification scheme necessarily requires practitioners to be competent in that strand of environmental health for which they seek certification. Further, practitioners need to possess skills that will enable them to engage in continuing professional development in order that they can maintain their certification.

Inevitably, these considerations will require some of the stakeholders in the various strands of environmental health to review the training and education courses relevant to their particular strand to ascertain whether they are adequate for the purpose of certification of their graduates and their subsequent practice. With some strands of the profession this will be a big task that will take much time. A further consideration is that any changes to the training and education courses that are mandated by a review will take time to introduce. So it seems an opportune time to start the various reviews at the beginning of this mooted important change in the environmental health profession.

This article seeks to make a contribution to a review of the work of environmental health officers by looking at an aspect of one of their main tasks, namely statutory decision-making. It is inconceivable that an environmental health officer (EHO) should be able to obtain certification without demonstrating competency in the skills and knowledge required by the statutory decision process.

The question of whether graduating health officers are equipped to deal with the complexity of statutory decision-making is important for the several stakeholders in this activity. For example, government authorities have a financial interest in the decision-making of officers; they may be faced with sizeable monetary costs when prosecutions fail or they are required to pay damages for the actions or non-actions of their officers. Those persons who are the focus of the decision-making such as applicants for approvals, licences or registrations, offenders and so forth have the right to be treated fairly and in a competent manner. Wrong decisions can cause these people much harm in emotional and monetary terms. The rights of those members of the public who are the beneficiaries of the legislation must be considered also. Taxpayers have an interest in the statutory decision-making of officers because they fund the operation of the courts, appeal tribunals and ombudsmen. Individual officers may suffer much stress when they are ill-equipped to handle the complexities of statutory decision-making not to mention the misery that may be experienced when their sins of omission or commission are incorporated into legal judgements or decisions, some of which are placed on the Internet for all interested persons to see. A certification scheme will bring into focus another stakeholder in both the statutory decision-making and certification processes, namely certified environmental health practitioners as a body. Their interest in this matter will become clear in this article and is the main reason for selecting statutory decision-making as the focus of this review.

It follows, then, that those who are involved in the preparation and teaching of courses that might be used as entry into the environmental health profession as an EHO have a responsibility to ensure that their graduates are equipped to engage in competent practice. This is also an important consideration for those who determine which qualifications are suitable for acceptance in the certification process.

In looking at statutory decision-making, it is not sufficient to merely discuss it in general terms. In this article, attention will be drawn to the skills and knowledge required for that aspect of the decision process which is the focus of this review by working through a detailed exercise. This should provide educators such as those academics who may not be qualified EHOs themselves, or may not have worked in such a capacity, with a yardstick by which they can measure their training courses.

A common problem that confronts many EHOs will be used for this exercise using Tasmanian legislation. This is not a narrow focus because the rules for working with the law apply throughout Australia. Indeed, implicit in the concept of professional certification is the assumption that certified practitioners will be able to competently practice in any Australian jurisdiction. It is, therefore, of no import as from where the legislation is drawn.

Reason for Selecting Statutory Decision-making as the Review Focus

Statutory decision-making, that is to say administrative decision-making within and according to the framework of the law, is a major component of the work of EHOs. Law governs so much of what EHOs do. The law, that is to say the mix of statute and common law, prescribes what has to be done, what may be done, and how it should be done. Decision-making is central to working in this law oriented environment. The results of the decision process, namely the decisions, which are sometimes referred to as actions, may find their way into the public arena in various ways.

Two basic guidelines should be in the mind of a statutory decision-maker. The first is to ask of himself or herself whether the decision can be explained satisfactorily in a witness box or to the ombudsman. The second is to bear in mind that both the decision process itself and the outcome of that process could end up being considered by the High Court.

One of the lessons to emerge from *Pyrenees Shire Council v Day* ([1998] HCA 3 (23 January 1998) at para 6) is that an ordinary letter written by a regulatory enforcement officer could be considered by the High Court. In this case, a letter written by a building inspector, complete with all the errors that had not been picked up in proof reading and subsequently identified by the appeal justices with the use of "(sic)", was published in the judgement and placed on the Internet for any interested party to see. No anonymity was accorded to the officer as his name appeared at the end of the letter.

There are very few decisions, even those of a routine nature, that are not reviewable by some outside body such as the courts, tribunals and ombudsman, all of whom do, or may, publicly release their findings in various ways. Decisions may even be raised in Parliament as occurred following an action by EHOs employed by Glenorchy City Council (House of Assembly, Tasmania 1989). Decisions may be reviewed for either their legality as, for example, in their conformity with administrative law or, if there is statutory provision, they may be appealed or subject to a merit review. Merit, in this context, means that the decision is correct and/or preferable (Katzen & Douglas 1999 pp. 8 & 23). An ombudsman considers whether there has been defective administrative action as defined by the ombudsman's legislation as, for example, in s. 28 (1) *Ombudsman Act 1978* (Tas).

Environmental health officers not only respond to those who scrutinise their work but also, on occasions, may place matters, themselves, before a court, as in a prosecution. And on rare occasions, an EHO may have to appear as a witness in a coroner's court as occurred in South Australia following the death of a young girl who had eaten contaminated Garibaldi garlic mettwurst (Chivell 1995). Both types of court proceedings are conducted in an open forum with representatives of the media often present.

When an officer appears in the witness box, the question normally asked following the giving of his or her name, address, and occupation is one concerning the officer's qualifications. At the present time, the name of the qualification and the name of the institution at which the qualification was obtained are given.

When the proposed professional certification scheme becomes reality, the qualification named will be that of certified environmental health practitioner. If the work and evidence of the certified practitioner remains substantially intact through the proceedings, this will reflect well on the standards required by the certification body. Conversely, a poor showing has the potential to reflect badly on the certification process. Whilst the system may cope with an occasional poor showing, frequent or well-publicised incidents will be detrimental to the certification process. Certification will be perceived as having little substance. Therefore, it should be in the interests of all certified environmental health practitioners to ensure that not only high standards are initially set but also adhered to.

Statutory Decision-Making

Statutory decision-making comprises two parts. The first part is the collection and analysis of the initial facts. As with other decision processes one has to have an occasion to make a decision. All evidence has to be lawfully collected which of itself involves an entire decision process. The second aspect is to find and use the appropriate law to deal with the facts. Additional evidence may need to be collected after the appropriate legislation has been determined. Statutory decision-making has to be carried out within the framework of administrative law and with due consideration being given to the law of negligence; matters that will not be dealt with in this article but warrant a review in their own right.

In this article, consideration will be given only to finding legislation to deal with a

problem very familiar to many EHOs. Attention will then be turned to demonstrating the interpretation process by using one of the identified provisions.

The Hypothetical Problem

The effluent from a defective septic tank system has been found to be pooling at the lower end of the property on which the system is located. The effluent is also finding its way onto a neighbouring property. The neighbour has complained to the council about the matter. A fluorescein dye test carried out by the municipal EHO has confirmed the problem.

Tasmanian Legislative Provisions: Past and Present

In order to recognise that working with the law is a more complex process now than was the case in the past, and thus requires a greater competency in statutory decision-making, the provisions of legislation that have been repealed will be cited so that a comparison can be made with provisions that are currently in force.

Repealed Local Government Act 1962

Under the *Local Government Act 1962* finding the appropriate provisions to deal with a defective septic tank system was a relatively simple task.

Section 558 of this repealed Act deals specifically with septic tanks and incorporates a provision to deal with defective installations:

> *If an installation licensed or permitted to be used under this section becomes, in the opinion of a health officer, defective or a nuisance or dangerous to health, the Minister or the corporation may, by notice, require the owner or occupier concerned-*
>
> *(a) to remedy the defect or abate the nuisance; or*
>
> *(b) to remove, fill up, or disconnect the installation,*
>
> *and, in either case, to discontinue the use of the installation forthwith or from a date specified in the notice (s.558 (8)).*

Another potentially useful provision that was available to EHOs is found in s. 556, which deals with the repair of unhealthy buildings. Section 556 (1) (d) states:

> *(1) Where any building used, or intended to be used, or capable of being used, for human habitation or occupation-*
>
> ...
>
> *(d) has roof guttering, spouting, drainpipes, or drainage which (including storm-water drainage) is seriously defective or insufficient;*
>
> ...

The hypothetical problem appears to fall within the ambit of this section.

The statutory nuisance section of the *Local Government Act 1962* also contains an appropriate provision. Under s.599 (1) (e), the following condition is classed as a statutory nuisance:

> *A privy or drain carrying faecal or putrescent matter from which the contents overflow or escape.*

These repealed provisions are very specific and make the statutory interpretation process not unduly demanding. In applying the law to the facts, all an officer basically had to do was to establish that the effluent was, in fact, effluent and that it was coming from the septic tank in question. This was done by performing a fluorescein dye test. In other words, working with the repealed legislation was relatively straight forward as the legislation clearly specified the conditions that came within the scope of the various provisions. The same cannot be said of the current legislation.

Relevant Provisions in Force - June 2002

The results of a legislation search show that there are provisions contained in three Tasmanian Acts of Parliament that fall within the jurisdiction of an EHO which may be able to be used to cure the problem, namely:

Environmental Management and Pollution Control Act 1994
Local Government Act 1993
Public Health Act 1997.

Working from several pieces of legislation immediately places extra demands on a decision-maker. Each Act contains several provisions that must be used to respond to a problem, for example, the section that defines the problem, and the remedial, sanction and appeal provisions have to be considered also. Provisions in one Act are not mirrored in another. The eventual choice of Act to use may, in fact, be determined by provisions other than that which defines the problem.

In this short article, there is scope to consider only those parts of the definition or description sections of the three Acts that seem to be most relevant to the problem.

1. Section 3 *Environmental Management and Pollution Control Act 1994* defines an environmental nuisance in the following way:

   "environmental nuisance" means -

   (a) the emission of a pollutant that unreasonably interferes with, or is likely to unreasonably interfere with, a person's enjoyment of the environment; and

   (b) …

2. Under s.199 *Local Government Act 1993*

   "nuisance" includes anything that -

   (a) causes, or is likely to cause, danger or harm to the health, safety or welfare of any person; or

   (b) causes, or is likely to cause, a risk to public health; or

   (c) gives rise to unreasonable or excessive levels of noise or pollution; or…

3. The defective and unhealthy premises provision of the *Public Health Act 1997* provides that a premises can be classed as being unhealthy in the following circumstances:

   Premises used, intended to be used or capable of being used for human habitation or occupation have a defect and are unhealthy if the premises are in a condition which an authorised officer reasonably believes is, or is likely to become, offensive, injurious or prejudicial to health (s. 91).

In the current provisions, no mention is made of drains, content of drains, defective drainage, septic tank and so forth which appear in the repealed Act. There are no specific conditions listed either. These provisions are very general in nature. An officer must, therefore, possess the skills and knowledge to apply the general provisions to specific conditions. This indicates that an officer needs to have sufficient knowledge to recognise that the hypothetical problem may be a "nuisance" or an "unhealthy premises". In other words, diagnostic skills, which produce key words and phrases, are required to perform a legislation search. Unless an officer possess diagnostic skills, it may be very difficult to carry out an efficient and productive legislation search to identify potentially useful provisions. For example, merely using the terms "septic tank" and "defective drainage" in the legislation search did not produce any useful statutory provisions that fell within the jurisdiction of an EHO.

One way to develop diagnostic skills may be to use repealed legislation as a resource. A comparison between the repealed and current provisions shows the value of using repealed legislation in this particular instance. In the matter being treated here, an officer is given a very good idea of what constituted a nuisance and unhealthy building in the repealed legislation because conditions were specifically mentioned. The second way diagnostic skills can be developed is to have sufficient exposure to the work of EHOs during undergraduate years through work experience, internships, cadetships and/or extensive reading of appropriate literature.

The Interpretation Process

Once possible provisions have been identified, a critical task is to interpret them.

It is necessary for an officer to interpret all three provisions in order to select the provision that best fits the facts. However, for the purpose of this article, it is not necessary to work through each of the three in force provisions. Working through one such provision will be sufficient to demonstrate the interpretation process. The provision that will be used for this exercise is the term "environmental nuisance" as defined in s. 3 *Environmental Management and Pollution Control Act 1994* and cited above.

With respect to the term, environmental nuisance, the following matters need to be taken into account as part of the interpretation process.

- The definition uses the word "means". This indicates that the definition should be regarded as exhaustive because it closes the meaning of the definition (Pearce & Geddes 2001, p. 192, Gifford & Gifford 1994, p.73).

- One of the basic rules of law is that unless words are specifically defined in an Act, the plain, ordinary meaning of a word should be used. (Gifford & Gifford 1994, pp. 92-4). "[T]he language of a statute is to be construed in its ordinary and natural sense, even if the result is inconvenient" *(Woolworths (Vic) v City of Glenorchy* [1990] Tas R 87 at 89).

- The word "emission" is not defined in the Act so the plain meaning has to be adopted. It is prudent to consult a standard English dictionary to determine the ordinary meaning as it must be remembered that the courts constantly use a dictionary to discover the meaning of everyday words. For example, in *Doyle v Maypole Bakery Pty. Ltd* ([1981] Tas R 376) the court consulted the *Oxford English Dictionary* to assist in finding the meaning of the word "contains".

- In order to find out what is meant by the word "pollutant", it is necessary to ascertain whether pollutant is defined in the Act. A definition is provided in s. 3.

- When one looks at the definition of "pollutant", it is noted that there is reference to "environmental harm". Again the Act needs to be checked to see if this term has been defined.

- The definition of "environmental harm" in s. 3 directs the reader to s. 5 of the Act where environmental harm is fully defined.

- There is no definition of the phrase "unreasonably interferes with a person's enjoyment of the environment" but the word "environment" is defined in s. 3. Therefore the plain meaning rule must be used in conjunction with the meaning of "environment" as defined.

  It is also valuable for an EHO to have built up an understanding of the phrase, or those of a similar nature, through on-going research. It may be prudent for the officer to see whether the phrase has been judicially considered or to consult cases where this phrase has formed part of a case. For instance, in *D & K Draper v T & J Rainbow* ([1999] TASRMPAT 202, (29 October 1999)), an environmental nuisance matter involving noise, the Resource Management and Planning Appeal Tribunal said:

  The issue of whether the noise complained of unreasonably interferes with that enjoyment must involve regard to what can reasonably be expected in the

enjoyment of a residence in a residential suburb such as Norwood (at para 21).

- From this, one understands that it may be necessary to compare the problem, no matter what that may be, with the conditions which exist in the vicinity as part of the evidence collection process.

  Further useful guidance is given in *City of Knox v Rentokil Initial* ([2000] VCAT 1296 (30 June 2000)) where it is said that in relation to a common law nuisance, consideration should be given to the reactions of a normal and reasonable person on the street, rather than that of the most sensitive or abnormally sensitive person. Whilst this is referring to a common law nuisance rather than a nuisance defined by statute, it is useful to bear in mind, that although a complainant may claim unreasonable interference with the enjoyment of the environment, the case may fail at any hearing, if it is found during cross-examination that the complainant is unduly sensitive to the problem. Precisely this point was put to some witnesses during cross-examination in *Adelaide Mushroom Nominees Pty Ltd v Devonport City Council* ([1997] TASRMPAT 85 (7 May 1997)) when an environmental nuisance, as defined by s. 3 *Environmental Management and Pollution Control Act 1994* was being considered.

- It is noted that the definition of environmental nuisance provides two grounds for something to be determined as an environmental nuisance; an actual situation or something that "is likely to" unreasonably interfere with a person's enjoyment of the environment. If there is a defective septic tank that is causing a nuisance at a given point in time, it can be expected reasonably that it is likely to go on causing a nuisance in the future, until the problem is cured. This understanding is necessary to avoid lack of clarity or ambiguity when the decision-maker reaches that point in the decision process where possible remedies are being considered and brought into play.

So in order to understand what the term "environmental nuisance" as defined in s. *3 Environmental Management and Pollution Control Act 1994* means, it is necessary to refer to three additional definitions provided in the Act; to discover the plain meaning of other words; and, it is beneficial to have built up some knowledge by reading cases.

In addition to working through the definition of environmental nuisance, there are two other important considerations that must be addressed before a decision is made to proceed under the environmental nuisance provisions of the *Environmental Management and Pollution Control Act 1994*.

First, it is noted that the definition of environmental nuisance revolves around a "person's enjoyment". This means that in dealing with a complaint, the person lodging the complaint will have to be prepared to be a witness in a court or tribunal hearing to say how his or her enjoyment of the environment is being, or is likely to be, unreasonably interfered with, should this become necessary. The complainant will have to be prepared also to be cross-examined on his or her evidence in chief. It is not just a question of an officer pursuing legal action through the courts; a person on whom an environment protection notice has been served under s.44 (2) has the right of appeal to the Resource Management and Planning Appeal Tribunal under s.44 (6). Should the complainant be reluctant to be a witness, good decision-making requires an officer to exclude the environmental nuisance provisions under the *Environmental Management and Pollution Control Act 1994*

from the list of potential responses to the problem.

Second, the decision-maker also will need to note that under s. 53 of the Act, it is an offence to wilfully and/or unlawfully cause an environmental nuisance. The word "unlawfully" has been determined by the Supreme Court of Tasmania to mean without lawful justification (*In The Matter of a Reference Pursuant to the Resource Management and Planning Appeal Tribunal Act 1993*, s.27 and *In The Matter of the Environmental Management and Pollution Control Act 1994*, ss. 48 and 53 [1999] TASSC 85). Therefore, an EHO would have to ascertain whether there was lawful justification for the creation of the environmental nuisance. Guidance as to what may constitute lawful justification can be found in the matters dealt with by the Supreme Court ([1999] TASSC 85, para. 11).

Only after the decision-maker has satisfied himself or herself that the facts fit the definition of environmental nuisance, and, importantly, can be proved by way of evidence, should attention be turned to the possible courses of action that are provided in the Act; a matter that is not being pursued here. If the law cannot be applied to the facts under one piece of legislation, it will be necessary to consider using other Acts of Parliament if they have presented themselves in the legislation search. With respect to the matter at hand this was, in fact, the case.

Review Check Questions

The process of working through this exercise raises review questions that can be used as a yardstick by which the content of education and training courses can be measured.

Are graduating students able to:

- demonstrate a capacity to work with the changing and evolving nature of the law?
- work with several pieces of legislation, if necessary, when responding to a matter?
- demonstrate basic diagnostic skills?
- efficiently undertake a legislation search?
- retrieve and read cases?
- use cases to build up their knowledge of statutory decision-making?
- understand and use the basic rules of statutory interpretation?
- demonstrate knowledge of evidence collection and the proving of allegations?
- apply the law to the facts?
- demonstrate a knowledge of the resources that are available to EHOs as they work with the law and to recognise the advantages and limitations of those resources?
- understand, through direct observation and reading cases, the rigour that is applied by the courts and tribunals when reviewing decisions?

One way of confirming that these questions are valid within the context of the work of an EHO is to read several decisions, reports and judgements of matters placed before relevant tribunals and courts. Not all readings will cover every aspect but several readings will build up a picture of the requirements for statutory decision-making. Two decisions that can be recommended for this purpose are *Adelaide Mushroom Nominees Pty Ltd v Devonport City Council* ([1997] TASRMPAT 85 (7 May 1997)) and *CSR Humes Pty Ltd v Launceston City Council* [1996] TASRMPAT 166 (22 July 1996).

Conclusion

This article has demonstrated that contemporary statutory decision-making is a

complex, intellectually demanding activity. It has been shown that, in relation to an everyday problem that confronts many EHOs, namely a defective septic tank, the decision process using current legislative provisions is far removed from that used under the now repealed Tasmanian *Local Government Act 1962*. Under this repealed Act, all that an officer needed to do was to pay due regard to the wording of the Act and to establish that the septic tank was defective by using a simple dye test, no matter which of the three relevant legislative provisions was being used to cure the problem.

The contemporary decision process, because the nature of legislation has changed from the very specific to the general, requires an officer not only to use this dye test but also to employ the same techniques that lawyers, courts and tribunals use to interpret legislation. When one considers that the Resource Management and Planning Appeal Tribunal of Tasmania needed to refer to the Supreme Court of Tasmania the word "unlawfully" within the context of the *Environmental Management and Pollution Control Act 1994* for determination, one can recognise that statutory interpretation is a difficult process; a process more challenging for an EHO because, unlike the Tribunal, an officer does not have the power to refer matters to the Supreme Court for determination.

A number of statutory decision-making review questions have been identified in this article but they can be summarised by asking the following question of those engaged in the education and training of EHOs and those who are responsible for accrediting courses for employment or certification as environmental health practitioners. Would a graduating student have sufficient knowledge and skill to be able to work through the exercise carried out in this article, or one very similar, in a manner that would stand up to scrutiny?

If the answer is yes, then attention can be turned to reviewing other statutory decision-making considerations such as administrative law and the law of negligence. If the answer is no, then a review of the syllabus is warranted because ill-equipped graduates will flounder in their employment, make costly mistakes and leave unattended environmental health concerns. These scenarios will detract, inevitably, from the credibility of professional certification.

Professional certification will initially enhance the status of EHOs. However, retaining that enhanced status will depend on gaining and maintaining the respect of the community through the competent work practices of individual officers. It is, therefore, in the interests of all EHOs to ensure that the basic training courses equip graduates with the skills and knowledge to practice their profession in a manner that will stand up to the scrutiny and accountability that exists in our administrative-legal system.

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Correspondence to:
Eve Richards
36 Windsor St
Kingston Beach, Tasmania, 7050
AUSTRALIA

What Do University Residential College Students Know about Bacterial Meningitis, Infectious Mononucleosis and Influenza?

Yu-Ping Chen and Jane Heyworth

School of Population Health, University of Western Australia

The aim of this cross-sectional study was to evaluate the knowledge of university residential college students, regarding three important infections - bacterial meningitis, glandular fever and influenza. Students were approached to complete a self-administered questionnaire regarding their knowledge about the infections. In total, 478 students completed the questionnaire. Only 58% of respondents had heard of meningitis and among these, 57% had poor scores on the 10-item knowledge scale assessing overall knowledge of meningitis. For glandular fever, 59% of students had heard of it but of these, 50% showed poor knowledge on a 12-item knowledge scale. For influenza, only 8.6% demonstrated poor knowledge on a 9-item knowledge scale. It was concluded the residential college community could benefit from public health campaigns to educate them about relevant infections, including meningitis and glandular fever.

Key Words: *Bacterial Meningitis; Glandular Fever; Influenza; University Students; Residential College Students; Infectious Disease Knowledge*

University residential colleges have long been recognised as a setting where infectious diseases can be easily transmitted between their residents (Froeschle 1999; Harrison 2000; Brodsky & Heath 1972). In this setting, large numbers of young individuals living in a close environment provides the medium through which a variety of infections can be spread. Meningococcal disease has been the subject of recent public health interest because it is apparent that its incidence and the number of outbreaks are increasing (Froeschle 1999). In a study of 228 young persons diagnosed with meningococcal disease, it was found that among the college student group, there was a significant difference in incidence of the infection between those students living on-campus and those living off-campus, with incidence rates of 3.24 and 0.96 per 100,000 respectively (p=0.05) (Harrison et al. 1999). The incidence of the disease in college students overall was greater, but not significantly so, than that of the general population of the same age; the rates being 1.74 and 1.44 per 100,000/year respectively. Studies by Neal et al. (1999) and Froeschle (1999) showed similar results.

Infectious mononucleosis and influenza are other infectious conditions that are common in young adults in the residential college setting (Brodsky & Heath 1972). Mainous et al. (1997) found that among patients attending a university-based family practice, the normal course and presentation of uncomplicated upper respiratory tract infection (URTI) was not well understood. Also it was found there was a lack of understanding of the effectiveness of antibiotics as a treatment in URTI, and that a large proportion of individuals expected their doctor to prescribe antibiotics for every URTI.

There is a lack of data that define the level of knowledge of college students and for that matter, the general population concerning infectious diseases. Information regarding the level of knowledge of infectious diseases

may prove to have an important role in reducing the morbidity and mortality from these diseases, as early detection and management leads to improved prognosis. Further identification of areas of poor knowledge amongst residential students will be useful in designing relevant public health education programs.

The aim of this survey was to ascertain the level of knowledge of university students living in residential colleges, with regard to three infectious diseases that are relevant to the college setting: bacterial meningitis, infectious mononucleosis and influenza.

Methods

We collected data on the knowledge of the three infectious diseases among students from all six residential colleges of the University of Western Australia over a period of eight days in the year 2000.

Data collection

The questionnaire was distributed to the residents during college meal times, and collected upon completion. Data were collected on demographic variables and the knowledge of the respondent regarding the three infections of interest. The demographic data included gender, age, college of residence and duration of residence, country of secondary education (as an indicator of country of origin) and information about their tertiary education (including past and present tertiary courses). The respondents were asked if they had ever heard of each infection and if so, data were collected on past diagnosis with the infection, transmission mode, symptoms, treatment, and prognosis of each infection. All questions were presented in a forced-choice format.

Knowledge scores

A scoring system, which combined the number of correct responses to knowledge variables, was devised to assess respondents' knowledge on transmission, symptomatology and prognosis separately, and then altogether, as an overall knowledge score (Table 1). Depending on the number of correct responses, the scores were then designated as either: (1) good, moderate and poor level of knowledge; or (2) good and poor level of knowledge. If a respondent had not heard of the particular disease, their knowledge was classified as poor.

There was a wide range of countries of origin in this study with 31 separate countries identified. The "countries of

Table 1. Scoring systems used to evaluate level of knowledge for each disease regarding transmission, symptoms, prognosis and overall knowledge. [1]

	Bacterial Meningitis			Glandular fever			Influenza[3]		
	Number of correct responses								
	Good	Mod[2]	Poor	Good	Mod	Poor	Good	Mod	Poor
Transmission	3	-	0-2	4	2-3	0-1	4-5	3	0-2
Symptoms	4-5	3	0-2	4	2-3	0-1	4	2-3	0-1
Prognosis[4]	1	-	0	1	-	0	-	-	-
Prevention	2-3	-	0-1	-	-	-	-	-	-
Response to disease[5]	-	-	-	1	-	0	-	-	-
Overall knowledge[6]	8-10	5-7	0-4	10-12	7-9	0-6	7-9	5-6	0-4

1 Scoring systems assessed level of knowledge for each knowledge variable by combining the number of correct responses.

2 Moderate level of knowledge

3 Knowledge about prognosis, prevention and response to disease was not assessed for influenza

4 Level of knowledge about the prognosis of glandular fever and bacterial meningitis was either good or poor (no moderate level defined). Knowledge about the prognosis of influenza was not assessed.

5 Good knowledge was to seek medical attention immediately. Any delay or failure to do so was poor knowledge.

6 Overall knowledge scoring system combined the correct answers to all knowledge variables (transmission, symptoms, prognosis, response to disease and prevention) for each disease. Glandular fever has a 12-item knowledge scale, bacterial meningitis a 10-item scale, and influenza a 9-item scale.

origin" were grouped into "regions of origin". These were Australia, Asia (Bangladesh, Brunei, China, Hong Kong, India, Indonesia, Japan, Malaysia, Nepal, Philippines, Singapore, Sri Lanka, Taiwan, Vietnam), North America (USA, Canada), Europe (Denmark, Germany, Sweden, United Kingdom, Switzerland, Holland, France, Norway, Turkey and Russia) and Africa (South Africa, UAE, Kenya, Zimbabwe).

Statistical analysis

Bivariate relationships between nominal variables were assessed using Pearson's χ^2 test. Knowledge on the three diseases was compared across the university faculties and region of origin. Demographic variables of gender, regions of origin and enrolled faculty were also cross tabulated with the summary knowledge variables.

Results

Demographics

Of the 495 residents approached to complete the survey, 100% responded. Seventeen were discarded because of obviously facetious responses, leaving 478 responses. The total college resident population at the time of the survey was 1068 and this figure includes all resident students and tutors, the latter of which are enrolled university students themselves. Thus, 44.8% of the whole residential college population of university students were sampled. The gender distribution was skewed slightly towards females (56.1%) reflecting the fact that St. Catherine's College is a female college. The mean age was 20.6 years with a range from 16 to 41 years, and 82.5% were less than 23 years of age.

Bacterial meningitis

Fifty-eight percent (278) of the sample population had heard of bacterial meningitis and a further 1.1% (3) of this group had had a previous diagnosis of meningitis by a doctor.

Fifty-seven percent of respondents were rated as having a poor overall knowledge of bacterial meningitis; 26.8% moderate and 15.9% good knowledge (Table 2). There were significant statistical differences in level of knowledge by region of origin and by university faculty ($p<0.0001$). There were higher proportions of Australian and medicine/health students with good levels of knowledge (Tables 3 and 4). There was a greater proportion of students from the Asian region with poor knowledge (76.5%). There was no significant difference between gender ($p = 0.225$).

The knowledge of bacterial meningitis transmission, symptomatology and prognosis was generally poor. Thirty-four (7.1%) respondents demonstrated good knowledge of transmission mode with 92.9% (444) having poor knowledge. Knowledge of the hallmark symptoms of the disease, which included fever, photophobia, neck stiffness and a skin rash, was poor among 54.2% of respondents, moderate in 15.7% (75) and good in 30.1% (144). Sixty-nine percent (331) of respondents did not know that without treatment, the infected usually die.

Glandular fever

Fifty-nine percent (n=282) of the sample population had heard of glandular fever. Within this group, 15.1% had a past diagnosis of glandular fever by a doctor.

Among the 478 respondents, 237 (49.6%) were rated to have poor overall knowledge of glandular fever, 74 (15.5%) had moderate knowledge and 169 (34.9%) had good knowledge (Table 2). A statistically significant difference in the overall knowledge of glandular fever was observed between the region of origin ($p<0.001$) (Table 3). A far greater proportion of residential students from Australia was rated as having good knowledge of glandular fever.

A greater proportion (63.6%) of students studying in a medicine or health faculty were rated as having good knowledge about glandular fever compared with students in other faculties ($p<0.001$) (Table 4). No significant difference in knowledge between genders was observed ($p = 0.341$).

Table 2: Percentage of good, moderate and poor level of knowledge for each knowledge variable assessed in the three infections (number)

	Bacterial Meningitis			Glandular fever			Influenza		
	Good	Mod[1]	Poor	Good	Mod	Poor	Good	Mod	Poor
Transmission	7.1% (34)	-	92.9% (444)	26.2% (125)	24.5% (117)	49.4% (236)	73.8% (353)	18.6% (89)	7.5% (36)
Symptoms	30.1% (144)	15.7% (75)	54.2% (259)	31.0% (148)	34.9% (167)	34.1% (163)	64.4% (308)	25.9% (124)	9.6% (46)
Prognosis	30.8% (147)	-	69.2% (331)	53.3% (255)	-	46.7% (223)	-	-	-
Prevention	-	-	-	37.7% (298)	-	62.3% (298)	-	-	-
Response to disease	55.0% (263)	-	45.0% (215)	-	-	-	-	-	-
Overall knowledge	15.9% (76)	26.8% (128)	57.3% (274)	34.9% (169)	15.5% (74)	49.6% (237)	76.2% (364)	15.3% (73)	8.6% (41)

1. Moderate level of knowledge

Table 3. Percentage of good, moderate and poor level of overall knowledge of each infection by the student's region of origin (number)

		Bacterial Meningitis			Glandular fever			Influenza[3]		
Regions of Origin[1]	%[2] (*n*)	Good	Mod[3]	Poor	Good	Mod	Poor	Good	Mod	Poor
Australia	59.1% (275)	20.7% (57)	33.1% (91)	46.2% (127)	54.9% (151)	21.1% (58)	24.0% (66)	80.7% (222)	10.9% (30)	8.4% (23)
Asia	32.9% (153)	6.5% (10)	17.0% (26)	76.5% (117)	4.6% (7)	3.3% (5)	92.1% (141)	68.6% (105)	24.2% (37)	7.2% (11)
America/ Canada	4.5% (21)	14.3% (3)	28.6% (6)	57.1% (12)	28.6% (6)	23.8% (5)	47.6% (10)	85.7% (18)	4.8% (1)	9.5% (2)
Europe	3.5% (16)	18.8% (3)	19.9% (3)	62.5% (10)	6.2% (1)	18.8% (3)	75.0% (12)	75.0% (12)	12.5% (2)	12.5% (2)

1. Six of the participants were from various countries in Africa.These were excluded from this analysis because of a small sample size.

2. Percentage of residents from each region of origin

3. Moderate level of overall knowledge

Table 4: Percentage of good, moderate and poor level of overall knowledge for each infection by the student's current university course of enrolment (number)

		Bacterial Meningitis			Glandular fever			Influenza		
Faculty enrolled	%[1] (*n*)	Good	Mod	Poor	Good	Mod[2]	Poor	Good	Mod	Poor
Medicine/ Health	9.2% (44)	36.4% (16)	45.5% (20)	18.2% (8)	63.6% (28)	15.9% (7)	20.5% (9)	88.6% (39)	6.8% (3)	4.5% (2)
Science	18.6% (89)	15.7% (14)	30.3% (27)	53.9% (48)	47.2% (42)	20.2% (18)	32.6% (29)	82.0% (73)	11.2% (10)	6.7% (6)
Law	4.0% (19)	10.5% (2)	42.1% (8)	47.4% (9)	42.1% (8)	21.1% (4)	36.8% (7)	73.7% (14)	15.8% (3)	10.5% (2)
Engineering/ Architecture	15.2% (73)	16.4% (12)	30.1% (22)	53.4% (39)	42.5% (31)	12.3% (9)	45.2% (33)	79.5% (58)	12.3% (9)	8.2% (6)
Commerce/ Economics	30.9% (148)	10.8% (16)	16.9% (25)	72.3% (107)	14.9% (22)	12.2% (18)	73.0% (108)	68.2% (101)	24.3% (36)	7.4% (11)
Arts	14.4% (69)	13.0% (9)	27.5% (19)	59.4% (41)	27.5% (19)	15.9% (11)	56.5% (39)	73.9% (51)	15.9% (11)	10.1% (7)
Others	7.7% (37)	18.9% (7)	21.6% (8)	59.5% (22)	48.6% (18)	18.9% (7)	32.4% (12)	78.4% (29)	2.7% (1)	18.9% (7)

1. Percentage of residents enrolled in each university faculty/course

2. Moderate level of knowledge

Within glandular fever, the components for which knowledge was poor were prevention and route of transmission. Sixty-two percent of residents were rated as having poor knowledge on prevention by avoiding kissing or sharing drinks with the infected individual. Just over half (53.3%) knew the illness as one where there is normally recovery without severe consequences. Knowledge on symptomatology (fever, lymphadenopathy, lethargy, poor appetite) was poor among 34.1% of respondents, moderate in 34.9% and good in 31.0% (Table 2).

Influenza

Among the respondents, 76.2% (364) were rated as having good overall knowledge of influenza. There was difference found between the genders, although not significant, with a greater proportion of females with good knowledge (81.0%), compared to males with 70% ($p = 0.085$). A significant statistical difference was observed when the overall knowledge of influenza was compared between the regions of origin ($p = 0.015$) and university faculties ($p = 0.019$). Greater proportions of students from North America and Australia were rated as having good knowledge compared with students from other regions, as were students studying in medical/health faculties compared with other students. Knowledge about the transmission and symptomatology, as expected, was greater for influenza compared to glandular fever and bacterial meningitis.

Discussion

This study demonstrates important shortfalls in knowledge regarding bacterial meningitis in particular, but also moderate and mild deficiencies in knowledge about glandular fever and influenza respectively.

Bacterial meningitis

Bacterial meningitis had the poorest rating with only 58% of residents who knew of it. In total, 57.3% had poor overall knowledge and only 15.9% had good knowledge. Just 55.0% of respondents reported that they would seek immediate medical attention if they considered they had this disease. The areas of deficient knowledge were identified as the route of transmission, presenting symptoms and prognosis of this disease with poor knowledge in 92.9%, 54.2%, and 69.2% respectively.

The discrepancy in knowledge about different aspects of the disease may reflect the impact of the media and other resources, which focus on how to identify it, the severity of the disease and the action to be taken, rather than how it is transmitted. However, it is important to note that, although students knew more about symptoms and prognosis, there were still deficiencies in these areas that need to be targeted along with the route of transmission of meningitis. Knowledge of the way the disease is transmitted would be of significance in its prevention.

Glandular fever

With regard to glandular fever, 50% of students reported that they had heard of it. Of the studied population, 49.6% demonstrated poor overall knowledge and 34.9% had good knowledge. Areas of deficient knowledge were found in the route of transmission and how to prevent the illness with poor knowledge in 49.4% and 62.3% respectively. The symptoms were relatively well known with up to two-thirds of subjects with moderate-to-good knowledge. These are important aspects of glandular fever since prevention is important in this condition which may lead to long-term sequelae or incapacitate an individual for a period of time while the infection runs its course.

Influenza

Influenza saw the highest rates of good overall knowledge and more specific knowledge regarding the transmission and symptomatology of this common infection. This may be associated with the high incidence of this infection resulting in most

people having personal experiences with the infection and therefore, familiarity with the condition.

Significant statistical differences in level of overall knowledge of all three infectious diseases were observed when comparing across the regions of origin and university faculties. Students with poor knowledge tended to be residents of Asian origin, and enrolled in Commerce/Economics. The factors that may be responsible for reduced knowledge among the Asian students needs further investigation, but there are a number of possibilities. First, an important contributing factor may have been difficulty in completing the questionnaire in English as a second language, particularly as their scientific or medical English may have been limited. Second, according to Lee, Tsang and Lee (2000), there is a relative lack of emphasis on health education and promotion in the education system and community in Asian countries. Third, the relative importance of infectious diseases between regions may have led to differences in the salience of these diseases among students. Fourth, Rashid and Jagger (1992) suggest there is less emphasis on health education and health promotion within the role of health professionals in Asian countries. An important factor influencing the poor rating knowledge among residential hall students studying Commerce/Economics may have been the higher proportion of Asian college residents studying Commerce/Economics (64.5%).

This cross-sectional study has a number of limitations. As already mentioned, that the questionnaire was administered in English is the most important of these. While students are completing their studies in English, they may have been less familiar with medical terminology. The questionnaire was, by necessity, long and this may have affected the reliability of responses. The sample was not randomly selected, but selected on the basis of attendance at dinner on the night of the survey. However, the study population represented approximately half the target population of college residents and of those students who attended to dinner on the night of the survey, all students were approached and completed the questionnaire. There is no reason to believe that those who attended dinner were different from those who did not, with regard to their infectious disease knowledge.

Conclusion

This cross-sectional study has demonstrated the need for further health promotion about infectious diseases, in particular, bacterial meningitis and glandular fever, among residential colleges. In particular these programs should focus on the route of transmission of bacterial meningitis and glandular fever, as well as methods for prevention. Education programs targeting students from other countries, in particular Asia, to study in Australia are warranted. These students may well be at greater risk because of their lack of knowledge, and because often halls of residence are the accommodation of choice for overseas students.

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Yu-Ping Chen
C/o Jane Heyworth
School of Population Health
University of Western Australia
35 Stirling Highway
Crawley, 6009, Western Australia
AUSTRALIA
Email: yu_ping.chen@health.wa.gov.au, lil_puddles@hotmail.com

Jane Heyworth
School of Population Health
University of Western Australia
35 Stirling Highway
Crawley, 6009
Western Australia
AUSTRALIA
Email: heyworth@dph.uwa.edu.au

Correspondence to Yu-Ping Chen

Climate Variation and Ross River Virus Infection in Queensland: Is There a Difference between Various Geographical Locations?

Peng Bi[1] and Kevin A Parton[2]

The Centre for Healthcare Related Infection Surveillance and Prevention, Princess Alexandra Hospital, Brisbane[1] and Faculty of Rural Management, University of Sydney, Orange, NSW[2]

To determine the impact of climate variation on the transmission of Ross River (RR) virus infection, a comparison study on the incidence of the disease and climate variability was conducted across different meteorological regions of Queensland over the period 1985-96. Two towns were selected from northern, central, southern coast and inland regions, respectively. The results showed that autumn was the season of highest incidence. At this time of the year, there were higher incidences of RR virus infection in coastal regions than in the inland region. The incidence of RR virus infection in autumn in the northern coast region was higher than that in central and southern coast region. There was also a difference in the incidence of the disease within each meteorological region, generally with a higher incidence in northern locations. Apart from other potential risk factors, the differences in rainfall, relative humidity and mean high tide were possible contributors to the variation in the incidence of RR virus infection in the above locations in Queensland.

Key Words: *Ross River Fever; Climate Variation; Geographical Location*

Ross River (RR) virus infection, or epidemic polyarthritis, is a mosquito-borne disease caused by an alphavirus, Ross River virus. The virus has been isolated from 38 species of mosquito belonging to six genera, and all of them are vectors of RR virus (Russel 1995). For example, tidal-breeding *Aedes vigilax* and *Aedes camptorhynchus* are important in the coastal regions of Australia (Kay 1987), as are floodwater *Aedes* species in many inland areas (Kay 1989). *Culex annulirostris*, which breeds in vegetated semi-permanent and permanent fresh water, is important in areas of the tropics and temperate regions that are subject to flooding or irrigation during summer (Kay 1989). Species such as *Aedes notoscriptus* may be important in semi-rural and urban areas (Curson 1996). The natural hosts for RR virus infection are marsupials, particularly macropods. Man has also been shown to be an effective host in epidemic situations in the South Pacific (Aaskov et al. 1981).

RR virus infection is the most prevalent vector-borne disease in Australia and thousands of the cases are reported annually (Curran et al. 1997; Mackenzie, Lindsay & Coelen 1994). The national reported incidence of the disease in 1996, for example, was 42.7/100,000 (Curran et al. 1997). The economic cost of RR virus infection has been estimated at approximately $2,500 per case, and a minimum of tens of millions of dollars are spent annually in direct and indirect health costs nationally (Boughton 1994; Russell 1998). The disease is recorded as geographically scattered cases throughout the year, but with the preponderance of

cases in the period January to May, particularly in the tropics. This distinctive seasonal pattern is largely dependent upon the life cycle and habits of the mosquitoes. Occasional severe outbreaks have also been recorded in temperate Australia following extensive summer rainfall (Lindsay et al. 1993).

As with all vector-borne viruses, a complex interaction of environmental factors such as temperatures, precipitation and relative humidity, as well as the rise of sea level is crucial in the ecology of RR virus and in providing conditions that are conducive to transmission of the virus. For example, rainfall and/or tidal inundation of salt marshes are essential for breeding of salt marsh mosquitoes, and temperature is important for virus replication in the vector and the development of the mosquito (Lindsay et al. 1993).

Queensland is the state where the majority of RR virus infections are transmitted with more than 60% of RR virus infections in Australia occurring there in the past decade (Curran et al. 1997; Mackenzie, Lindsay & Coelen 1994). It is important to study the impact of climate variability on the transmission of RR virus infections because global warming might lead to higher temperatures and sea level, bring changes to future precipitation, all of which may impact on the developments of the mosquito and the virus. We have reported our research results regarding the association between climatic variables with the incidence of RR virus infection in Queensland over the period 1985-96 (Tong et al. 2001). This study, however, was an attempt to identify the potential impact of climate variability on the transmission of RR virus infection from another aspect. By disaggregating the data, differences were examined in seasonal incidence of the disease between geographical locations with different latitudes. Further, the different way in which the climatic variables affected the incidence of the disease in different locations was investigated.

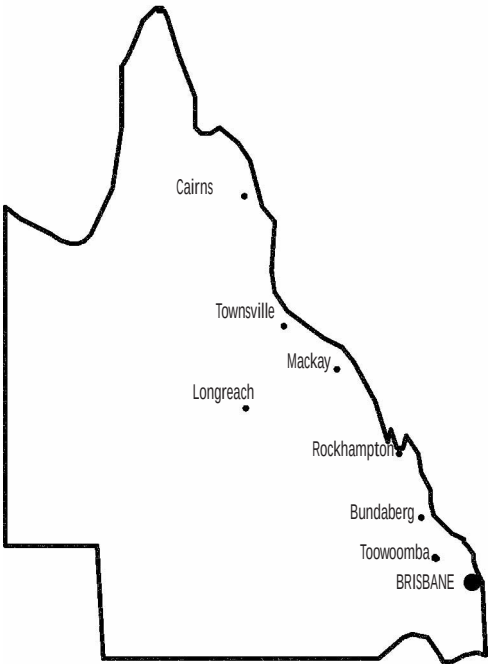
Materials and Methods

Research Sites and Population

Eight major towns from different geographical locations in Queensland were selected as research sites and their residents over the period 1985-1996 were treated as the study population.

According to the weather forecast districts in Queensland from the Australian Bureau of Meteorology, different geographical locations were determined: Cairns and Townsville were selected from the northern region of Queensland, Mackay and Rockhampton from central Queensland, Bundaberg and Brisbane from the southeast region of Queensland, and Toowoomba and Longreach are in the inland region (Figure 1).

Figure 1. Study sites in Queensland



Data collection

Notified cases of RR virus infection were provided by the Queensland Department of Health. Population data from eight selected cities were provided by the Australian

Bureau of Statistics. Climate data were retrieved from the Australian Bureau of Meteorology.

Data analysis

Seasonal average incidences of RR virus infection over the study period were calculated for each town (December, January and February are the summer months, March, April and May are in autumn, winter is June, July and August, and spring is September, October and November). Mean values of seasonal climatic variables, such as mean maximum and minimum temperatures, relative humidity, the amount of precipitation and mean high tides, were computed. A $\chi 2$ test and ANOVA were used in comparisons.

A comparison was first made of the difference in RR virus infection and climatic variables between two towns within each district. A second comparison was then made between regions. This presented more of a challenge for data collection and analysis because the disease incidence is across a wide region, whereas it is not possible to aggregate the disease incidence and meteorological data available to us across such regions (see also the additional remarks on point-source ground data in the Discussion section). The compromise reached was to select the town with the larger population to represent each district, and comparisons were conducted among different districts, on both the incidences of the disease and climatic variables.

Results

Seasonal comparisons between the incidences of RR virus infection and climatic variables within each geographic district

Comparisons between Cairns and Townsville, Mackay and Rockhampton, Bundaberg and Brisbane were performed by examining the incidences of RR virus infection and climatic variables. The means of seasonal incidences of the disease and climatic variables between the pairs were compared. It was found that there were significant differences in the incidence of the disease in autumn among these three pairs. Hence, in order to consider the lagged effect of climatic variables on incidence, both the summer and autumn values of these variables were included.

Table 1 shows that the autumn incidence of RR virus infection was significantly higher in Townsville than in Cairns over the period of 1985-96. With climatic variables in autumn and summer, there was no significant difference in temperatures, but higher relative humidity and rainfall in Cairns and higher monthly mean high tide in Townsville.

In central Queensland, there was a significant difference in the incidence of RR virus infection in autumn between Mackay and Rockhampton (higher in Mackay). Also there were significant differences in rainfall, relative humidity and mean high tide in both summer and autumn between the two locations (higher in Mackay).

In southeast Queensland, the incidence of RR virus infection in Bundaberg in autumn was higher than that in Brisbane. Higher maximum temperatures in autumn and higher mean high tide in autumn, and summer were also discovered in Bundaberg.

Comparisons of the incidences of RR virus infection and climatic variables among different geographic districts

Table 1: Seasonal comparisons of the incidences of RR virus infection and climatic variables in autumn and summer within northern, central and southern Queensland, 1985-96

Locations	Incidence	MaxT	MinT	Rain	RH	HT
Cairns and Townsville	-	# (#)	# (#)	+ (+)	+ (+)	- (-)
Mackay and Rockhampton	+	# (#)	# (#)	+ (+)	+ (+)	+ (+)
Bundaberg and Brisbane	+	# (+)	# (#)	# (#)	# (#)	+ (+)

+ significantly greater in the first named location; - significantly smaller in the first named location (P<0.05); # not significant; () the results in autumn

After the comparisons within each district, further comparisons between districts were conducted on the seasonal incidence of RR virus infection and climatic variables. The aim was to assess the contribution of climate variations to the difference in the incidence of RR virus infection among different geographic (meteorological) districts. It was found that the only incidence difference was in autumn, so comparisons were again performed for summer and autumn in order to include any lagged effect. In the coastal districts, Townsville was chosen to represent northern Queensland, Mackay to represent central Queensland and Brisbane to represent southern Queensland. Longreach was chosen to represent the inland region. The results are summarised in Table 2.

There was no significant difference in the autumn incidences of RR virus infection between Townsville and Mackay. Similarly, there were no significant differences in relative humidity and rainfall, although the differences in temperatures (higher in Townsville) and high tide in autumn were significant (higher in Mackay).

There was a significant difference in the incidence of RR virus infection in autumn between Townsville and Brisbane (higher in Townsville). There were significant differences in most climatic variables. For rainfall, however, a significant difference was found only in summer.

Mackay had a higher incidence of RR virus infection, relative humidity, mean high tide and maximum temperature in autumn, and the amount of precipitation in summer was higher than for Brisbane.

A higher incidence of RR virus infection in autumn was found in Townsville, Mackay and Brisbane than that in Longreach. Similarly, the climatic variables except for temperatures were higher in the coastal locations than in Longreach.

Location and incidence of RR virus infection

The location where the cases were notified was created as an independent variable by defining each location by its latitude, given that latitude partly determines climate. To identify the relationship between the incidence of the disease and the latitude, a Spearman's rank correlation analysis was performed between monthly, yearly and total incidence of RR virus infection in the six coastal locations and the latitudes, over the period 1985-96 (Table 3).

There was an inverse correlation between

Table 2: Seasonal comparisons of incidences of RR virus infection and climatic variables between northern, central, southern coast and inland region in Queensland, 1985-96

Locations	Incidence	MaxT	MinT	Rain	RH	HT
Townsville and Mackay	#	# (+)	# (+)	# (#)	# (#)	# (-)
Townsville and Brisbane	+	+ (+)	+ (+)	+ (#)	+ (+)	+ (+)
Townsville and Longreach	+	- (-)	# (-)	+ (+)	+ (+)	^
Mackay and Brisbane	+	# (+)	# (#)	# (+)	# (+)	# (+)
Mackay and Longreach	+	- (-)	# (#)	+ (+)	+ (+)	^
Brisbane and Longreach	+	# (-)	- (#)	+ (+)	+ (+)	^

+ significantly greater in the first named location; - significantly smaller in the first named location (P<0.05); # not significant; () the results in autumn; ^ data unavailable;

Table 3: Correlations between latitude and the incidence of RR virus infection in coastal districts of Queensland, 1985-96

	Location	P value
Monthly incidence of the disease	-0.299	0.000
Annual incidence of the disease	-0.548	0.000
Total incidence of the disease	-0.829	0.000

latitude and the incidence of RR virus infection in the coastal districts of Queensland.

Discussion

Arbovirus diseases including RR virus infection are among the most sensitive of all diseases to climate and the environment (Lindsay & Mackenzie 1996). Climate variation may alter the ecology of these viruses, lead to an increase in the activity of vectors and impact greatly upon the incidence and distribution of vector-borne diseases including RR virus infection.

Temperature has a dramatic effect on the length and efficiency of the extrinsic incubation period of RR virus in its vectors. Mosquitoes exposed to higher temperatures after ingestion of RR virus become "infectious" more rapidly than mosquitoes of the same species exposed to lower temperatures (Lindsay & Mackenzie 1996). Transmission of RR virus may therefore be enhanced under warmer conditions because more mosquitoes become infectious within their often short life span. Temperatures, especially minimum temperatures, may play an important role in maintaining the survival of mosquito larvae in winter and thus have a significant impact on the development of adult mosquitoes. But too high a temperature might speed the death of adult mosquitoes. Also high temperatures, in summer might force people to stay in their houses and reduce their contact with mosquitoes.

Rainfall is important in the transmission of mosquito-borne diseases including RR virus infection. All mosquitoes have aquatic larval and pupal stages and therefore require water for breeding. Sufficient amounts of precipitation will assist in maintaining the mosquito's breeding habitats further into the summer months, which is particularly important for fresh water breeding mosquitoes. It is also likely that rainfall contributes to the epidemic potential by providing improved breeding conditions for the kangaroo and other vertebrate hosts of RR virus, resulting in significant numbers of non-immune young. Timing of rainfall and the pattern of rainfall are important in the transmission of RR virus infection.

Tidal inundation of salt marshes is a major source of water for the breeding of the important arbovirus vectors *Aedes vigilax* and *Aedes camptorhynchus*. Adult females of both species lay their eggs on soil, mud substrate and at the bases of plants around the margins of their breeding sites. Large populations of adult mosquitoes can emerge as little as eight days after a series of spring tides, depending on temperature. A rise in sea level may lead to more frequent and widespread inundation of coastal saltmarshes in the region, by consequence extending the breeding grounds of *Aedes vigilax* and *Aedes camptorhynchus*. This, in turn, could gave rise to much larger summer populations of *Aedes vigilax* and *Aedes camptorhynchus*, exposing large numbers of urban dwellers on the eastern seaboard to infection. This is particularly important to the transmission of RR virus infections in the coastal region, especially the northern coastal district of Queensland, because the main mosquito species there are *Aedes vigilax* and *Aedes camptorhynchus* (Lindsay et al. 1993; Russell 1995). If global warming results in a significant sea level rise, the distribution of breeding sites for saltwater mosquitoes will also change locally along low lying parts of the Queensland coast.

Relative humidity affects the longevity, mating, dispersal, feeding behaviour and oviposition of the mosquito. Under conditions of high relative humidity, mosquitoes generally survive for longer and disperse further. Hence, they have a greater chance of feeding on and infecting an animal and also surviving to transmit a virus to other animals and humans.

The impact of climatic variables, as mentioned above, on the transmission of vector-borne diseases has been studied widely (Bi et al. 1998; Tong et al. 1999; Tong et al. 2001). Most of these studies selected a single research site to conduct a

statistical analysis on empirical data (between climatic variables and incidence of disease) and then set up a regression model. This study, however, studied location differences in the incidence of RR virus infection and potential influencing factors. Geographical differences in RR virus infection may be due to various factors, such as environmental variation, dominant mosquito species, human behaviour, and social and economic differences, but variations in climate variability including high tide did contribute to the incidence difference.

A comparison was first conducted within each meteorological district. The comparison within the north coastal region of Queensland found that the incidence of RR virus infection in autumn was higher in Townsville than in Cairns. Regarding climatic variables, more rainfall and higher relative humidity were found in Cairns but there were higher high tide flows in Townsville. Given similar social and economic profiles between these two towns, the results indicate that high tide might have made a significant contribution to the transmission of RR virus infection in northern Queensland. Such a conclusion is consistent with the fact that the main vectors of RR virus infection in the northern Queensland coastal region are *Aedes Vigilax* and *Aedes Camptorhynchus*, the tidal-breeding mosquitoes.

The impact of high tides was confirmed in the comparisons that were conducted between the meteorological districts. Significantly higher incidences were associated with high tidal flows in Townsville and Mackay compared with Brisbane.

In addition, the incidence of RR virus infection was generally directly related to rainfall and relative humidity. In the comparisons between regions, there were five cases in which there were significant differences in incidence. In all five cases there was a direct relationship between autumn incidence and relative humidity, and in four of the five cases a direct relationship between autumn incidence and rainfall. In summer, a higher incidence of RR virus infection was associated with higher relative humidity and higher rainfall in four of the five cases.

There was a significantly higher incidence of RR virus infection in autumn in coastal regions (Townsville, Mackay and Brisbane) than inland. Most of the climatic variables in coastal regions (except temperatures) were higher than inland. This could be partly explained by the incidence difference.

The inverse correlation between latitude and the incidence of RR virus infection suggested that climatic factors related to latitude might play an important role in the transmission of RR virus infection.

Economic position in the community, housing conditions, unprecedented population growth, urbanisation, increased travel, population immunity and human behaviour may also be related to the transmission of RR virus infection. Clearly, the variations in climatic variables are only part of the driving force behind the incidence of RR virus infection across various regions in Queensland. All of these need to be considered in future research. Nevertheless taking all the comparisons in the current study together, the evidence is that differences in RR virus infection are directly related to rainfall and high tides, and more weakly, directly related to temperature.

Most of the meteorological data used in the analysis are point-source ground meteorological data collected at an airport. This is, to some degree, controversial because of the discrepancy between data gathered at such a site (with a high degree of micro-climatic effects due to the large concrete/asphalt surface area), and forests and marshlands. Further studies might incorporate remotely sensed data such as Landsat, AVHRR-DNVI, SeaWiFS, or others, which enable closer targeting of the analysis to the study site.

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Peng Bi
The Centre for Healthcare Related Infection Surveillance and Prevention
Princess Alexandra Hospital
Ipswich Road
Brisbane, QLD, 4102
AUSTRALIA
Email: peng_bi@health.qld.gov.au

Kevin A Parton
Faculty of Rural Management
University of Sydney
Orange, NSW 2800
AUSTRALIA
Correspondence to Peng Bi

Environmental Health Officers' Knowledge and Attitudes Towards Infection Control

Aurmporn Oberdorfer[1] and John H Wiggers[2]

School of Medical Practice and Population Health, University of Newcastle[1], & School of Medical Practice and Population Health, University of Newcastle & Hunter Centre for Health Advancement, Hunter Area Health Service, NSW[2]

Blood borne diseases can be transmitted through commercial skin penetration procedures. In New South Wales, Australia, environmental health officers from local government councils and public health units have responsibility for ensuring premises involved in skin penetration services comply with guidelines, and therefore improve their infection control. A telephone survey was carried out of all local council and public health units' environmental health officers who were involved in skin penetration inspections in New South Wales. Two hundred and forty five (92%) environmental health officers from local councils and 30 (86%) environmental health officers from public health units participated. Most from local councils and all from public health units reported having received the skin penetration guidelines, but only two thirds of both groups distributed them to operators. More than half of those from local councils and one fourth from public health units reported that they did not know the meaning of the "standard precaution approach". Almost half of both groups did not know the correct disinfection procedures. Only one third of local councils and half of public health units received training in inspections, and approximately 50 to 70% of them believed they needed more skills to effectively encourage compliance among operators. There is a need to improve the knowledge and skills of environmental health officers involved in skin penetration inspections.

Key Words: *Environmental Health Officers; Skin Penetration; Guidelines; Infection Control, Knowledge; Attitudes.*

Blood borne diseases such as HIV, hepatitis B and C are a major concern in many countries (Hirsch & Wright 2000; Kane 1995; Lavanchy 1999; The Joint United Nations Programme on HIV/AIDS - World Health Organization [UNAIDA-WHO] 1998). Transmission of all three diseases can occur through direct percutaneous exposure to blood; such as through injecting drug use, use of non-sterile medical equipment and use of infected blood products. Transmission can also occur in other settings such as tattooing, beauty therapy and hairdressing (Davis 1995; Davis & Kowalik 1996; Ko et al. 1992; Mele et al. 1995; Sladden et al. 1997; Tumminelli et al. 1995). In Italy from 1986 to 1993, 6,395 hepatitis B and 2,558 hepatitis non-A non-B cases were associated with use of tattooing, ear piercing, and barber shop shaving or manicurist services (Mele et al. 1995). In a further Italian study, 38% of barbers were found to be hepatitis C positive after having used unsterilised shaving blades (Tumminelli et al. 1995). Compared with a tattoo-free group, a higher prevalence of hepatits has been found among persons who had a tattoo but who had never injected drugs (Davis 1995; Ko et

al. 1992), with a prevalence of hepatitis C infection of 12.6% in 87 tattooed men, an odds ratio of 5.9 (CI 1.6 to 22).

The development of regulations and guidelines is a commonly used strategy to reduce risk of blood borne disease transmission through commercial skin penetration services (Bonfield 1998; Government of South Australia 1998; New York City Department of Health 2000; Queensland Health 1999; State of Oregon Health Licensing Office 2001a, 2001b; State of Rhode Island and Providence Plantations 1993; Victorian State Government 1990; Whitney 1995). In New South Wales, Australia, the *Public Health Act 1991* provides two authorities, local councils and regional Public Health Units (PHUs), with the power to enter and inspect premises that carry out skin penetration procedures, and to take action in relation to those premises (New South Wales Department of Health 1999). In general terms, local councils are responsible for the registration and ongoing monitoring of such premises and PHUs respond to complaints and outbreaks of disease, associated with such premises. Environmental health officers (EHOs) undertake those tasks within both types of organisations.

In July 1999, new infection control guidelines for all skin penetration procedures were developed and disseminated by the New South Wales Department of Health, Australia (New South Wales Department of Health 1999). The guidelines addressed among other issues the transmission of HIV, hepatitis B, and C and were directed at a variety of procedures, including tattooing, beauty therapy and hairdressing. The guidelines aimed to minimise the risk of infection, promote safe work environments, and public awareness. EHOs in local councils were given the primary responsibility for ensuring compliance of premises with the guidelines. Copies of the guidelines were forwarded to PHUs and local councils for distribution by EHOs to premises' owners/managers. In addition, multiple copies were sent to professional associations for distribution to their members. Workshops and training for EHOs were provided to local councils by PHUs.

The effectiveness of regulations and guidelines is dependent on the extent of support and acceptance among key stakeholders (Byleveld 1979; McKnight & Streff 1994), and on the success of dissemination strategies in developing appropriate levels of stakeholder knowledge and skills. Key stakeholders in the prevention of blood borne disease transmission by skin penetration operators are the operators themselves, and the EHOs who have the authority to enforce relevant guidelines and regulations. We have previously reported on the knowledge and attitudes of the owners and managers of premises involved in skin penetration procedures (Oberdorfer et al. 2002).

Very limited data have been reported regarding the knowledge and understanding of EHOs regarding their range of roles and duties. In one study, qualitative semi-structured interviews of 15 EHOs employed by the Northern Territory health service, Australia reported a lack of role clarity, and a lack of confidence in providing support and education to their clients (Clark 1999). An earlier study, a postal survey of 765 randomly selected Victorian officers from municipal councils, found that despite these officers having responsibility for childhood vaccination, only 9% were able to describe recommended vaccination schedules correctly (MacIntyre & Nolan 1994). Similarly, a study conducted in Northern Ireland reported that EHOs from Local Authority Environmental Health Departments lacked knowledge and training in how to ensure retail premises implemented recommended practices (Leitch, Blair & McDowell 2001).

No previous studies have reported on the knowledge and attitudes of EHOs regarding the prevention of blood borne diseases in

skin penetration premises, and importantly, few data have been reported following the introduction of new infection control guidelines.

Given the investment by governments in policy development and dissemination, and limited data regarding environmental health officer knowledge, attitude and skills, this study was undertaken to determine for all EHOs in the state of New South Wales their receipt of new skin penetration guidelines, knowledge of recommended practices for preventing blood borne disease transmission, attitudes towards the guidelines, and perceived level of guideline implementation skill and resource availability.

Methodology

Setting and sample

In either local councils or PHUs, there are no complete registers of EHOs who conduct inspection of premises that provide skin penetration procedures. Therefore we contacted all eligible city and municipal councils and all 16 PHUs in New South Wales, Australia, listed in a computerised telephone directory, and asked the general manager to provide details (name, contact details) of all EHOs responsible for conducting skin penetration inspections. Using a "snowball" technique (Kotz, Johnson & Read 1988), we telephoned nominated EHOs to confirm their involvement in skin penetration inspections and to provide the names and contact details of all other EHOs in that organisation that conducted such inspections. When contacted, each nominated officer who confirmed being involved in the conduct of skin penetration inspections was eligible to participate in the study.

Procedures

An information letter was sent describing the study objectives to each eligible council/PHU officer. Two weeks following this, the council/ PHU officer was contacted by a trained telephone interviewer and asked to participate in a telephone interview. If the officer was not available, arrangements were made to call back at a later time. At least three contact attempts were made for each respondent. The study was conducted in October-December, 2000.

Measures

Knowledge and attitudes

A 51-item interview schedule was developed based on previous research (Oberdorfer et al. 2002) and recommendations concerning infection control practices included in the 1999 New South Wales Skin Penetration Guidelines (New South Wales Department of Health 1999). The interview included items addressing:

1. Receipt of guidelines (2 items);
    - Whether EHOs had received copies of the Guidelines and if so, from what source
2. Training in infection control (3 items);
    - Whether EHOs had received any infection control training, and if so from what source
    - Their perceptions of need of more training
3. Knowledge of skin penetration practices stipulated in the guidelines (22 items);
    - Standard precautions approach to infection control-1 item (yes/no)
    - General infection control procedures-5 items (true/false)
    - Disinfection procedures-6 items (true/false)
    - Sterilisation procedures-10 items (true/false)
4. Attitudes towards the skin penetration guidelines (12 items-agree/disagree);

- Acceptance of the guidelines-5 items
- Barriers to compliance with the guidelines-7 items

5. Attitudes, and perceived level of skill and resource availability (15items-agree/disagree);
   - Acceptance of environmental health officer' s role-6 items
   - Resources availability of the organisation-3 items
   - Personal knowledge and skills-2 items
   - Possible methods of increasing infection control compliance-4 items.

Demographic characteristics

Respondents were asked their age, gender, highest level of education, and position title. The study and survey instrument was approved by the Human Research Ethics Committee of the University of Newcastle.

Data Analysis

Descriptive and comparative statistical analyses were performed using the statistical program SAS. Data describing respondents' receipt of guidelines, training in infection control, and knowledge and attitudes are reported as proportions. For such analysis, knowledge responses were classified as correct or incorrect, and attitudes responses were classified into agree and disagree categories.

Results

Sample

Two hundred and sixty five EHOs from all 172 local councils and 37 officers from all 16 PHUs were identified as eligible to participate in the study. Of these, all were contacted, with 245 officers (92%) from local councils and 30 (86%) from PHUs involved in skin penetration inspections consenting to participate and complete the interview.

Demographic characteristics

As shown in Table 1, most respondents from local councils (83.3%) and PHUs (73.3%) were men. Almost two thirds of respondents from both groups were less than 41 years of age, 63% (council) and 83% (public health) held a graduate degree (University) or higher, and 30% (council) and 24% (public health) held senior environmental health officer or manager positions in their organisations. Almost all worked in a full time position in their organisations.

Receipt of guidelines

Ninety three percent of respondents from local councils and PHUs involved in inspections reported having received the guidelines. Of those who received the guidelines, 77% of public health unit respondents and approximately 40% of local council respondents reported receiving them from the New South Wales Department of Health. Approximately 40% of local council respondents reported receiving the guidelines from PHUs.

Training in infection control

Less than half of the council (40%) and half of the public health (53.3%) respondents reported having received training in skin penetration inspection practices. Such training was received from a wide variety of sources, with council officers most likely to report receiving training from their own council (30.9%) and public health unit officers most likely to have received it from the New South Wales Department of Health (43.7%).

Knowledge of Skin Penetration Practices

Knowledge of "Standard precautions approach" to infection control

Respondents were asked if they understood the meaning of the term "standard precautions approach to infection control", the approach to infection control that was described in, and underpinned the guidelines. Public health respondents (72.4%) were more likely than local council

Table 1: Demographic data

Characteristics	Council % (*n*) *n*=245	PHU % (*n*) *n*=30
Gender		
* Male	83.3(204)	73.3(22)
* Female	16.7(41)	26.7(8)
Age		
* Less than 30 yrs	32.2(79)	25.9(7)
* 31-40 yrs	31.4(77)	37.0(10)
* 41-50 yrs	21.2(52)	29.6(8)
* more than 50 yrs	15.1(37)	13.8(4)
Highest level of Education		
* High School certificate	3.3(8)	3.7(1)
* Technical college, Diploma certificate	33.9(83)	11.1(3)
* Graduate degree (University)	51.3(120)	55.6(15)
* Postgraduate+Other	12.0(28)	29.6(8)
Status		
* Full time	97.6(239)	100.0(30)
* Part time	2.4(6)	0(0)
Position		
* Manager	11.4(28)	0(0)
* Senior EHO	17.5(43)	24.1(7)
* EHO	50.6(124)	62.1(18)
* Trainee	1.6(4)	3.4(1)
* Other (Engineer, Surveyor, Building inspectors etc)	18.8(46)	10.3(3)

respondents (36.9%) to report that they knew the meaning of this term.

General infection control procedures

As shown in Table 2, the prevalence of EHOs having correct knowledge of general infection control procedures varied between 68% and 97.1%, with greater prevalence among Public Health Unit respondents for most items.

Knowledge of disinfection procedures

Generally low prevalence of correct knowledge (17% to 70% for public health, 18% to 58% for council respondents) of recommended disinfection procedures was evident for both groups for all but one item.

Knowledge of sterilisation procedures

Generally, high prevalence of correct knowledge (>82%) was evident for recommended sterilisation procedures among public health officers. However, between one third and one quarter of council officers incorrectly identified boiling, chemical disinfectant, ultraviolet light, and microwave as recommended methods of sterilising equipment.

Table 2: Knowledge of the 1999 NSW Skin Penetration Guidelines

STATEMENT	CORRECT ANSWER (%) Council *n*=245	PHU *n*=30
I. GENERAL INFECTION CONTROL PROCEDURES		
1. All premises should record in a diary or log book the details of when and how equipment has been sterilised (T)	72.2(177)	86.7(26)
2. A 70% or stronger alcohol solution should be applied to the surface of the skin before piercing (T)	81.6(200)	93.2(28)
3. Staff must always wash their hands before performing a skin penetration procedure on a client (T)	97.1(238)	96.7(29)
4. Only staff with broken skin on their hands needs to wear gloves when performing skin penetration procedures (F)	71.8(176)	80.0(24)
5. Warm water and detergent should be used for washing combs (T)	68.2(167)	86.7(26)
II. DISINFECTION		
6. Disinfectant is recommended for cleaning skin penetration equipment (F)	48.4(118)	36.7(11)
7. Disinfection is necessary for re-useable equipment that contacts blood or body fluid (F)	32.4(79)	43.3(13)
8. Disinfection is necessary for re-useable equipment that penetrates the skin (F)	35.7(87)	66.7(20)
9. Boiling in water for 5 minutes is sufficient for disinfection of skin penetration equipment (T)	18.0(44)	16.7(5)
10. An electric dish washer is suitable for disinfection of skin penetration equipment (F)	88.6(217)	86.7(26)
11. A pasteuriser is suitable for disinfection of skin penetration equipment (F)	58.0(142)	70.0(21)
III. STERILISATION*		
11. Sterilisation is necessary for all re-useable equipment that contacts blood or body fluid (T)	95.5(233)	86.2(25)
12. Sterilisation is necessary for all re-useable equipment that penetrates the skin (T)	94.3(230)	96.6(28)
13. Boiling and pasteurisation are used for sterilisation (F)	63.5(155)	86.2(25)
14 Wiping and soaking with chemical disinfectant are used for sterilisation (F)	73.8(180)	89.7(26)
15. Exposing to ultraviolet light is used for sterilisation (F)	63.9(156)	82.2(24)
16. A pressure cooker or microwave are used for sterilisation (F)	76.6(187)	93.1(27)
17. Pre-sterilised single-used equipment is used for sterilisation (T)	96.3(235)	100.0(29)
18. An electric dish washer is used for sterilisation (F)	92.6(226)	100.0(29)
19. A domestic oven is used for sterilisation (F)	93.6(229)	100.0(29)
20. An autoclave is used for sterilisation (T)	96.3(235)	100.0(29)

T=TRUE, F=FALSE

** Council n=244, PHU n=29*

Attitudes Towards the Skin Penetration Guidelines

Acceptance of the guidelines

As shown in Table 3, more than 80% of respondents in both groups agreed that the new guidelines were helpful, comprehensive and easy to understand.

Barriers to compliance with the guidelines

Almost half of council officers and two thirds of public health officers considered that the owners of most premises did not understand the information contained within the guidelines, and 60% or more of both groups believed that owners require more knowledge and skills in order to comply with the guidelines. Up to one third of respondents considered that difficulties in managing premises and staff were barriers to premises' adoption of recommended procedures.

Attitudes and Perceived Level of Skill and Resource Availability

Acceptance of environmental health officer's role

Almost all EHOs from both councils and PHUs considered that it was appropriate to reduce the risk of blood borne disease transmission in skin penetration premises. Similarly, almost all respondents from both groups agreed that regular inspection of skin penetration procedures is an appropriate part of council duties (Table 4). Fifty seven percent of council officers and 72% of public health officers agreed that council officers should inspect skin penetration premises more frequently. Educating operators about the prevention of blood borne disease was considered to be an appropriate role of both council and PHUs to undertake by between 69% and 95% of officers.

Table 3: Attitudes towards the 1999 New South Wales skin penetration guidelines by environmental health officers involved in inspections and reported having received the guidelines

STATEMENT	AGREE (%)	
	Council (*n*=229)*	PHU (*n*=30)*
I. ACCEPTANCE OF GUIDELINES		
1. The Guidelines are comprehensive	89.5(205)	86.2(25)
2. The Guidelines are very helpful for conducting skin penetration inspections	86.0(197)	75.9(22)
3. The Guidelines are easy to understand	88.2(202)	86.2(25)
4. Most premises are willing to comply with the Guidelines	82.5(189)	72.4(21)
5. Most premises accept the need for the Guidelines	85.6(196)	82.8(24)
II. BARRIERS		
6. Most premises understand the information contained in the Guidelines	55.0(126)	34.5(10)
7. There are too many issues to address in the Guidelines	18.8(43)	24.1(7)
8. It is too costly for premises to comply with the Guidelines	15.3(35)	10.3(3)
9. Most premises are too busy to comply with the Guidelines	26.6(61)	13.8(4)
10. It is difficult for premises to ensure all their staff comply with the Guidelines	34.5(79)	31.1(9)
11. Most premises need more knowledge regarding the Guidelines	82.5(189)	89.7(26)
12. Most premises need more skills in order to comply with the Guidelines	60.3(138)	69.0(24)

**n = Environmental health officers involved in inspections and reported having received the guidelines*

Resource availability of the organisation

Less than half of the respondents agreed that there were enough staff and time allocated to undertake adequate blood borne disease prevention inspections.

Personal knowledge and skills

Up to 89% of respondents reported that they had sufficient knowledge to implement the guidelines. However, 71% of council officers and 48% of public health officers reported that they required more skills to monitor and facilitate effectively the adoption of the skin penetration practices by operators.

Table 4: Attitudes towards the prevention of blood borne diseases by council/PHU

STATEMENT	AGREE (%)	
	Council (*n*=245)	PHU (*n*=29)
I. ACCEPTANCE OF EHO's ROLE		
1. It is a waste of time trying to reduce the spread of blood borne diseases by improving the infection control practices of premises	1.2(3)	3.4(1)
2. Regular checking of skin penetration procedures is an appropriate part of council duties	92.7(227)	93.1(27)
3. Council officers should inspect skin penetration premises more frequently	57.6(141)	72.4(21)
4. Public health unit officers should inspect skin penetration premises more frequently	29.4(72)	69.0(20)
5. Educating operators about the prevention of blood borne diseases is an appropriate role for councils to undertake	76.7(188)	69.0(20)
6. Educating operators about the prevention of blood borne diseases is an appropriate role for PHUs to undertake	95.5(234)	86.2(25)
II. RESOURCES AVAILABILITY*		
7. There are adequate staff available to enforce blood borne disease prevention practices	47.8(109)	31.0(9)
8. Staff have sufficient time to undertake adequate blood borne diseases prevention inspection among operators	43.2(99)	34.5(10)
9. There is sufficient support from the community for the prevention of blood borne diseases	65.1(149)	51.7(15)
III. PERSONAL KNOWLEDGE AND SKILLS*		
10. I have sufficient knowledge to implement the guidelines	83.0(190)	89.7(26)
11. I need more skills to effectively encourage practices of skin penetration operators	70.7(162)	48.3(14)
IV. SOLUTIONS		
12. Encouraging skin penetration operators to use infection control techniques helps reduce the spread of blood borne diseases	96.3(236)	100.0(29)
13. Providing accreditation to premises would increase compliance with infection control procedures	78.4(192)	72.4(21)
14. Imposing financial penalties on premises for a breach of skin penetration regulations would increase their use of infection control procedures	85.3(209)	79.3(23)
15. Providing information to premises is a way of increasing their use of infection control procedure	94.3(231)	86.2(25)

**Council n=229*

Possible methods of increasing infection control compliance

Approximately three quarters of the respondents agreed that providing accreditation to premises would increase compliance with infection control procedures, and most (79% to 100%) agreed that imposing financial penalties for breaches of skin penetration regulations, providing information to premises, and encouraging skin penetration operators to use infection control techniques would help reduce the spread of blood borne diseases.

Discussion

Although EHOs had generally high levels of knowledge in techniques of sterilisation, comparatively few could correctly identify procedures for disinfection. This perhaps is not surprising for council officers, as less than half reported having receiving training in the implementation of the guidelines. Officers from local councils had less knowledge than those from PHUs in almost all items. This differential suggests, given the primary role of councils in monitoring compliance with guidelines, that the guideline dissemination approach was least successful with those officers who were most likely to influence the ultimate end users of the guidelines, the premises themselves.

A large group of both council and public health unit officers reported that they had sufficient knowledge of the guidelines and their content. In contrast, however, a large proportion of both groups acknowledged that they lacked the skills to encourage operators to implement the guidelines. This acknowledged lack of skills supports the results of our previous research in which approximately two thirds of skin penetration operators in New South Wales reported that council and public health officers lacked sufficient skills regarding the prevention of blood borne diseases (Oberdorfer et al. 2002. The results of the current study also support more generally those of previous studies (Clark 1999; Leitch, Blair & McDowell 2001; MacIntyre & Nolan 1994) that reported a lack of skill among EHOs, even

after training. These findings, coupled with a high level of acceptance of the need for guidelines and their enforcement, and for more frequent inspections suggest both a need and an opportunity to improve environmental health officer monitoring, promoting and enforcement of skin penetration guidelines.

A common feature of environmental health guidelines and inspections is a focus on the presence or absence of physical components such as building and equipment requirements. Although necessary, the presence of such components is not sufficient to ensure prevention of disease transmission. What is also important is the procedural compliance of premises staff in the operation and application of such components. Our results suggest that EHOs lack the skills to facilitate both organisational and individual behavioural compliance with these aspects of the guidelines. This implies that current tertiary and/or continuing professional education courses fail to address adequately these organisational change issues.

In addition to enhancing basic and continuing professional education, an alternative or enhanced model of disseminating new guidelines and policies appears warranted. Previous research suggests that there is no single way to ensure the effective implementation of clinical or professional guidelines (Feder et al. 1999), and that multifaceted interventions are most likely to be effective (Bero et al. 1998). There is also evidence (Thompson, Lavender & Madhok 1995) to suggest that the greater the educational component of dissemination strategies, the greater the likelihood of adoption. We could not find any reports that had trialed such a model to disseminate skin penetration guidelines, or environmental health guidelines more generally. Further research in this area is required.

More than 60% of EHOs agreed that there were not enough staff or time to undertake adequate inspections. Most officers reported having to undertake other inspection activities in their organisation (e.g. food, building inspection). Previous research suggests that skin penetration inspection receives a lower organisational priority in such circumstances (Oberdorfer & Wiggers 2002). If this is the case, the capacity of the guidelines to achieve their stated infection control objectives are likely to be compromised.

A number of factors should be considered when interpreting the results of this study. First, to the best of our knowledge, this study is the first reported study addressing EHOs' knowledge and attitudes towards the prevention of blood borne diseases in commercial skin penetration practices. All EHOs responsible for inspections of skin penetration premises were the source population for our sample. As such the study provides an important basis for future policy development and research in this area. Second, it is the first study to report appraisal of outcomes following the dissemination and implementation of skin penetration guidelines. The results therefore provide an indication of the effectiveness of this dissemination. Firm conclusions concerning such effectiveness cannot, however, be drawn given the absence of either a control group or pre-post dissemination comparisons.

Third, given the high consent rates it is likely that response bias is minimal and the reported results are representative of the two environmental health officer populations in the state. Nevertheless, the extent to which the results are generalisable to officers in other jurisdictions is unknown given differences in legislative requirements between jurisdictions.

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Aurmporn (Peninnah) Oberdorfer
Hunter Centre for Health Advancement
Locked Bag 10
Wallsend, 2287, NSW
AUSTRALIA
poberdorfer@hunter.health.nsw.gov.au

John Wiggers
Hunter Centre for Health Advancement
Locked Bag 10
Wallsend, 2287, NSW
AUSTRALIA
jwiggers@hunter.health.nsw.gov.au

Correspondence to John Wiggers

Global Climate Change and Challenges Attributable to Poor Performance of Prophylactics, Therapeutics and Diagnostics

Subhash C. Arya

Centre for Logistical Research and Innovation

Global climate change has been a matter of concern for educators, health care professionals and researchers from innumerable biological disciplines. The harmful effects of extremes of climate on the performance of the health care weaponry pose serious challenges for humanity. The consequent issues require meticulous attention by scientific personnel in industrialised and developing countries.

Key Words: *Global Climate Change; Therapeutic Failures; Substandard Drugs; Stabilised Formulations; Diagnostic Errors*

The changes in the global climate have been remarkable during the past decade. The July 1995 heat wave in Chicago was accompanied by 300 deaths (Kellermann & Todd 1996). A new record for global temperature was established during July 1998, when the average global temperature reached was 15.5°C making that month the hottest month on record (United States Environmental Protection Agency 1998). There has also been a gradual rise in temperature and humidity in the United States, accompanied by progressively rising apparent temperature, an accurate index of temperature and humidity, in the airport towns in the eastern and western thirds of the United States (Gaffen & Ross 1998). Current and recent days' temperatures have both been strongly predictive of mortality in 11 cities of the Eastern United States (McMichael, Patz & Kovats 1998). Elsewhere, an interaction between the Pacific Ocean and air above has been the central factor in the El Niño Southern Oscillation (ENSO). ENSO is responsible for shifts in weather and ocean conditions in the tropical pacific, leading to massive rainfall in the western coast of the Americas, and drought in Oceania, Southeast Asia, the Indian subcontinent and South Africa (Curriero et al. 2002).

In developing countries, frequent heat waves and rains are often accompanied by an inadequate supply of electricity. This disrupts the performance of electrical appliances necessary to maintain temperature at a stipulated level (Kumar 1998). The global climate scenario and the ENSO would alter range and seasonality of different infectious diseases. There has been genuine concern about the future distribution of infectious diseases, food security and population displacement (Curriero et al. 2002). Nevertheless, the simultaneous effects of high temperatures and humidity, including ENSO, on the efficacy of prophylactic or therapeutic substances and common diagnostic procedures (PTD), has been of little concern. The existing ground realities require an appreciation of this problem to counter the exponential rise in inadvertent failures.

Prophylactic Agents

The poor quality of live poliovirus vaccine was evident in Chicago during the early 1970s. The vials had been exposed to sun for many hours. The vaccine 'take' among recipients of the vaccine was unsatisfactory (Rasmussen, Thomas & Mulrooney 1973). During the late 1980s, therapeutic administration of antivenom preparations against Russell's viper in the Anuradhapurm area in Sri Lanka was disastrous.

Administration of antivenom to 20 patients bitten by Russell's viper failed to clear antigenemia in 19 patients. The antigenemia continued unabated (Phillips et al. 1988). Recently, the prophylactic state-of-the-art therapy for rabies was a failure in a 9-year-old boy and a 72-year-old Thai woman in Bangkok, Thailand. Postexposure therapeutic intervention with Vero cell rabies vaccine and rabies immunoglobulin was associated with development of rabies and death in both cases (Hemachudha et al. 1999).

Therapeutic Agents

The assay of active ingredients of tetracycline, trimethoprim/sulfa-methoxazole, ampicillin/clavulanate and chloroquine being offered to patients in Nigeria and Thailand showed 36.5% of samples to be substandard. Moreover, in six samples of chloroquine, there was no active ingredient left (Shakoor, Taylor & Behrens 1997). The quality of three brands of ergometerine injections imported into Zimbabwe was poor while 17 of 26 lots failed before the distribution to centres outside Harare and Bulawayo. The field specimens exhibited serious instability with a mean 17% loss in active ingredient within 4.8 months (Nazerali & Hozergeil 1998). Extemporaneously prepared ophthalmic solution of fumagillin at Columbus, Ohio lost 17-30% of initial concentration during a one-week storage at 25°C. Storage at 4°C with protection from light led to 12% loss by week four. There was no change in colour or odour with only a minor change in pH (Abdel-Rahman & Nahata 1999).

Laboratory Diagnostics

In Brazil, a 75g load of glucose in 1030 pregnant women led to 0.2 mmol/L (3.6 mgm %) higher glucose concentration at 25-31°C than at 20-24°C. The corresponding value at 5-14°C was 1.03 mmol/l (18.6 mgm %) lower than at 25-30°C (Schmidt et al. 1994). A close relationship was evident between the ambient temperature as mean dry bulb temperature and potassium concentration in blood. For each degree rise in temperature, there was a reduction in mean potassium concentration of 0.02 mmol/ L (Ulahannan, McVittie & Keenan 1998). Improperly stored or post-expiry period assay reagents for HIV antibody in a Zambian hospital had the sensitivity and specificity reduced by 11-18%. The use of pre-tested blood with such reagents was associated with at least six times higher than expected risk for HIV transmission (Consten et al. 1997).

Recommended Strategies

The majority of the issues outlined above would operate in high temperatures and poor storage conditions even without climate change. Nevertheless, future climate change would exert a further effect. The unfortunate consequences should be addressed through a multidimensional strategy:

- distinct and prominent symbols have been mandatory for inflammables, poisons and radioactive substances. It is essential to insist for distinguishing markings pointing to precise storage conditions. Internationally approved markings on vials, tablets, infusions and diagnostic kits would ensure their safe handling;
- the storage temperatures for PTD are listed individually in textbooks, pharmacopoeia, physicians' desk references and other catalogues. Consolidated lists pointing to precise storage requirements should be available in subsequent publications. This would guide warehouses, prescribers, consumers and so on about the best way of transportation and storage of PTD;
- the harmful effects of temperature, including low temperatures, humidity, air velocity, radiation and

atmospheric pressure could best be addressed by stabilisation of PTD against every adverse environmental parameter. The stabilisation of live poliovirus vaccine by the addition of pirodavir and deuterium oxide has been remarkable (Verheyden, Andrus & Rombart 2001);

- the quality of PTD would best be monitored by a one or two-step assay procedure that does not require costly equipment or trained personnel. A quick and simple test has been offered to identify artesunate, an antimalarial, in the field without many chemicals or much equipment (Green et al. 2000). Such assays would assist measurement of PTD potency and utility in many non-pharmacy distribution centres and the clinician's office setting;

- the high electricity demands for the effective air-conditioning of hospital wards and shelters (Kellermann & Todd 1996) would leave the electricity needed for refrigerators or cold storage appliances designed to store PTD in deficit. Innovative engineering modifications in cooling appliances are indicated to reduce the drop in the cooling efficacy in the event of sudden electricity failure;

- electronic loggers rather than thermometers would be ideal to monitor cold storage meant for PTD storage. The environment around PTD should be monitored using appliances that record temperature, humidity, and atmospheric pressure simultaneously.

Conclusion

The efficient weaponry of prophylactic, therapeutic and diagnostic substances is essential against impending environmental hazards for humans, animals, or plants. Stabilised formulations that resist the rigorous environment would also be of benefit. They would be ideal to resist global climate changes and the El Niño Southern Oscillation, or any accompanying natural disasters, wars, drought, storms, and flooding. Funds have been available for research to tackle greenhouse gas emissions, clean energy technologies, and threats of the environment on human health (United States Environmental Protection Agency 1998). Additional fiscal input to stabilise PTD would be cost effective to lower disease mortality and morbidity.

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Correspondence to:
Subhash C. Arya
Centre for Logistical Research and Innovation
M-122 (of part 2)
Greater Kailash-II, New Delhi, 110048
INDIA
Email: subhashji@hotmail.com

Monitoring, Enforcing and Promoting Skin Penetration Guidelines in New South Wales, 2000

Aurmporn Oberdorfer[1] and John H Wiggers[2]

School of Medical Practice and Population Health, University of Newcastle[1], & School of Medical Practice and Population Health, University of Newcastle & Hunter Centre for Health Advancement, Hunter Area Health Service, NSW[2]

The objectives were to determine the skin penetration inspection practices of local councils and public health units in New South Wales. The general manager of all local councils and public health units was contacted and asked to provide details of the senior environmental health officer responsible for overseeing the conduct of skin penetration premises inspections in their area, who were then invited to participate in a telephone survey. Ninety nine percent of local councils and all public health units completed the survey. Approximately 85.1%, 76.5% and 83.8% of councils with tattooing, beauty therapy, and hairdressing premises respectively in their area reported their council conducted inspections of such premises. All public health units reported conducting inspections of tattooing and hairdressing premises and 93.7% reported conducting inspections of beauty therapy premises. Two thirds of councils carried out skin penetration inspection annually, whereas public health units mainly carried out skin penetration inspections in response to complaints. Fifty five percent of councils and 60%-82% of public health units reported providing information concerning cleaning, disinfection and sterilisation during inspections. No single pattern concerning inspections of tattooing, beauty therapy and hairdressing premises is evident in New South Wales. Standardised monitoring and enforcing of State legislation concerning infection control from these services needs to be considered.

Key words: *Local Government; Public Health Unit; Skin Penetration Inspection; Monitoring; Promoting; Enforcing.*

The development of legislation and/or regulations and guidelines is a commonly used strategy to maintain and protect the welfare of the community (Kingston, Krumberger & Peruzzi 2000; Stockall 1999; Wan 1999; Woolf 1996). Legislation and regulation of premises that provide skin penetration services occur in a number of countries (Armstrong & Fell 2000; Guiard-Schmid et al. 2000; Loimer & Werner 1992; New South Wales Health Department 1999, 2000; State of Oregon Health Licensing Office 2001a, 2001b; State of Rhode Island and Providence Plantations Department of Health 1993; Zwerling 2001). In the USA, for example, a number of states have banned tattooing (Zwerling 2001), and others require tattooists to undertake specific education and examinations (State of Oregon Health Licensing Office 2001a, 2001b; State of Rhode Island and Providence Plantations 1993; Texas Department of Health 2000a, 2000b). Similarly, a number of states regulate body piercing or plan to do so (Zwerling 2001). However, in those states where body piercing and/or tattooing is regulated, the regulations primarily address client

eligibility (age, the influence of intoxicating substances, heart conditions, pregnancy) and operator characteristics (age, highest education level, training courses in their professions and training in infection control). Limited jurisdictions have regulations that are specifically designed to prevent the transmission of blood borne diseases, addressing issues of sanitation of premises, sterilisation of equipment, and waste disposal (Armstrong & Fell 2000; Zwerling 2001).

In the UK, professional tattooists, ear piercers, beauty therapists (electrolysis), and acupuncturists are regulated by local government by-laws (Leifer 2000; Wright 1995). However, other forms of body piercing are unregulated, and it has been argued that national infection control standards are required for them in Australia.

In New South Wales, Australia, Public Health (Skin Penetration) Regulations (1991) require skin penetration premises and operators to meet personal minimum hygiene and infection control standards in order to reduce the risk of blood borne diseases transmission. The legislation specifies registration requirements, physical standards, operator hygiene, and requirements for articles or equipment used in skin penetration procedures. Skin penetration is defined as any process including the piercing, cutting, puncturing or tearing of the skin or any other part of the body, or the administration of a dye or other substance for the purpose of colouring the skin of the body (New South Wales Department of Health 1999).

The effectiveness of legislation and regulation is dependent upon the adequacy of its enforcement, monitoring and promotion (Byleveld 1979; Gray & Scholz 1991; McKnight & Streff 1994; Reulbach & Tewksbury 1994; Stead & Lancaster 2001). For example, a study of food hygiene regulations in Iowa, USA (Moore et al. 1990) found that increasing the frequency of inspections of establishments and the promotion of compliance was effective in increasing compliance. Importantly, the study found that despite an increase in the frequency of inspections, the initiative resulted in a reduction in overall inspection time due to a reduction in inspections arising from complaints.

Despite such evidence, a recent survey of all 742 local government councils in Australia (Yeatman 1996) responsible for ensuring food hygiene found that involvement in legislated food and nutrition enforcement activities was variable. In terms of regulation and monitoring, almost all councils reported regulation of food premises, and 89% reported monitoring such premises. However, only 75% provided hygiene education programs. Larger local governments tended to be more involved in the latter activities than their small counterparts, and rural local councils were less involved than those in urban areas. Lack of resources was cited most frequently as the reason why local councils involved in food and nutrition did not achieve initiatives.

No equivalent or similar data describing the extent of enforcement of skin penetration procedures has been reported. Research among skin penetration operators suggests, however, a demand for greater council involvement, with half of the operators reporting a need for more visits from council officers, 28% indicating difficulties in accessing council officers and approximately 70% reporting inadequate skills and capacity of council officers (Oberdorfer et al. 2002).

Despite such evidence concerning both the effectiveness and need for regular enforcement and monitoring of skin penetration laws, the extent of enforcement is variable or limited in many jurisdictions. For example, in those states in the USA that have regulations, few actively undertake inspection or enforcement procedures to ensure compliance (Armstrong & Fell 2000; Whitney 1995; Zwerling 2001). Similarly in the UK, although inspections and enforcement procedures do occur in some areas, inspections are not regularly

undertaken (Leifer 2000; Wright 1995). In New South Wales, Australia, the *Public Health Act 1991* provides public health and local government environmental health officers (EHOs) with the power to enter and inspect skin penetration premises, and to take action in relation to those premises. Local councils are required to keep a register of premises that carry out skin penetration procedures in their areas, and to record details of any inspections that are carried out (New South Wales Department of Health 1999). Public health officers primarily respond to complaints and outbreaks of disease, associated with premises.

Limited data suggest that in New South Wales, despite the opportunity that legislation provides for monitoring and promoting appropriate skin penetration procedures, the extent, frequency, and quality of inspection is variable (New South Wales Department of Health 2000). For example, a review by one council in 1998, of the risk of blood borne diseases from skin penetration procedures, concluded that although local government health officers had a role in ensuring the prevention of blood borne disease transmission from such procedures, the level of risk was not sufficient to require regular inspection (Western Sector Public Health Unit 1998).

The actual extent, to which local councils undertake these roles and the characteristics of these activities, when undertaken, is unknown. This study therefore aimed to determine the extent of characteristics and inspection practices of skin penetration premises by councils and public health units in New South Wales, Australia.

Methodology

Setting and sample

All councils and Public Health Units in New South Wales, listed in a computerised telephone directory were eligible to participate in the study. The general manager or director of each council and public health unit was asked to provide details (name, contact details) of the senior environmental health officer in their organisation who was responsible for overseeing the conduct of skin penetration premises inspections in their area.

Procedures

An information letter was sent to each nominated senior environmental health officer describing the study objectives. Two weeks following this, the officer was contacted by a trained telephone interviewer and asked to participate in a telephone interview. If the officer was not available, arrangements were made to call back at a later time. Up to three contact attempts were made for each respondent. The study was conducted in October-December, 2000.

Measures

Skin penetration inspection practices

A twelve-item interview schedule was developed. The interview included items addressing:

1. The existence of tattooing, beauty therapy, and hairdressing premises in each council area and public health unit area (1 item-yes/no);

2. Where a council or public health unit reported that these specific types of premises existed in their area, they were asked:

   - whether they carried out skin penetration inspections (1 item-yes/no);

   - the number of officers involved in inspections (1 item-open);

   - whether they were involved in any other inspection activities conducted (1 item-yes/no);

   - frequency and cost of inspections (2 items-open);

- and details of their inspection procedures (6 items, 5-yes/no, 1-open).

The Human Research Ethics Committee of the University of Newcastle approved this study and survey instrument.

Data analysis

Descriptive and comparative statistical analyses concerning skin penetration premises and their practices, number and proportion of environmental health officers involved in inspection, frequency and cost of inspections, were performed using the statistical program SAS.

Results

Sample

Senior environmental health officers overseeing the conduct of skin penetration inspections in all 174 local councils were contacted, as were all 16 public health units in NSW. All but two councils (98.8%) and all public health units participated in and completed the interview.

Council/public health unit characteristics

Half of the responding councils were in rural areas and half were in urban areas. Two thirds of council areas had a population of less than 30,000 people and 20% had a population of 30,000-70,000 people. Most public health unit areas had a population of more than 100,000 (88%), and 43% of these public health unit areas had a population of more than 500,000 (Table 1).

Table 1: Characteristics of councils and PHUs

Characteristics	Council (%) n=172	PHU (%) n=16
Area		
* Rural	52.9 (91)	-
* Urban	47.1 (81)	-
Population		
* <30,000	65.1 (112)	0 (0)
* 30,000-70,000	19.2 (33)	12.5 (2)
* 70,001-120,000	5.2 (9)	6.3 (1)
* >120,000	10.5 (18)	81.2 (13)

Skin penetration premises in each local government area in NSW

As shown in Table 2, 39.6 % (67) of council officers reported that tattooing premises operated in their local government area, and 88.2% (149) and 98.8 % (167) reported that beauty therapy and hairdressing premises respectively operated in their area. All public health unit officers reported that all types of premises operated in their area.

Table 2: Percentage of skin penetration premises in responding councils

Type of premises	Premises exist in area (%)	
	Council area (n=169)	PHU area (n=16)
Tattooing	39.6 (67)	100.0 (16)
Beauty therapy	88.2 (149)	100.0 (16)
Hairdressing	98.8 (167)	100.0 (16)

Skin penetration inspection practices

Fifty-seven (85.1%) council officers with tattooists in their area reported that their council conducted inspections of such premises. One hundred and fourteen (76.5%) councils with beauty therapy premises reported conducting inspections of such premises, and one hundred and forty (83.8%) councils reported conducting inspections of hairdressing premises. All public health unit officers reported conducting inspections of tattooing and hairdressing premises and 15 (93.7%) reported conducting inspections of beauty therapy premises.

Number of environmental health officers involved in inspection

One hundred and ten (78.5%) councils and ten public health units (62.5%) reported no more than two officers being involved in the conduct of skin penetration inspections (Table 3). On average, each environmental health officer from a council had the responsibility of inspecting an average of 49.8 hairdressing premises, 21.8 beauty therapy premises and 1.5 tattooing premises.

Table 3: The number of environmental health officers involved in carrying out skin penetration inspections among council and public health areas in which inspections are conducted

Number of EHOs reported working as skin penetration inspectors	% (n)	
	Council area (n=140)	PHU area (n=16)
1	46.4 (65)	25 (4)
2	32.1 (45)	37.5 (6)
3	10.7 (15)	25 (4)
4 to 5	6.5 (9)	12.5 (2)
6 to 9	4.3 (6)	0

Involvement in other inspection activities

Almost all environmental health officers from councils (99.6%) and public health units (93.1%) who conducted skin penetration inspections reported being involved in other inspection activities conducted by their organisation.

Frequency and cost of skin penetration inspections

Details of the infection control policies and practices of councils and public health units are shown in Table 4. All councils carried out both routine and complaint inspections whereas public health units mainly carried out inspections for all three types of skin penetration premises in response to complaints. Six public health units undertook regular inspections of tattooing premises, but none carried out regular inspections of beauty therapy or hairdressing premises.

Two thirds of councils reported the conduct of routine inspections on an annual basis, and one fifth reported conducting inspections every 6 months. All public health units and approximately 10% of local councils reported that they did not charge a fee for inspections. Of those councils that charged an inspection fee, the cost varied between $AU 50 (~$US 25) to $AU 350 (~$US 175), with half charging between $AU 50 (~$US 25) to $AU 100 (~$US 50).

Inspection procedures

The majority of both councils (73%) and public health units (86%) reported that they did not notify premises before conducting inspections (Table 5). Environmental health

Table 4: Inspection practices of councils/ PHUs

Inspection/Practices	Tattooing % (*n*)		Beauty therapy % (*n*)		Hairdressing % (*n*)	
	Council *n*=57	PHU *n*=16	Council *n*=114	PHU *n* =15	Council *n*=140	PHU *n*=16
1. Carry out						
regular	10.5(6)	0	9.6(11)	0	15.0(21)	0
complaints	8.8(5)	62.5(10)	11.4(13)	80(12)	12.0(17)	75.0(12)
both	78.9(45)	37.5(6)	78.1(89)	20(3)	71.4(100)	25.0(4)
don't know/not sure	1.8(1)	0	0.9(1)	0	1.4(2)	0
2. Frequency						
every 6 months and less	23.6(12)	0	21.0(111)	0	22.3(27)	0
>every 6 months-every 1 year	66.7(34)	66.7(4)	73.0(73)	33.3(1)	70.2(85)	0
every 2 years	2.0(1)	16.7(1)	4.0(4)	33.3(1)	5.0(6)	25.0(1)
Don't know/not sure	7.8(4)	16.7(1)	2.0(2)	33.3(1)	2.5(3)	75.0(3)
3. Fee Cost						
none	7.0(4)	100(16)	10.5(12)	100(15)	15.0(21)	100(16)
<50$	29.8(17)	0	30.7(35)	0	31.5(44)	0
50-100 $	43.9(25)	0	47.4(54)	0	43.5(61)	0
more than 100 $	21.0(11)	0	9.7(11)	0	6.9(11)	0
Don't know/not sure	1.8(1)	0	1.8(2)	0	2.1(3)	025.0(1)

Table 5: Inspection procedures of councils/ PHUs

Inspection/Practices	Tattooing % (*n*)		Beauty therapy % (*n*)		Hairdressing % (*n*)	
	Council *n*=57	PHU *n*=16	Council *n*=114	PHU *n* =15	Council *n*=140	PHU *n*=16
1. Notification						
yes, always	8.8(5)	6.3(1)	8.0(9)	6.7(1)	7.9(11)	6.3(1)
yes, sometimes	1.8(1)	12.5(2)	4.4(5)	20(3)	5.0(7)	18.8(3)
no	86.0(49)	81.3(13)	85.8(97)	73.3(11)	85.0(119)	75.0(12)
don't know	3.5(2)	0	1.8(2)	0	2.1(3)	0
2. Inspection time by EHOs (Mean & *SD*)	26.3 minutes (*SD*=9.5)	41.4 minutes (*SD*=17.3)	22.7 minutes (*SD*=13.1)	29.7 minutes (*SD*=9.6)	21.3 minutes (*SD*=8.9)	29.0 minutes (SD=8.6)
	Council* *n*=99	PHU* *n*=27	Council* *n*=203	PHU* *n*=27	Council* *n*=245	PHU* *n*=28
3. Provision of						
cleaning info.	57.6(57)	78.6(22)	58.1(118)	77.8(21)	55.1(135)	78.6(22)
disinfect info.	57.1(56)	75.0(21)	54.7(111)	70.4(19)	53.9(132)	78.6(22)
sterilisation info.	54.5(54)	82.1(23)	50.2(102)	66.7(18)	46.9(115)	60.7(17)
sterilisation demonstration	4.0(4)	21.4(6)	2.5(5)	3.7(1)	2.0(5)	7.1(2)
training course referred	4.0(4)	7.1(2)	3.0(6)	7.4(1)	4.1(10)	21.4(6)
4. Checklist Using	62.6(62)	75.0(21)	67.5(137)	74.1(20)	65.7(161)	71.4(20)

** Responses were from the environmental health officers involved in inspections.*

officers from councils reported spending between 21.3 minutes (*SD*=9.0, *SE*=0.6) and 26.3 minutes (*SD*=9.5, *SE*=1.0) where as public health units reported spending between 29.0 minutes (*SD*=8.7, *SE*=1.9) and 41.4 minutes (*SD*=17.3, *SE*=3.8) for each inspection. Tattooists received more inspection time than either hairdressers or beauty therapists. No data were obtained to describe what differences exist in inspection practices between service types.

Approximately 55% of councils reported that they provided information concerning cleaning, disinfection and sterilisation during inspections, whereas up to 82% of public health units reported that they provided such information (Table 5). Few councils (4%) and public health units (21%) demonstrated sterilisation procedures or referred premises to training courses.

Approximately two thirds of councils and approximately three-quarters of public health units reported that they used standardised checklists when conducting inspections (Table 5). Considerable variability existed in the source of these checklists. One third to one half of councils used checklists developed by their own organisation. Among those councils who reported that they used checklists when carrying out inspections, almost all reported that they always/often used them. Lower proportions of public health units reported that they always/often used checklists during inspections.

Discussion

No single pattern concerning the inspection of tattooing, beauty therapy and hairdressing premises is evident across councils or public health units in New South Wales, Australia. This is to be expected given that inspections are supported but not mandated by law and the infection control role of local councils is unclear across a number of legislative instruments (New South Wales Department of Health 2000). As a consequence, up to 25% of councils reported not inspecting such premises. The risk to public health of such non-inspections is of concern, and is enhanced by the previously reported

findings that a considerable variety of skin penetration services are conducted by these premises types. In a survey of skin penetration premises, most of the hairdressers (72%) provided only hairdressing services, however, 14% of them also provided beauty therapy, and body piercing services. Approximately 30% of beauty therapy premises also provided body piercing, and 4% provided tattooing services (Oberdorfer et al. 2002).

No previous studies have described the extent and nature of enforcement, monitoring and promotion activity of either local government or public health officers concerning the prevention of blood borne diseases in skin penetration premises. This study therefore provides valuable data for which further research and policy development can be based. Previous studies of owners of skin penetration premises suggest that councils should conduct inspections more frequently and adopt more of an educational and skill development focus for their inspection processes (Oberdorfer et al. 2002). Our findings support this view since between 15% and 25% of councils did not conduct inspections, only 20% conducted six-monthly inspections, only slightly more than half provided educational information during such inspections, and inspections were no longer than 26 minutes.

Most councils reported no more than two officers involved in the conduct of inspections. Furthermore, almost all officers from both councils and public health units were involved in other inspection activities in their organisation (e.g. food, building inspections). Although flexibility in organisational management of inspection tasks is important in the context of resource availability, effectiveness as well as efficiency of inspections also needs to be considered when allocating resources in this manner. Previous research indicates that council officers perceive that skin penetration inspections receive a low priority in resource allocation relative to other inspection tasks (Oberdorfer et al. 2002). This appears to occur most often where an officer is responsible for a number of inspection functions. Interestingly, the role and responsibilities of environmental health officers from both organisations was not clear.

Approximately 30% of operators reported in a previous study (Oberdorfer et al. 2002) that inspection fees were too expensive. The current study found that approximately 50% of councils charged inspection fees that varied between $AU 50 and $AU 100. In the US (State of Oregon Health Licensing Office 2001, 2001; State of Rhode Island and Providence Plantations 1993), inspection fees are much higher, with costs for initial and renewal licences being $US 250 (State of Oregon Health Licensing Office 2001; Zwerling 2001).

One of our previous studies (Oberdorfer et al. 2002) showed that 30% of operators reported difficulties in being able to contact or obtain information from environmental health officers, and 72% reported that such officers lacked specific skill/knowledge relating to skin penetration issues. The present study supported this, as only half of councils reported providing educational information to premises during inspections, and sterilisation procedures were rarely demonstrated to tattooing and beauty therapy premises. The extent to which environmental health officers lack knowledge, as found in other studies (Clark 1999; Leitch, Blair & McDowell 2001; MacIntyre & Nolan 1994), or other factors account for this is unknown and worthy of further research.

Evidence concerning the effectiveness of public health legislation (Byleveld 1979; Gray & Scholz 1991; McKnight & Streff 1994; Reulbach & Tewksbury 1994; Stead & Lancaster 2001) suggests that the mere existence of legislation is not sufficient to ensure compliance. Interventions that educate retailers about legislative requirements can improve compliance, and the most successful interventions utilise a

multi-strategic approach, including personal visits and community support (Stead & Lancaster 2001). Inspections of premises can be effective in changing retailer behaviour, however, the evidence suggests a reduced effectiveness if inspection occurs less than 4-6 times a year. The challenge for public health policy makers is to translate this evidence into feasible enforcement, monitoring, and promotion protocols that are within the resource capacity of enforcement agencies at the state and local level to implement.

A number of factors should be considered when interpreting the results of this study. First, to the best of our knowledge this study is the first reported large-scale study of agencies concerned with the monitoring and enforcement of skin penetration regulations. All agencies that are responsible for inspection of premises that undertake skin penetrations in the largest state of australia were surveyed. Second, the very high consent rates indicated that the response bias is minimal and results are generalisable across the state. The extent to which the findings can be generalised more broadly is unknown given differences in legislative requirements between states. Finally, the use of self-report data is subject to inaccuracies due to recall, and other biases such as acquiescent response. In the event that this occurred, it is likely that the results over-estimate the prevalence of activities.

In conclusion, no single pattern concerning inspections of tattooing, beauty therapy and hairdressing premises is evident in New South Wales, Australia. Standardised monitoring and enforcing of State legislation concerning infection control from these services needs to be considered.

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Aurmporn (Peninnah) Oberdorfer
Hunter Centre for Health Advancement
Locked Bag 10
Wallsend, 2287, NSW
AUSTRALIA
poberdorfer@hunter.health.nsw.gov.au

Correspondence to John Wiggers
John Wiggers
Hunter Centre for Health Advancement
Locked Bag 10
Wallsend, 2287, NSW
AUSTRALIA
jwiggers@hunter.health.nsw.gov.au

Norwalk-Like Virus Outbreak at Children's Camp: Outbreak Investigation and Control Issues

Catherine Harper, Brad Adams, Noel Cowell, Andrew Langley

Central Public Health Unit Network, Queensland Health

An outbreak of Norwalk-like virus (NLV) spread rapidly among three consecutive groups of school children at a recreational camp on the Sunshine Coast. This paper highlights the rapid and efficient transmission of NLV. The outbreak continued despite disinfection of the premises and chlorination of water supplies that were found not to meet NHMRC Australian Drinking Water Guidelines. This underscores the importance of adequate cleaning of environmental surfaces and the appropriate use of handwashing facilities at recreational camps. The specific communication processes, and the need for timely samples associated with the investigation of outbreaks involving children are also reported. Checklists for environmental health assessment of recreation camps and guidelines for investigation of outbreaks involving children have been developed by the Public Health Unit, Queensland Health.

Key words: *Norwalk-like virus; Outbreak Control*

The Outbreak

In June 2001, the Central Public Health Unit Network was notified of an outbreak of gastroenteritis at a school camp on the Sunshine Coast. Children aged 9 to 14 years, from four schools, attended the camp in three groups over a two-week period in June 2001. Table 1 provides a breakdown of the school groups attending the camp during the 4th and 18th June, and basic information about the disease. Group 1 attended camp on 4-6th June; group 2 joined group 1 at camp for lunch and joint activities on 6th June, and stayed at camp until 8th June. Group 3 attended camp on 12-15th June. Within 38 hours of arrival, children and teachers in group 1 became ill with vomiting, diarrhoea, nausea and fever, with a median incubation period of 56 hours (Table 1). Group 2 and group 3 attendees started becoming ill with the same symptoms within 7 hours and 34 hours of arrival respectively. A further 49 cases were identified as possible secondary cases in family contacts.

Table 1: Main outbreak features, by groups

	Group 1	Group 2	Group 3	Total
Attendance dates (2001)	4-6th June	6-8th June	12-15th June	
Attendees (n)	44	96	99	239
Attack rate (%)	64	71	47	60
Median incubation period (inter-quartile range: hrs)*	56 (53-58)	34 (28-37)	64 (59-77)	59 (41-67)
Median duration of illness (inter-quartile range: hrs)	48 (24-72)	51 (33-72)	48 (30-72)	48 (30-72)
Symptoms (%)				
- vomiting	82	91	70	83
- diarrhoea	54	25	43	36

** based upon time of arrival of group at camp*

Microbiological investigation

Norwalk-like virus is highly infectious and causes a usually mild and self-limiting gastroenteritis. Known routes of transmission include person-to-person contact, ingestion of contaminated food or water, fomites, aerosols and exposure to contaminated environments (Marshall & Wright 1992).

Five primary cases and four secondary cases provided faecal specimens, all from the second group to attend camp except one

primary case from group one. Four primary cases provided vomitus specimens, two from each of group two and three. All specimens were tested for bacterial enteric pathogens and reverse transcriptase polymerase chain reaction (RT-PCR) for NLV. RT-PCR for NLV was positive for one of the vomitus specimens from group two. Two samples of leftover food were available for testing and both were negative for bacterial enteric pathogen testing.

To maximise timely sample collection, vomitus samples were obtained from children while at camp. Consent to obtain such samples was interpreted as included in the parental/care givers consent for the child to attend the camp.

Epidemiological investigation

A cohort study was undertaken with all students and teachers attending the camp using a Public Health Services standardised questionnaire customised to include foods known to be served at the camp, and camp activities potentially associated with food or water-borne disease, as well as symptom history.

In order to collect the illness and food history rapidly from children, a number of strategies were implemented. Questionnaires were forwarded to parents/guardians as part of a take home package from the school principal. The response rates for the schools ranged from 60% to 95%, within 14 days of dissemination of the questionnaire.

Information was also obtained directly from children in the classroom setting. This enabled rapid notification of illness and food history to the Public Health Unit. However, the information had to be interpreted cautiously due to incomplete and/or incorrect recording of information by children and some key information, such as illness upon arrival at camp, required verification with parents/care givers.

The exposure distribution of 205 different foods and liquids was analysed, including exposure to dam water while swimming and unpasteurised milk. The epidemiological evidence did not provide support for an association between disease occurrence and consumption of specific investigated foods, liquids or activities. Such a finding may occur when there is a highly infectious agent presenting multiple exposure pathways or where the pathways are not adequately characterised by a questionnaire (Weber, Menajovsky, & Wenzel 2001)

As there was no specific culpable activity(ies) identified other than camp attendance, the incubation period was estimated as the average time of arrival at camp of the group to self-reported symptom appearance.

Outbreak control

Inspection of the camp revealed no substantial problems with food storage or preparation, although the camp did not have a food safety program in place. Handwashing facilities for toilets consisted of cold running water with liquid soap but no paper towels or other means of effective hand drying. After the first cases of illness, and before an Environmental Health Officer intervened, a single bucket of water was provided for communal hand washing prior to consuming meals.

Untreated rainwater was the only source of drinking water supplied at the camp. The water used for showering was untreated dam water. Six of eight samples from rain water tap outlets and two of two dam water samples taken on 8th June did not comply with Australian Drinking Water Guidelines (ADWG) (National Health & Medical Research Council [NHMRC] 1996) due to high coliform and *E.coli* counts. All rainwater tanks were then directed to be chlorinated, and the premises disinfected, using a hospital grade disinfectant, prior to the arrival at camp of group 3. Bottled municipal water was supplied for drinking to group 3. On 12th June, five samples were taken from rainwater tap outlets and none complied with the ADWG, having similar coliform and *E.coli* counts as before

chlorination of the tanks, probably due to inadequate chlorination. One of two dam water samples taken on 12th June did not comply with the ADWG. All rainwater tanks were then superchlorinated, to approximately 10ppm free chlorine, and the camp was again cleaned using a hospital grade disinfectant.

The investigation indicated the possible importation by one child in group 1 of the gastrointestinal agent into the camp. This child had a single episode of diarrhoea immediately prior to camp but no other or subsequent symptoms. During the course of this investigation and the ensuing media exposure the Public Health Unit was notified of a possible six children who had attended the camp in May 2001 and who had became ill with gastrointestinal symptoms, principally vomiting. Together, these data indicate that the gastrointestinal agent was probably not imported into the camp by the ill child in group 1.

Discussion

School assessment of environmental health of recreation camps

The rapid transmission underscores the imperative of adequately cleaning environmental surfaces and the availability and use of adequate hand-washing facilities at recreational camps. This outbreak also highlights the importance that potable water is supplied to recreational camps. As a result of this investigation a checklist has been developed to enable camp providers to assess the environmental health of proposed campsites. Two critical interventions that can readily be undertaken are: (1) prohibit children with gastrointestinal symptoms from attending camp (and, if possible rapidly remove/isolate those who become sick); and (2) ensure good handwashing facilities (soap, running water and individual hand drying facilities) are available.

The definitive source of this outbreak was not able to be determined, despite extensive microbiological and epidemiological investigation. The investigation found that water supplies for the camp did not meet the ADWG. This outbreak spread rapidly through camp attendees, particularly following interaction between groups 1 and 2. This rapid transmission underscores the importance of cleaning environmental surfaces and the use of hand-washing facilities at recreational camps. Environmental surfaces can be adequately cleaned by comprehensive physical cleaning using a suitable disinfectant followed by thorough drying of the area. Superchlorination of the water tanks and substantial further disinfection of all environmental surfaces within the camp appeared to arrest the transmission of outbreak to subsequent camp attendees.

The detection of NLV in a case vomitus sample indicated a likely agent. Water and food samples were not analysed for viral content on scientific advice. Outbreaks due to NLVs have been reported in various settings, including recreation camps, hospitals, nursing homes, restaurants and schools (Fankhauser et al. 1998). To circumvent known obstacles to laboratory diagnosis of NLV, clinical and epidemiological criteria were developed that correlate with the presence of NLV in outbreaks of acute gastroenteritis (Kaplan et al. 1982). These criteria closely match the characteristics of the reported outbreak, providing further evidence in support of NLV as the outbreak cause.

NLVs have several features that facilitate their transmission during outbreaks and serial or protracted outbreaks. These are: a low infectious dose (<100 viral particles) easily enabling spread by environmental contamination, person-to-person transmission, fomites and droplets; relative resistance to chlorine and temperature extremes (survival occurs within the range 0°C to 60°C); and the community's limited cross-protective immunity because of the diversity of strains and lack of long term immunity (Centers for Disease Control and Prevention 2001). Serial outbreaks have

occurred on the same cruise ship over more than 12 cruises (Centers for Disease Control and Prevention 2001).

Outbreak investigation in children

This outbreak primarily occurred in young children, which posed a number of specific challenges. As a result of this investigation a checklist has been developed to assist Public Health Units in the specific communication, consent and information retrieval processes required in the investigation of outbreaks in children.

Direct questioning of children results in more timely information, but caution must be used in the interpretation of the information due to both incorrect and incomplete recall. The size of this potential source of error increases in younger children and, if time permits, information may be more accurately collected from parents/care givers. The age of the child should be considered when developing the questionnaires, especially if information must be collected from young children. For young children, standard questionnaires should be extremely simple. We found that numerous young children were unable to answer questions relating to onset, nature and duration of symptoms sufficiently accurately to enable good epidemiological interpretation.

Obtaining faecal or vomitus samples from children requires consideration of the prior approval provided by parents/care givers. In order to increase the potential for identification of the outbreak cause, samples were taken from children at camp. School management supplied consent in loco parentis, as consent was unable to be obtained from parents/care givers in the required timeframe. Parents/care givers were advised of results.

"Incubation period" is one of the standard epidemiological measures used in the investigation of an outbreak. When planning clinical and environmental investigations and planning management while awaiting laboratory results (or where laboratory results do not allow the identification of agent or source), the incubation time is a useful parameter for hypothesising the source and/or agent. This measure is particularly important in the application of the established criteria for the presence of NLV in outbreak of acute gastroenteritis (Kaplan et al. 1982). Because no specific exposure was associated with this outbreak, the incubation period was calculated from the average time of arrival at camp of the group to self-reported symptom appearance. Thus the incubation time does not specifically relate to duration between the onset of disease and the time of a specific exposure. The estimation of incubation time, using this methodology, is often required when the outbreak is due in part, or totally, to ongoing transmission from indeterminate exposures. A review of the standard textbooks for outbreak investigation has not revealed a better method for estimating incubation period in these situations. This is particularly so for a highly infectious agent such as NLV where widespread opportunities for exposure may be occurring.

Conclusion

Most schools include attendance at recreation camps as part of the learning experience for children. Unfortunately, outbreaks of food or water-borne disease do occur in recreation camps. To assist in the prevention of such outbreaks, a checklist has been developed to enable camp providers to assess the environmental health of proposed campsites. A further checklist has been developed to assist in the specific communication, consent and information retrieval processors required in the investigation of outbreaks involving children. Both these checklists are available from Central Public Health Unit Network – Sunshine Coast. Two critical interventions that can readily be undertaken are: (1) prohibit children with gastrointestinal symptoms from attending camp (and, if possible, rapidly remove/isolate those who become sick); and (2) ensure good handwashing facilities are available and their use encouraged.

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Correspondence to:
Catherine Harper
Central Public Health Unit Network – Brisbane Northside
Public Health Services
Queensland Health
PO Box 1507
Fortitude Valley, Qld, 4006
AUSTRALIA
Email Catherine_Harper@health.qld.gov.au

Controlling Odours the Sustainable Way

Mitchell Laginestra

GHD, Sydney

Malodours are a major issue in the eyes of the community. Current legislation requires that odours must not be detected outside the boundary of these facilities. As a result, industry is under considerable pressure to comply and find effective means of control. In developing a strategy, a review of source control versus "end of pipe" control should be undertaken. A complex mixture of gaseous contaminants causes odour, but control methods do not have to be complex. For end of pipe solutions, bulk media biofiltration provides a cost effective, high performance means of reducing contaminants including hydrogen sulphide (H_2S), ammonia and volatile organic compounds. Their use has been demonstrated in a wide variety of applications. The systems are very simple, easy to operate and involve a natural process. In addition, this type of system represents the lowest environmental impact of all odour control options, meeting cleaner production principles, and includes negation of chemical usage, and minimal use of natural resources. Through application of appropriate design practices and environmental principles (including use of recycled materials, passive ventilation, and perhaps solar power for extraction of foul air from the source) the bulk media biofiltration option for odour control approaches real sustainability.

Key Words: *Biofiltration; Odour Control; Sustainable Development*

Malodours are a major issue in the eyes of the community. Sewerage mains, transfer and treatment systems, and industrial facilities (such as animal processing, food and beverage manufacture) are a very common and potentially significant source of odour. Current legislation requires that odours must not be detected outside the boundary of these facilities. As a result, industry is under considerable pressure to comply and find effective means of control.

There are a number of odour control alternatives available. However, there is considered to be no such thing as a blanket or general solution, which will address all odorous situations. Each treatment method has advantages and disadvantages specific for the situation. The final solution is what is right for the operator and some of the aspects which need to be considered are volume of foul air generated, type of contaminant gases, concentration, operating costs, seasonal variations, existing environment, available area, and possible impact on other processes (such as downstream treatment works). If one considers that odour is only a symptom of a "disease", then its control can be facilitated in two ways: either attack the cause, or if that is not applicable, treat the symptoms. These approaches can be considered as source control or "end of pipe" solutions.

Alternative Odour Control Systems

Source control of odours can be achieved through preventative design or chemical addition. It is most applicable to municipal situations (sewerage systems) where odour (and corrosion) typically occurs with the onset of septicity within the sewers (development of low dissolved oxygen (DO), followed by anaerobic microbial activity and a series of reduction reactions resulting in the formation of dissolved sulphides and then gaseous hydrogen sulphide). There is no general rule to controlling septicity, but there are strategic approaches that can be undertaken including:

- Giving the microbes what they want (oxygen), through aeration/oxygen injection or nitrate addition;

- Precipitation of sulphides, through metal salt addition;

- Oxidation of odorous compounds through addition of hydrogen peroxide or hypochlorite chemicals (Laginestra & Williams 1997).

The success of the above approach will depend on size and arrangement of sewers as well as concentrations of contaminants. If you cannot prevent the odour, then there is no alternative but to remove it, that is, ventilate the sewer or the odorous process unit/facility and treat the off-gas. This is the "end of pipe" approach to odour control, where the foul air from the system is vented through an odour control unit.

End of pipe odour control systems consist of three main components:

- A collection system for the foul air (a cover on the odour source)

- A foul air extraction system (fan) that will ventilate from the cover through the odour control unit, and

- The odour treatment system, of which there are a number of options:

  – Absorption - involving spraying of fine water droplets over air stream to achieve absorption of odorous contaminants into the liquid phase;

  – Oxidation (chemical wet scrubbing) - transfer of chemical contaminants from the gas phase into the scrubber liquid, with subsequent chemical oxidation. The most common scrubbing system is the recirculating liquid packed tower. The liquid in the sump of the tower is recirculated with a small portion continuously bled off and discarded. Typical oxidants include sodium hypochlorite, chlorine, hydrogen peroxide, potassium permanganate (WEF 1995).

  – Adsorption of odorous compounds - typically using activated carbon (although alumina and silica gel may be used). The carbonaceous material used can be derived from coal, wood or coconut shells and each differs in pore structure; the choice will be dependent on the foul air characteristics.

  – Thermal Oxidation - destruction of odorous and volatile compounds at high temperature. This is typically used to control industrial emissions. Speed and efficiency of the process increase with temperature and the level of hydrocarbons in the odorous stream.

  – Biological degradation - after transfer of odorous compounds from the gas phase to the liquid phase, biological degradation destroys the odorous molecules. Alternatives include application of activated sludge systems, bioscrubbers (trickling filters with counter current liquid and airflow) and bulk media biofilters (also called soil beds).

The Ideal System

As stated above, there is no common solution/panacea to all malodorous situations. The ideal system would be one that involves the following aspects:

- Simple to operate

- Low capital cost
- Minimal operating costs
- Reduces all odorous gases
- Runs by itself with virtually no operational/maintenance requirements.

Meeting the above is a very tall order, particularly regarding the latter two criteria. However, there is an option that comes very close – bulk media biofiltration, or soil beds.

Contaminant gases in odorous air streams may be categorised into two broad categories:

- Reactive inorganic compounds (hydorgen sulphide H_2S, ammonia NH_3, oxidised nitrogen forms NO_x, sulphur dioxide SO_2);
- Degradable volatile organic compounds, which may be classified further, depending on the speed of degradation achievable:
  - Rapidly degradable (short chain compounds such as alcohols, ketones, organic acids);
  - Medium (more complex organic compounds, such as hydrocarbons and phenols);
  - Slowly (halogenated and polyaromatic compounds) (Bohn 1992).

Bulk media biofilters, basically control odours through biological degradation of the compounds, and to achieve this, the microbes assimilate and adapt to the contaminants that need to be treated. Consequently, the biological system is capable of treating a wide array of contaminants, which is important to note, given that odorous air streams rarely consist of just a single contaminant. Thermal oxidation will cater for all contaminants, but involves very high operating costs associated with ongoing fuel requirements. Carbon adsorption is also good at catering for numerous contaminants, but requires regular regeneration and dehumidification. Chemical scrubbing is specific to certain contaminants such as H_2S, and is typically associated with high annual costs for chemical dosing. On the other hand, the biological system only requires water irrigation (to ensure the viability of the microbes). In addition, in terms of operating the system, only 4 – 7 drives/control instruments (fan, flow & pressure monitoring) are required, compared to 40 – 50 for chemical scrubbing (fans, flow monitoring, pump recirculation, chemical dosing etc). In terms of capital costs, soil beds are typically lower than other options also, but their main advantage is their low operating cost (a fraction of other operating systems).

Consequently, it may be seen that biofiltration comes closest in meeting an ideal system based on the above criteria. It should, however, be noted that soil beds systems typically involve larger areas than other systems, since it is dependent on detention of the contaminants within the media to ensure degradation. Thus, if space is restrictive at the site, then bulk media biofilters may not be ideal since they will not fit or higher cost options, such as enclosure for a box arrangement (which may be placed on the roof of the building or comprise some landscaped garden feature) may be considered.

Bulk Media Biofilters

The bulk media or soil bed odour control system comprises the following components:

- a collection system for the foul air, i.e., a cover on the odour source;
- a foul air extraction system (fan) that will ventilate from the cover through the odour control unit (note that these two items are common to all odour control systems);
- a bed of bulk media and ancillaries incorporating irrigation and drainage

– air distribution system/plenum

– soil/media mix which supports the viable microbial population

– irrigation system (the viability of the microbes depends on moisture)

– drainage system (excess water must be allowed to freely drain from the bed to ensure avoidance of development of anaerobic conditions).

The media typically comprises a bulk mixture of various materials including compost, bark, peat, wood chips, soil, dewatered sewage sludge, shells, sand, or synthetic substrates. The functional mechanisms are as follows:

- presence of a microbiological population which is supported by the bulk medium;
- diffusion/absorption of odorous compounds into the (moist) biologically active layer;
- possible adsorption of some contaminants by the bulk medium (which provides adequate retention time for destruction);
- degradation of pollutants by aerobic microorganisms.

Biofilters have been used for odour control in many applications including:

- sewage treatment works and sewerage systems odour control;
- animal rendering processes;
- piggeries and other intensive rural industries;
- industrial wastewater treatment works odour and volatile organic compound (VOC) reduction;
- VOC removal from chemical manufacturing plants and fuel storage tanks (Bohn 1991; Bohn & Bohn, 1988; Leson & Winer 1991).

The removal of gaseous pollutants by soil bed facilities has been reported as ranging from 90% to over 99%. The differences reflect the design of the system and the rapidity of degradation of the odorous compounds. Some examples are summarised in Table 1.

Table 1: Examples of soil bed odour control systems

Application	Area of Soil Bed (m^2)	Soil Mix	Detention Time (mins)	Reported Performance
STW Inlet works, NSW	50	bark, soil, peat, manure	4.5	99 % OU removal
STW Process, NSW	540	bark, soil, peat, manure	2	99 % (avg. OU removal)
STW Inlet works, USA	280	Wood chips	1.1	99 % (H_2S) 98 % (acetone)
Rising main, NSW	64	loam, soil	7	98.7 - 99.9 % (H_2S)
Manakau STW, NZ	7000	scoria, soil	1.5	n/a
Industrial site, NSW	45	compost	8.5	n/a (treating hydrocarbons)
Animal rendering, USA, Europe	various	various	0.5 - 1	> 99 % odour removal
Chemical Manufacture, USA	n/a	n/a	n/a	90 % (propane)

(Bohn & Bohn 1988; Laginestra et al. 1995; Wong Velez & Greer 2000).
Notes: 1. STW = sewage treatment works
2. n/a = not available
3. OU = odour unit

Case Study: Sewage Treatment Plant

A case study of a Sewage Treatment Plant (STP), treating around 5 ML/d average dry weather flow (ADWF) has been considered. Sulphides are present in the sewage as it arrives at the STW, as the retention times within the reticulation system are lengthy.

Although sulphides are considered to be the main odour problem, other contaminants are also present.

As the first air release point, the inlet works (and screens and grit storage) are typically the high odour areas resulting from release of H_2S with flow turbulence. If we extract air from this source at around 5 air changes per hour for the inlet receival and screenings areas, an appropriate air extraction flow rate is estimated at 0.6 m^3/s. Chemical scrubbing is typically most applicable for high volumetric through put. Thermal destruction methods are considered high operating cost and generally unsuited due to the high moisture in the air stream. Both these cases are typically high capital and technically complex situations for the small STP. While bioscrubbing is a useful alternative, odour reduction is not typically as great as the other options, and in this particular case, the inlet works is relatively remote from the activated sludge system.

Consequently, the main viable options for the system are considered to be:

- Chemical dosing source control to prevent the release of sulphides from the liquid phase (iron salts);
- Activated carbon adsorption - covering inlet works and treating ventilated air; and
- Biological filtration (soil bed) - covering inlet works and treating ventilated air.

Source control alternative

Most chemical systems, whether they are a bactericide, nitrate compound or precipitation chemical, involve a technically similar installation (bulk liquid tank, FRP or other, variable speed dosing pumps with flow pacing). Ferrous and ferric chloride based chemicals (such as Orica's Odorlock) are known to be effective in binding up sulphides over a wide pH range, and result in reduced odours at the air release point. Consequently, this method has been adopted for the comparison. Based on a concentration of 5 mg/L sulphides in the sewage, and dosage rates of 65 - 70 mg/L, it is estimated that about 140 tonnes per year of ferrous chloride solution would be required. In addition to chemicals, annual costs involve power associated with dosing pumps.

End of pipe odour control alternatives

An activated carbon system typically consists of an air extraction system, stainless steel container, comprising plenum and activated carbon bed through which the foul air is passed. The carbon does require regeneration or replacement once the pores are completely saturated. For wastewater situations this is likely to be every 1 – 2 years depending on a variety of factors, including air moisture, temperature, and concentration of contaminants. Current costs of carbon range from $6 - 18/kg depending on the grade and quantity used. Annual costs are based on replenishment of carbon and power for air extraction fans.

The soil bed bulk media system consists of media/soil mix bed (1 m deep, over a gravel plenum) contained within concrete retaining walls, with surface spray irrigation system (reclaimed effluent) and drainage system with underdrainage being returned to the inlet works.

Table 2: A comparison of features and costs of three options

Odour Control Option	Adopted parameters	Estimated capital Costs, $'000	Annual Costs, $'000	Nett Present Cost 5 years, 7%	Nett Present Cost 10 years, 7%	Considered effectiveness, other notes
FeCl2 dosing	65 mg/L average dose rate in sewage	$55	19.6	$132	$189	Reasonable (may be other odorous gases besides H_2S). Protects sewer from corrosion.
Activated carbon	Mass of 815 kg carbon	$120	8.3	$142	$176	Good – effectively reduces H_2S and range of organic compounds.
Soil Bed biofiltration	Bed of 80 m3 (soil mix)	$95	5.9	$109	$128	Good – effectively reduces H_2S and range of organic compounds.

Note: Both the soil bed and activated carbon systems include covers of the inlet works to collect the foul air.

A comparison of features and costs of the three considered options are considered in Table 2.

Based on the Table 2, the soil bed system has significant cost advantages.

Advantages of Bulk Media Biofilters

Based on the above considerations including the performance of example systems presented, and the case study, bulk media biofilters (soil beds) are considered to have significant advantages for odour control, including the following:

- they involve low overall costs;
- they consistently achieve a very high odour removal;
- they involve very low maintenance requirements - with minimal instrumentation and control required;
- due to the above they are simple to operate;
- soil beds are relatively unobtrusive, typically involving a low lying grassed area;
- air from the soil bed is discharged at low velocity over a wide area, which subsequently enhances dissipation and dilution of the treated air at ground level. Stack discharges while discharging at high velocity, rely on high wind conditions to disperse the treated air;
- they do not produce a visible plume;
- they are generally resistant to shock loads and continue to perform at high efficiency even during periods of peak odours;
- they treat a wide variety of gaseous contaminants.

Another Opportunity: Landfills

While I have considered one common municipal application (and presented several other applications in Table 1), I have also considered another potential municipal application - the waste disposal depot (landfill site). This has been reviewed since there is currently little work being undertaken in this direction in Australia (mainly overseas), and there is regarded to be significant potential for bulk media biofiltration for this application - not only to control odours, but also to reduce greenhouse gases. It is also presents an alternative way of looking at the mechanical extraction aspect, since, although technically feasible, might be difficult at some sites

In Australia there are a large number of landfills, which do not incorporate control measures for landfill gas. These include many old/former landfill sites, rural landfill sites, inert solid waste landfill sites and non-putrescible solid waste landfill sites. Consequently landfill gas at these sites is emitted uncontrolled into the environment. Due to the degraded state of waste at old/former landfills, or the small size of the rural landfills, or low organic content of non-putrescible solid waste and inert waste landfills, these landfills do not usually generate large volumes of landfill gas. However, the emissions from such low gas generation landfills can be significant, through their contribution to greenhouse emissions, potentially creating off site odour nuisance, and potentially presenting health and safety hazards as a result of gas migration off site (Dever, McNeill & Laginestra 2000).

One of the primary gases of concern in landfill gas is methane. Methane typically forms a major proportion of landfill gas (45-60%), and presents a hazard in relation to explosion potential. Methane is also a significant contributor to green house gas emissions (being some 21 times the greenhouse strength of carbon dioxide). It has been reported that compost cover layers at landfills can reduce the emission of

hydrogen sulphide and other sulphur compounds such as mercaptans by significantly more than 90% (like municipal sewage, sulphur compounds are generally the primary cause of odours from landfill gas) (Muntoni & Cossu 1997). Other compounds of concern in landfill gas that are of potential concern include hydrocarbons and chlorinated hydrocarbons. Soil bed biofilters reportedly have a large potential to degrade benzene and toluene and that trichloroethylene and trichloroethane can also be degraded when in the presence of methane (Kjeldsen, Dalager & Broholm 1997).

Numerous overseas and Australian studies at existing landfill sites have confirmed that methane emissions from landfill sites can be significantly reduced by microbial methane oxidation in a soil or compost cover layer, and have demonstrated that use of a biofilter is very simple and its operation effective, cheap, and safe (Dever, McNeill & Laginestra 2000). At low gas generation landfill sites where energy recovery is not a viable option, the application of biofiltration would appear to be an appropriate and suitable option to treat landfill gas emissions and therefore reduce environmental impacts. Based on the research undertaken, there are a number of possible approaches to utilising biofiltration to treat landfill gas emissions at a landfill site, including the following:

i) The installation of a biofilter cover layer over the landfilled waste, in place of the traditional clay capping layer (in this case, gas simply is vented through the biofilters layer, without the need for mechanical extraction);

ii) Passive drainage of landfill gas and venting through dedicated biofilter units; and

iii) Active landfill gas extraction and (mechanical) venting through dedicated biofilter units (Dever, McNeill & Laginestra 2000).

The preferred approach is dependent on a number of issues including the size of the site and the space available for gas management activities, the level of landfill gas generation at a site, and power availability.

Environmental Aspects of Biofiltration

The effectiveness and application of soil bed systems have been demonstrated in this paper, but is soil bed/biofiltration a sustainable process? Certainly, it involves a natural process, and on the face of things, represents the solution of least adverse environmental impact of any odour control method. Today, it is also considered appropriate to review whether systems meet cleaner production and ecologically sustainable development (ESD) principles, since all industries and authorities are subject to environmental scrutiny with adoption of any new systems.

Cleaner production

Based on the United Nations Environment Program (UNEP) definition, cleaner production refers to a number of different aspects dependent on the type of operation and phase:

- In production processes, conservation of raw materials and energy, elimination of toxic raw materials and reducing toxicity of emissions and wastes;

- For products, reduction of impacts over the entire life cycle of the product, from extraction of raw materials to disposal of the product;

- For services, reduction of environmental impacts over entire life cycle of the product, from system design and operation to consumption of resources (Australian and New Zealand Environment & Conservation Council [ANZECC] 1998).

Cleaner production has relevance to a number of aspects for odour control – reduction of contaminant emissions, energy usage, use of resources in construction and during the life of the system, and disposal of by-products.

Below we consider how well biofiltration meets these criteria:

- Reduction of contaminants – EXCELLENT – biological biofilters have been widely used in industry. Well-designed and operated biofilters achieve removal efficiencies of 95% and greater for contaminants such as ammonia, hydrogen sulphide and volatile organic compounds (VOCs). They have been increasingly applied (successfully) to treat a number of complex and long chain compounds such as benzene.

- Energy use minimisation - EXCELLENT - fans are the main power use - there are no requirements for chemical manufacture, regeneration of activated carbon, transport of chemicals, fuel etc. In addition, some situations, such as rising mains or landfills (where the air is displaced under pressure), passive ventilation may be applied.

- Minimisation/Minimal use of natural resources – GOOD. There is no requirement for chemicals, only (recycled) water for irrigation to maintain microbial viability. The media consists of a large proportion of recyclable materials – dewatered sludge, composts, green waste. In many systems retaining walls are used, however, mounded construction may also be applied (negating need for concrete).

- Solid waste-by-product disposal - GOOD – Dependent on contaminant loading on the biofilter, the media only needs changing every 3 to 7 years, and spent soil may be re-used for landscaping.

Sustainable Development

Based on the above discussion, the soil bed is the most environmentally appropriate solution/"cleanest" technology. But can we have an ecologically sustainable solution to odour control? Although there are many commonalities between cleaner production principles and ecologically sustainable development aspects, I have tried to look at the aspects in a slightly different way. As stated above, the soil media mix typically comprises a number of recycled products – such as composts, green waste wood chips, dewatered sewage sludge (biosolids), shredded tyres. But it can also be said that the other major components of the bulk media, wood or bark chips, are a renewable resource. The other issues are overcoming the construction of the system and use of natural resources (in manufacturing pipework and in constructing retaining walls), and the use of power.

Construction of retaining walls is not always necessary, and can be readily negated by using a mound construction. Pipework and ducting will be required to transfer ventilated air from sources and distribute the air into the soil mix. Natural resource utilisation might, however, be minimised by application of fibreglass reinforced plastic (FRP) or polyethylene (PE) in lieu of stainless steel or uPVC materials (both of which rate poorly in terms of use of natural resources and energy in manufacture). In addition, it is noted that ducting is not required for capping of landfill systems with a biofilter layer.

On the issue of power - obviously for passive systems (like landfills) there is often no need for mechanical ventilation. In addition, under pressure situations, such as rising mains, or with pump wells (where the

air is displaced with varying levels), and provided the soil media is porous enough, the pressure drop over a soil bed might be low enough for passive ventilation to take place. Passive systems are in place for control of odours from rising mains and pump wells (Laginestra & Every 2001; Wong, Velez, & Greer 2000). The main skill to providing effective operation is to ensure that odour can travel readily through the soil bed and not be vented out an easier route in the system (via fugitive escapes). For sources such as wet wells, which generally require a forced draught situation, then consideration might be given to solar powering of the ventilation fan, with mains supply acting as a back up system.

On the above basis, we are getting very close to a totally sustainable odour control system.

Figure: Soil bed for Odour Control at Belmont Sewage Treatment Plant, NSW (85,000 EP)

Conclusion

In developing a strategy to overcome problematic odorous situations, a review of source control versus "end of pipe" control should be undertaken. Odour is caused by a complex mixture of gaseous contaminants, but control methods do not have to be complex. For end of pipe solutions, bulk media biofiltration provides a cost effective, high performance means of reducing contaminants including H_2S, ammonia and volatile organic compounds. Their use has been demonstrated in a wide variety of applications. The systems are very simple, easy to operate and involve a natural process. The effectiveness of soil bed odour control has been demonstrated to a significant degree; over 99 % odour reduction for municipal (and other) situations. In the case study presented, it represented the lowest cost option of other systems. In addition, this type of system represents the lowest environmental impact of all odour control options; the facility rates highly in terms of cleaner production principles, and includes negation of chemical usage, and minimal use of natural resources.

Soil beds are also considered effective and appropriate for controlling odours and greenhouse gas emissions from landfill sites. In Australia there are a large number of landfills which do not incorporate control measures for landfill gas and consequently landfill gas at these sites is emitted uncontrolled into the environment. Research has indicated that biofiltration costs for such are very low compared to conventional active landfill gas management systems, and that the systems require only minimal operating and maintenance inputs.

Through application of appropriate design practices and environmental principles (including use of renewable/recycled materials, passive ventilation, and perhaps solar power) the biofiltration option for odour control is approaching real sustainability.

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Correspondence to:
Mitchell Laginestra
Wastewater and Odour Control Project Manager
GHD
10 Bond Street
Sydney, NSW, 2000
AUSTRALIA
Email: mitchell_laginestra@ghd.com.au

Managing the Risk of Legionnaires' Disease in Victoria: Implementation of the Reform Package

Jan Bowman, Noel Cleaves and Diane Barbis

Department of Human Services, Victoria

Legionnaires' disease (Legionellosis) is a serious and sometimes fatal form of pneumonia caused by infection with Legionella *bacteria. Public concern in Victoria about the disease has increased significantly over the past five years due to a number of well-reported outbreaks. In 2000, the Victorian Government implemented a* Legionella *Risk Management Strategy to reduce the incidence of Legionnaires' disease. The strategy included the development of new legislation to, amongst other things, require registration of all cooling tower systems and the development of risk management plans and improved testing and maintenance standards of cooling tower systems. Extensive efforts were made to identify and communicate with all stakeholders including land and building owners, property and mechanical services maintenance companies, as well as water treatment service providers. This included the development of 14 different publications and the delivery of 27 workshops and a major conference attended by over 800 stakeholders. An inspectorate was also established within the Department of Human Services to inspect and test cooling towers. The outcomes of these interventions have included a fall in the rate of detection of* Legionella *in cooling towers as measured by the inspectors from 8% to 4% over the last 12 months. Awareness of risk management has increased amongst land and business owners with many operators complying with the new requirements in advance of statutory time lines.*

Key Words: *Legionella; Cooling Towers; Legionnaires' Disease; Risk Management*

Legionnaires' disease (Legionellosis) is a rare, serious and sometimes fatal form of pneumonia caused by infection with *Legionella* bacteria. There are over forty species of *Legionella*, however, only a few are known to be human pathogens. Species most commonly associated with human disease are *Legionella pneumophila* and *Legionella longbeachae*. Legionnaires' disease was first reported in Victoria in 1979.

In 1979, Legionnaires' disease was proclaimed as a notifiable infectious disease in Victoria, requiring all cases to be notified to the then Health Department Victoria. This requirement was continued under the *Health (Infectious Diseases) Regulations 1990*, which required notification on clinical suspicion within 24 hours by phone or fax. These Regulations also incorporated the *Guidelines for the Control of Legionnaires' Disease* (1989 in Department of Human Services 1999). The *Guidelines* were written in a style that was not prescriptive and were originally intended only as a guidance document. Registration of cooling towers was not required under these Regulations and there was no requirement for audit and inspection of systems.

The number of cases of Legionnaires' disease has gradually increased with notifications increasing markedly in Victoria in the past five years. This increase has partly been due to improved case detection and has been accompanied by a fall in case fatality ratios (Van Buynder et al. 2001). Although not all cases of

Legionnaires' disease are severe, between 5 and 30% of cases can be fatal. The fatality rate is affected by the patient's underlying risk factors such as smoking and immune status (Marston, Lipman & Breiman 1994).

Some of the increase in notifications is attributable to improved diagnostic technology and may represent cases that previously would have gone unrecognised (Van Buynder et al. 2001). Public concern about the disease has increased significantly in recent years. This concern has been reinforced by a number of well-reported outbreaks. In 2000 there were nearly 250 notifications, 115 relating to the Melbourne Aquarium outbreak. In 2001 there were 120 cases (Victorian Infectious Diseases Bulletin 2002).

Legionella Working Party

A Legionella Working Party was established in Victoria in December 1999 to advise the Minister for Health on options for managing the health risk associated with cooling towers. The Legionella Working Party considered a range of feasible options for enforcement of best practice for maintenance of cooling towers, including the roles and responsibilities of agencies and costs and benefits associated with the options (Department of Human Services 2000 (a)).

The Working Party included representatives of the Municipal Association of Victoria, Local Government, the Australian Institute of Environmental Health, the Victorian Employers Chamber of Commerce and Industry and Government agencies. The Government also consulted with engineers, the water treatment industry, microbiology experts, the Plastics and Chemicals Industry Association, the Property Council of Australia, Building Commission, suppliers of equipment for cooling tower treatment and key trade unions. At the request of the Government, the Working Party reviewed its recommendations in the light of the experience of the Melbourne Aquarium outbreak.

Government Response

In August 2000, the Victorian Government introduced a staged multi-faceted and comprehensive package of measures, which collectively focus on the issue of managing the risks from cooling towers based on the recommendations of the Legionella Working Party (Department of Human Services 2000 (b)).

The package of controls represented an innovative and comprehensive approach managing the risks from *Legionella*. It combined the adoption of proactive management requirements, through a compulsory development of annually audited and reviewed risk management plans for every cooling tower system. Enhanced monitoring was introduced through better testing and inspection of systems and better information flows, through the establishment of a register of cooling tower systems. An enhanced technical support and enforcement role for the Department of Human Services was also established (Department of Human Services 2000 (c)). Mandatory risk management plans were a key theme of this strategy placing the onus on industry to understand, address and manage the risks of their cooling tower system.

Implementation of Government Strategy

In November 2000, the Building Act was amended requiring: registration of all cooling tower systems with the Building Commission, preparation and implementation of risk management plans for all cooling tower systems and compulsory independent auditing of all risk management plans. Registration was considered essential not only to help investigations of cases of Legionnaires' disease by locating towers, but just as importantly to allow direct communication with owners and managers of systems about

Legionella control. Prior to the registration system there had been no list of the locations of cooling towers across Victoria.

In March 2001, a suite of new regulations was also introduced. *The Health* (Legionella) *Regulations 2001* introduced more stringent testing and maintenance standards for cooling towers and warm water systems. *The Plumbing (Cooling Tower) Regulations 2001* prescribed standards for carrying out plumbing work on cooling tower systems.

The Building (Cooling Tower System Registration) Regulations 2001 prescribed fees and information to be contained in an application to register a cooling tower system as well as information that must be contained in the public register of cooling tower systems. *The Building (*Legionella *Risk Management) Regulations 2001* specified matters that must be included in a risk management plan.

The Health (Infectious Diseases) Regulations 2001 continue to require notification of cases of Legionnaires' disease within 24 hours of a clinically suspected case. These regulations also prescribe standards for the treatment of spa pools, which have also been associated with cases of Legionnaires' disease.

An industry code of practice for water treatment service providers has been developed to address another aspect of this complex issue. The Code, which was launched in March 2002, will serve as a best practice standard for the water treatment industry to ensure consistent and accountable service and reduce potential occupational and public health risks from *Legionella*.

The package also included targeted inspections of cooling tower systems by an environmental health team within the Department. This new team of four inspectors:

- Provides an enhanced technical advisory service to business and industry
- Undertakes routine inspections of cooling towers to monitor industry compliance with the new registration, risk management, maintenance and testing requirements,
- and provides an enhanced outbreak investigation service.

Immediately a notification of disease occurs, an epidemiological investigation by the Communicable Diseases Section of the Department of Human Services commences. This entails confirmation of diagnosis and an interview with the next of kin or patient if possible. A questionnaire is used to establish the incubation period and to determine the risk exposures during the incubation period. While all cases are followed up, not all cases lead to an environmental investigation. However, most cases in employed persons involve a work place visit to determine whether there are any possible exposure sources other than a cooling tower system. Cases where the possibility of infection occurred while in a health care facility, or any other facility associated with high-risk individuals, such as nursing homes, are routinely investigated. Other possible sources such as public spa pools or warm water systems may be investigated.

If two or more cases are linked to a geographical area, the investigation is broadened to include sites within a 200-metre radius of the common area visited by the people who had contracted Legionnaires' disease. During a workplace inspection the tower maintenance records are examined and the towers are sampled for *Legionella* and Heterotrophic Colony Count testing. Precautionary system disinfection is required and workplace surveillance is instituted by retrospective and prospective examination of illness records, or by a staff alert notice.

Registration Compliance, Inspections and Audits

The cooling tower systems register established jointly with the Building Commission to date has 6006 cooling tower systems registered. The systems comprise 7144 cooling towers located at 3396 sites

throughout the State. (This compares well with the initial estimates, which were that there were 5000 cooling tower systems at 3500 sites, although the total number of cooling towers is lower than the estimated 10,000). Compliance with registration requirements has been spot checked through a number of publicised blitzes of businesses in specific geographic areas to ensure all cooling tower systems were registered. Compliance in these areas has been shown to be greater than 99%.

Recent outbreaks of Legionnaires' disease in Melbourne and Moonee Ponds in 2002 were contained quickly with programs of targeted testing by DHS, and follow up treatment of cooling tower systems in the vicinity of the areas visited by the cases. The rapid response was possible due to the information available on the cooling tower system register.

Since the implementation of the inspection program in April 2001, Departmental inspectors have inspected and sampled over 1800 cooling towers. The rate of positive (infected) towers has decreased from almost 8% when the new inspection team was introduced in April 2001 to approximately 4.0% by May 2002. Registration blitzes have occurred in the City of Whittlesea, City of Greater Dandenong, City of Port Phillip and City of Greater Shepparton and the Melbourne Central Business District, with over 1100 sites visited in the CBD alone. Inspectors have personally contacted all drycleaners, and the plastics industry is also the subject of a concerted campaign to ensure compliance with registration, testing and maintenance legislation.

The Department is currently implementing the auditing program by developing an accreditation process for individuals who want to become independent auditors. Ten Departmental staff have been trained in auditing and will be undertaking initial audits of cooling tower system risk management plans. All owners of cooling towers systems whose risk management plans (RMP) are due or overdue, as indicated by the cooling tower system register, have been contacted to ensure their RMP is being developed.

Information and Education

To ensure land and business owners were aware of the new regulatory requirements the Department undertook an extensive education and communication process. A database was established to facilitate this and now consists of over 10,000 stakeholders who receive regular information and newsletters about registration, maintenance and testing requirements.

An industry forum was held in April 2001 to introduce the changes in legislation to land and business owners. The forum attracted over 800 participants from business and industry.

The Department carried out a letterbox drop to all properties in the central business district with information about registration requirements. Every property in the central business district was visited to ensure all cooling tower systems were identified and registered. Visits to selected areas in the City of Greater Dandenong, City of Whittlesea, City of Port Phillip and City of Greater Shepparton also occurred. These operations were supported by media coverage and revealed registration compliance in excess of 99%.

A suite of publications was developed utilising various styles and communication methods including newsletters, technical notes, guidelines and on-site information kits.

Technical notes and pamphlets include "Legionella in the Workplace", Information for Occupational Health and Safety Representatives", "Legionella in the Environment", "What is a Cooling Tower?", "An Operating Guide for Owners of Evaporative Coolers" and "Legionnaires' disease".

A site kit was developed and distributed to owners and operators of cooling tower systems and included all technical notes and

pamphlets, as well as provision for storing records of maintenance and testing. The kit allows Departmental officers ready access to test results for individual systems during inspections or investigations, as well as facilitating the independent auditing process.

Guidelines included, *A Guide to Developing Risk Management Plans for Cooling Tower Systems*, which is designed to assist industry develop risk management plans and describes the actions necessary to control *Legionella* growth in cooling towers; Guidance notes for hospitals and aged care facilities with specific information to assist these establishments comply with the new regulatory requirements: *A Guide to Selecting Cooling Tower Systems for Acute Health and Aged Care Facilities;* and *Model Communication Plans for Hospitals* about *Legionella* and Legionnaires' disease.

To assist land and business owners develop risk management plans for their cooling tower systems, the Department conducted 27 risk management workshops around Victoria attracting over 1200 participants. Presentations about responsibilities and requirements were given to various business and industry peak bodies including the Australian Industry Group, Insurance Council of Australia, Property Council, Hospital Engineers and Australian Institute of Dry Cleaners.

A comprehensive Internet site has been set up at www.legionella.vic.gov.au and contains information about all of the new requirements and copies of all publications and legislation. This site also has links to other relevant sites including the Building Commission and the Plumbing Industry Commission.

A toll free 1800 technical advisory line has been established to assist community and industry with information and advice about minimising risks from *Legionella*. The Department has used state-wide, local and specialist media to provide information to land and business owners about registration, testing and maintenance requirements for cooling tower system as well as ways of minimising risks from *Legionella* in cooling tower systems. This was complemented by the Building Commission running a television advertisement during 2001 encouraging registration and awareness of the new legislation.

Future Initiatives

The Department will continue the random inspection program. The program has an annual target of 1000 cooling tower inspections. The target was exceeded in the first 12 months of the program. All cooling tower systems are required to have risk management plans prepared during this year (2002).

Risk management plan audit arrangements are underway, including the development of auditor competency standards, which will be followed by training and accreditation of auditors, preparation of audit regulations and guidelines and a mail out to owners of all cooling tower systems about their legislative responsibilities.

Approximately 160 cooling tower system risk management plans require audits before the end of 2002. The remaining plans must be audited before the end of 2003 and then annually from there on.

DHS inspectors will audit all hospital risk management plans before the end of 2002. The audit will also include an inspection of all public hospital cooling tower systems.

The Department is continuing its work with the water treatment industry to develop an accreditation process for water treatment service providers.

A geographical information system (GIS) will be implemented, which will allow the rapid identification of sites with cooling towers in the event of a case or outbreak of Legionnaires' disease. The GIS will assist the Department's response to cases of Legionnaires' disease to ensure immediate public health risks are mitigated. This system together with an electronic inspection system linked to the Building Commission Register of cooling towers will

also be on-line before October 2002. The computer system will record all inspection information and facilitate reporting on problem sites or industries to allow targeted programs to occur.

Conclusion

Victoria has adopted a comprehensive strategy to manage the risks associated with cooling tower systems. The strategy has succeeded in raising the awareness of land and business owners that own or are responsible for cooling tower systems.

There is heightened awareness amongst stakeholders, such as workers and unions, to the occupational health issues that may be associated with cooling tower systems. There is a growing expectation that they be in the "information loop" particularly in circumstances where *Legionella* is detected through routine testing.

Future challenges in Victoria are to continue achieving decreased rates of *Legionella* bacteria in cooling towers, to minimise the risk associated with cooling towers, and to use the opportunities afforded by recent legislative changes to enhance the knowledge required for risk management.

There is already evidence that building owners and managers have a better understanding of their systems and the actions to take to minimise risks. There is also an expectation that over time there will be decline in the number of cases of Legionnaires' disease.

In general, industry has embraced the changes to cooling tower system regulation with many operators meeting new requirements well in advance of the statutory timelines.

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Correspondence to:
Diane Barbis
Legionella Risk Management Program
Environmental Health Unit
Department of Human Services
Level 17/120 Spencer Street
Melbourne, Victoria, 3000
AUSTRALIA
Email diane.barbis@dhs.vic.gov.au

Body Piercing and Hepatitis C Infection: The Need for Education and Regulation

Margaret Hellard

Macfarlane Burnet Institute for Medical Research and Public Health, Melbourne

The hepatitis C virus (HCV) is a major health concern with an estimated 170 million people (3% of the world's population) being infected with the virus. It is estimated over 200,000 Australians have been exposed to HCV (1% of the population) with more than 10,000 new infections every year (Crofts, Thompson & Kaldor 1999).

HCV can be transmitted in any situation in which infected blood is transferred between individuals. In Australia HCV is most commonly transmitted in the context of injecting drugs. It is also recognised that HCV can be transmitted within health care settings following contamination of equipment and other surfaces, which come into contact with infected blood. There have been reports of HCV RNA being detected on equipment in dental surgeries and on injecting drug paraphernalia (Crofts et al. 2000; Piazza et al. 1995). These studies suggest that HCV transmission could occur during other practices that can release blood into the environment or onto equipment.

In recent years body piercing has markedly increased in popularity with a 1998 study reporting 31.5% of Australian had their ears pierced and 6.7% had their body pierced. This survey reported current injecting drug users are nine times more likely to have had their body pierced in the previous year compared with the general population (Makkai & McAllister 2001). In the current body-piercing trend, people are having their eyebrows and navels pierced as well as mucous membranes in the tongue and lips. Multi-use devices are used for many of these piercings, creating the potential for the spread of blood borne viruses.

The increasing popularity of body piercing has led to concerns about the increased risk of spread of blood borne viruses, in particular HCV. Many people have become newly involved in the industry in recent years, but little is known about their level of training or their understanding of piercings' potential to spread blood borne viruses. At the same time several studies have reported body piercing as a risk factor for infection with the hepatitis viruses and HIV.

At the 3rd Australasian Conference on Hepatitis C in 2002 researchers from New South Wales, Victoria and Western Australia presented work examining the issues surrounding body piercing and blood borne viruses. Oberdorfer, Wiggers et al. presented the results of a telephone survey conducted in New South Wales on 874 tattooist, body piercing and beauty therapists and hairdressers. Only 53% reported having received the *New South Wales Health Department Skin Penetration Guidelines* that had been recently distributed. Less than 39% correctly identified the recommended disinfection procedures; over 86% correctly identified the recommended sterilisation procedures. 42% to 67% of respondents were not aware of what constitutes inappropriate sterilisation procedures (Oberdorfer & Wiggers 2002a). In a separate study Oberdorfer, Wiggers et al surveyed 245 environmental health officers (EHOs) from local councils and 30 EHOs from public health units regarding their knowledge of and attitudes to prevention of blood borne diseases. A full report of this study is in the

current edition of this journal. More than half the EHOs from local councils and one fourth of EHOs from public health units reported they did not know the meaning of the "standard precaution approach" which is referred to throughout *New South Wales Health Department Skin Penetration Guidelines*. "Standard precaution approach" is the equivalent of universal precautions where all blood and bodily substances are considered potentially infectious. Almost half the EHOs did not know the correct disinfection procedures and many had not receiving training in inspection (Oberdorfer & Wiggers 2002b).

A Victorian study by Hellard, Aitken et al. surveyed 35 establishments that conducted body piercing. The study reported marked variation in the length of training and the quality of training body-piercing practioners received. Seven of 29 practitioners who reused piercing equipment did not follow the Victorian *Standards of Practice for Tattooing and Body Piercing: Health pursuant to Part 6 of Health (Infectious Diseases) Regulations*, 1990 for reprocessing piercing equipment. Fourteen of the 20 practitioners who used piercing guns did not follow the Victorian *Standards of Practice for Ear Piercing: pursuant to Part 6 of Health (Infectious Diseases) Regulations*, 1990 for reprocessing piercing guns. Many practitioners were unaware of how HCV was spread, with some practioners not knowing or being unsure of whether injecting drug use or body piercing could potentially spread HCV. Practitioners' understanding of universal precautions was limited with 19 practitioners reporting they did extra cleaning post piercing if they knew a customer was HCV positive (Hellard et al. 2002). The full report of this study has recently been endorsed by the Australian Institute of Environmental Health and can be obtained from the institute.

Researchers from Western Australia discussed a collaborative project that provided education and assistance to local governments in Western Australia to engender responsiveness to hepatitis C initiatives. One of the results from this work was to develop training for environmental health officers in regard to skin penetration practices (Bevan et al. 2002).

The results of these studies reveal that training in body piercing and related infection control are variable, and in some cases are clearly inadequate. Many practitioners neither had knowledge of, nor followed the local guidelines for prevention of spread of blood borne viruses. A number of practitioners did not understand the concept of universal precautions, leading to the potential for spread of blood borne viruses through body piercing (Center for Disease Control [CDC] Update; MMWR 2001). Body piercing is a currently popular activity but carries potential health risks if practitioners are insufficiently trained in infection control procedures. Body piercing practitioners should be required to undergo formal training in infection control and in the use of piercing equipment to protect customers from the spread of blood borne viruses. The research also highlighted the need for ongoing education and training for EHOs in regards to body piercing, the spread of blood borne viruses and the inspection of body piercing premises.

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Correspondence to:
Margaret Hellard
Macfarlane Burnet Institute for Medical Research and Public Health
GPO Box 2284
Melbourne, Victoria, 3001
AUSTRALIA
Email hellard@burnet.edu.au

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