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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.

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

In this the last issue for 2002, there are some of the most interesting papers that the Journal has published, and which are of immediate relevance. But before I mention some of these, I should like to acknowledge with my personal thanks, and those of the Advisory Board, the work of the reviewers of papers submitted to the Journal. Without the work of these anonymous reviewers papers could not be published. Papers are improved with their advice and suggestions. We have therefore included in this issue a list of the reviewers for volumes 1 and 2. Many of these people have reviewed more than one article. In the context of the timelines for publication, and work, reviewing is often another commitment in an already full life. It is something we value as much as we do our contributors. Thank you.

Many of the articles in this issue are about research, which should lead to improving our environment so that we can indeed improve health. Dunn et al.'s paper on the effectiveness of different types of wash basins on reducing the microbial load on the hands of those who handle food, and the brief note by Richards, point to one of the most difficult and intransigent areas in environmental health today. Three of the papers, Bell, Pholeros, and Stewart and Laksono, get to the heart of environmental health, how good housing and effective waste removal and the relevant research and interventions remain more than pertinent today, whether in Australia or overseas.

Our health and amenity is a concern for Shepheard et al., and for Scannell who examine respectively the levels of exposure to tobacco smoke or environmental noise. Scannell's paper is the first of two parts. Part 2 will be published in Environmental Health, vol. 3, no. 2, 2003. A number of the papers demonstrate how important legislation is in contributing to, and the regulation of, health. Vergotis is directly relevant in this way, but Bell, Shepheard et al., Scannell, and Richards, all refer to legislation.

The issue concludes with the inclusion of a most important Research Report. The product of a collaboration between the profession of environmental health and medical research, the Supplement addresses one of the most pressing of contemporary health issues: the infection control practices and knowledge of hepatitis C among body piercing practitioners. The Journal is pleased to acknowledge this research.

Heather Gardner
Editor

Environmental Health
The Journal of the Australian Institute of Environmental Health

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 facilitate the continuing professional development of environmental health practitioners
- 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.

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The Effectiveness of Different Wash Basins in Reducing the Microbial Load on the Hands of Food Handlers

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In Victoria, hands free wash hand basins in food preparation areas were a regulatory requirement introduced under the 1984 Health (Eating House and Food Premises) Regulations. *The food safety standards introduced in January 2001 replace existing state, territory and local government food hygiene regulations and the provision of a hands free wash hand basin is no longer prescribed (Australia and New Zealand Food Authority 2001). The aim of the pilot study was to investigate the hypothesis that there is no difference between the effectiveness of hands free wash hand basins and manual tap operated basins in reducing microbial flora on hands. Thirteen premises with manual hand basins and a comparison random sample of 19 premises with hands free basins were selected from the City of Yarra in Melbourne, Australia. Data collection involved an Environmental Health Officer visiting the premises, conducting a survey and swabbing the food handler's hands prior to and post washing. The impact of variables, including the temperature of water supplied to the wash hand basin, number of food handling employees, types of food handled, time the sample was taken and approximate number of meals sold per hour, were also investigated. The results indicated that the mean percentage reduction in the number of colonies compared for the manual and hands free hand basins showed no significant difference (Manual mean = 58%, Hands free mean = 79%, p = 0.163). Overall, there was large variability in pre and post microbial counts for both basins and considerable variability in the temperature of water to wash hand basins. No clear association, however, was found between the number of employees, temperature of wash hand basin, meals served or use of either facility, with the percentage reduction in the microbial load. The pilot study has indicated that there is no difference between the use of either a manual or hands free wash hand basin for a small group of food retailers. Consideration should be given to a range of factors which might have impacted on this study, including frequency of hand washing, types of foods handled, length of mechanical wash, and number of manual wash hand basins available for the study. Education regarding the need to maintain the temperature of the wash hand basin water between 22-40°C should also be investigated among food retailers as well as strategies for the correct washing of hands.*

Key words: *Manual and Automatic Wash Hand Basins; Food Premises; Microbial Load*

The City of Yarra in conjunction with the Swinburne University of Technology conducted a pilot study into the effectiveness of hand washing facilities in owner/operated retail food premises within its municipality. The study was undertaken as a result of the Food Safety Small Grants Program, funded by the Victorian State Government, which allocated funding to local government agencies to conduct

projects which were proactive in improving food safety and can help protect the health of all consumers of food. The study was undertaken between March and October 2001.

The Australia and New Zealand Food Standards Code, Food Hygiene Standard 3.2.3, no longer requires the provision of hands free wash hand facilities in food premises (Australia and New Zealand Food Authority 2001). In Victoria, hands free wash hand basins in food preparation areas were a regulatory requirement introduced under the 1984 Health (Eating House and Food Premises) Regulations. It continued to be required by local government authorities through the application of Construction Guidelines for Food Premises introduced in 1994 (Department of Human Services 1994).

The food safety standards introduced in January 2001 replace existing state and territory and local government food hygiene regulations. Thorough washing and drying of hands is acknowledged in the food safety standards as an important factor in the prevention of food borne illness. The standard specifies occasions when food handlers are obliged to wash and dry their hands. It also requires the provision of "basins or other facilities" that can be easily accessed by food handlers within areas where food handlers work if their hands are likely to be a source of contamination of food. However, the provision of a "hands free wash hand basin" in food preparation areas is no longer prescribed as this is considered to present businesses with unnecessary cost and difficulties, and cannot be justified in terms of public health and safety (Australia and New Zealand Food Authority 2001).

Published research regarding the effectiveness of hands free wash hand basins compared to manual wash hand basins in food preparation areas in reducing microbiological flora on the hands of food handlers is limited. A study by Turner et al. (1994) used image analysis to compare the hand washing effectiveness of manual hand washing to an automated system through the application of an oil-based suspension. Results involving 65 food handlers found that manual handwashing was decidedly superior to the use of an automated system for the removal of oil-based soil on the hands. However, the study only focused on the removal of gross contamination and not microbial removal. In this study, the focus is on the contamination of food handlers hands from a microbiological perspective in a realistic food setting, rather than through gross contamination.

Another study, which evaluated manual hand wash procedures and automated handwashing procedures involving the application of a test organism found little difference in manual handwashing (if done correctly) and automated handwashing (Paulson 1992). Other published studies involving automated hand washing practices have focused on hand washing practices and attitudes of health care staff. Two studies focused on the effects of replacing a manually operated wash hand basin with an electric wash hand basin and found that hands were washed significantly better, but less often with an automated sink ($p < .001$). Staff also expressed negative attitudes to the use of an automated sink (Larson et al. 1991; Larson et al. 1997).

An unpublished experimental laboratory based project, involving the comparison of the two facilities among students at Swinburne University, showed no significant difference between the use of the two facilities (p=0.89) (Holt & Cannard 2001). However, the study had a range of limitations including the need to control the type of soap and washing technique used in the experiment. Also, a more realistic environment involving food handlers is required to provide results with greater validity. The pilot study was undertaken to explore the difference in effectiveness of the hands free basins and manual tap operated basins in reducing the microbial flora on the hands of food handlers in food premises.

Method

The aim of the project was to investigate the hypothesis that there is no difference between the effectiveness of hands free wash basins and manual tap operated basins in reducing microbial flora on hands by:

(i) using a realistic environment by targeting owner/operator retail food premises in the City of Yarra, and

(ii) investigating the impact of the variables of water temperature supplied to the wash hand basin, number of food handling employees, types of food handled, time sample was taken and approximate number of meals sold per hour.

Sample selection

As there were only 13 premises with manual hand basins in the City of Yarra all were included in the study. For comparison a random sample of 19 premises with hands free basins was selected from the City of Yarra food premises database. "Hands free basins" included either electronic or foot operated hand basins.

The total sample size of 32 was determined by keeping the hands free sample, for statistical reasons, to no more than double that of the manual hand basins. For the purposes of analysis the set of premises with a manual hand basin were considered to be a sample from a wider population (such as would have existed before hands free hand basins were introduced).

Data collection and microbiological analysis

All proprietors were invited to participate in the project by the City of Yarra Environmental Health Officer (EHO). Once recruited, the EHO visited the premises, conducted a survey and swabbed the food handler's hands prior to and post washing. Prior to hand washing a sample was taken from the wrist to the index finger of the food handler. The hands were swabbed using sterile cotton-tipped swabs moistened in 1/4 strength peptone water (Oxoid Ltd.).

The food handler was instructed on the method for hand washing and provided with a standard amount of liquid soap (5mL) for use during the procedure. The method involved the food handler wetting his/her hands, applying liquid soap, washing the entire surface then drying with a paper towel, as per Australia and New Zealand Food Safety Standard 3.2.2. 15 (4) (b). The liquid soap was provided to try and eliminate variability between different types of disinfectants (Paulson 1992).

After hand washing, the hands were dried using a disposable paper towel and a second sample of the ring finger of the same hand was taken using a fresh swab. All samples were promptly transported on ice to the microbiology laboratory, Swinburne University of Technology and plated directly onto Plate Count Agar (Oxoid Ltd.). Plates were incubated at 30°C for 48 hours and the number of colonies arising was counted.

The EHO also conducted a survey on site. The officer collected data regarding the types of foods prepared, number of food handling employees, water temperature supplied to the hand basin and number of meals served per hour.

The data collection instruments were pre-tested. Both the survey and the hand washing procedure were trialed at a food premises, with pre-testing for the detection of microbial flora on the hands using the finger swabbing technique also taking place.

Evaluation

A process evaluation was carried out with the project officers involved in the project (Hawe, Degeling & Hall 1990). This evaluation involved obtaining positive and negative feedback to the project development and implementation through the completion of a short questionnaire.

Data analysis

In view of the small size of the dataset, several variables were re-coded into two categories in order to facilitate the analysis. These were the time the swab was taken, the number of employees, the number of meals sold per hour, and the number of types of food.

The percentage reduction of the number of colonies from the pre to post samples for both the manual and hands free hand basins was calculated and used as the key variable for comparison of the hand basin types and other groupings. The distributions of the pre, post and percentage reduction were examined and all variables summarised.

The two hand basin types were compared on percentage reduction using a t-test. Linear regression was used to determine if any of the pre, post and percentage reduction was related to temperature. The two hand basin types were compared on the percentage reduction for the categories of the four recoded variables using a t-test.

Results

The data as analysed are presented in Tables 1 and 2, separated into the manual and hands free wash basin groups. The sampled premises with manual wash hand basins employed an average of three food handlers and sold a range of foods which have been categorised into either four or fewer types or four or more types with the majority, 77%, selling four or more types. Food premises mostly sold between 20-40 meals per hour (53%), followed by 0-20 per hour (30%), with two selling 40-60 meals and 0-20 per hour respectively.

The sampled premises with hands free wash hand basins employed an average of three food handlers and sold a range of foods which have been categorised into either four or more types or four or less types with the majority, 84%, selling four or more types. Food premises mostly sold between 20-40 meals per hour (59%), followed by 0-20 per hour (32%), with one premises selling 40-60 meals per hour.

Table 1: Number of colonies recovered from food handlers and variables measured in food premises containing manual wash hand basins in food preparation areas

Food Premises *N*= 13	Number of colonies		Variables measured					Percentage reduction in number of colonies (post-pre)
	Pre washing	Post washing	Temp	Number of employees	Food Category*	Time taken: (between 10am and 2pm)	Meals per hour	
1	42	3	41	4	>4	10-11	20-40	92.9
2	1260	316	16	3	>4	10-11	20-40	74.9
3	67	2	22	3	>4	10-11	0-20	97.0
4	129	51	38	7	>4	11-12	20-40	60.5
5	53	0	35	2	>4	1-2	20-40	100
6	82	25	46	3	>4	11-12	0-20	69.5
7	112	31	46	4	≤4	11-12	40-60	72.3
8	24	23	32	1	≤4	11-12	0-20	4.2
9	736	70	43	2	>4	12-1	20-40	90.5
10	117	1	43	2	>4	12-1	0-20	99.1
11	0	0	40	2	>4	10-11	20-40	0
12	2	3	39	3	<4	10-11	20-40	- 50
13	13	8	29	2	>4	12-1	0-20	38.5

** Category of food includes either 4 or more or 4 or less of the following groups: cooked, cold; frozen; fruit and vegetables; meat, poultry and fish; sandwiches; cakes and pastries; coffee and teas; pasta and rice; small goods.*

Table 2: Number of colonies recovered from food handlers and variables measured in food premises containing hands free wash hand basins in food preparation areas

Food Premises *N*= 19	Number of colonies		Variables measured					Percentage reduction in number of colonies (post-pre)
	Pre washing	Post washing	Temp	Number of employees	Food Category*	Time taken: (between 10am and 2pm)	Meals per hour	
1	17	2	43	3	>4	10-11	0-20	88.2
2	44	21	31	2	>4	10-11	0-20	52.3
3	112	36	45	2	>4	10-11	0-20	67.9
4	5	4	44	3	>4	11-12	0-20	20.0
5	256	4	39	3	>4	10-11	20-40	98.4
6	33	23	15	2	>4	10-11	20-40	30.3
7	12	0	44	4	>4	12-1	20-40	100
8	2	0	31	2	>4	12-1	20-40	100
9	2	1	38	6	>4	10-11	20-40	50.0
10	18	1	34	2	>4	11-12	20-40	94.4
11	1008	28	44	3	>4	12-1	20-40	97.2
12	464	8	28	4	≤4	11-12	20-40	98.3
13	192	2	18	2	≤4	12-1	20-40	98.9
14	113	2	13	2	≤4	12-1	20-40	98.2
15	880	61	41	8	>4	10-11	40-60	93.1
16	12	7	20	4	>4	1-2	20-40	41.7
17	404	10	43	3	>4	10-11	0-20	97.5
18	496	140	22	2	>4	1-2	20-40	71.8
19	18	1	34	2	>4	11-12	0-20	94.4

** Category of food includes either 4 or more or 4 or less of the following groups: cooked, cold; frozen; fruit and vegetables; meat, poultry and fish; sandwiches; cakes and pastries; coffee and teas; pasta and rice; small goods.*

There was wide variation in the water temperature supplied to the basins. For the manual wash hand basins the range was 16-46°C and for the hands free 13-45°C. A plot of the pre count, post count and percentage reduction in the number of colonies against temperature showed no connection between these three variables and temperature (data not shown). This showed that the pre count, post count and percentage reduction in the number of colonies were not related to water temperature.

The mean percentage reduction for the re-coded categories of time, number of employees, number of meals served, and number of types of foods served showed no significant difference between the two types of hand basin on all four of these variables. Thus there was no overall difference in the percentage reduction in the number of colonies for the two hand basin types when compared at the two times (10am-12pm and 12pm-2pm), for the three employee sizes (1, 2 and 3 or more), for the number of meals served (0-20 and 20-60), and for the number of different types of food (4 or less and 4 or more).

It can be seen in Tables 1 and 2 that the pre and post counts were extremely variable. The large pre counts (>100) were evenly distributed over the numbers of employees variable showing that size of the enterprise had no bearing on the size of the (large) pre counts. The mean number of employees for large pre counts at 3.36 was greater than that for small pre counts at 2.78 but the difference was not significant (p=0.33). Similarly, there was no clear association between large pre counts and the time of swab.

The data showed some tendency for the larger pre counts to be associated with more than 20 meals served per hour, but the association was not significant (p=0.13).

The percentage reduction variable is probably only useful for non-trivial pre counts. Its values for both types of basin are shown in Figure 1. Ignoring the five pre counts less than 10, however, the microbial counts for both basins still shows a wide range of values of the percentage reduction with 4 out of 27 less than 50% and 11 out of 27 less than 75%. The efficacy of the hand washing is clearly not adequate to produce more desirable reductions, such as all reductions above 95%.

Evaluation

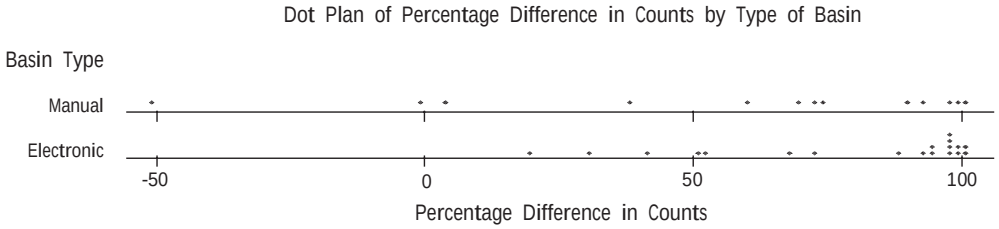
Overall, the evaluation results raised a number of positive aspects including general satisfaction with the planning, coordination and implementation of the project, with the EHOs perceiving the opportunity to be involved in the research as favourable. Negative issues included concerns of some proprietors regarding the sorts of outcomes the project would achieve, and the "poor" English skills of some proprietors, thus making it difficult to explain the project.

Discussion

The aim of the project was to investigate the hypothesis that there is no difference between the effectiveness of hands free wash basins and manual tap operated basins in reducing microbial flora on hands. The study has shown that no significant difference was found between the use of a manual or hands free wash hand basin. The range of variables tested had no significant effect on reducing the microbial load through the use of either a manual or hands free wash hand basin. The results of this project are in accord with the hypothesis for a small group of food retailers in the City of Yarra. However, given the nature of the pilot project, it might not be appropriate to conclude that this is the outcome for all food settings, and consideration needs to be given to a number of factors.

The limitations of the study included the small number of manual wash hand basins

Figure 1: Percentage difference in microbial counts for the manual and electronic hand basins



The mean percentage reduction in the number of colonies was compared for the manual and hands free basins using a t-test. This showed no significant difference in the mean percentage reduction (Manual mean = 58%, Hands free mean=79%, p=0.163). Although the difference in these two percentages (21 percentage points) may seem fairly large, the non-significance is due to both the small sample sizes and the wide variation in the percentage reductions. In addition, if the three smallest values are removed, namely -50, 0 and 4.2, all from the manual hand basins, the difference between the two types of hand basins disappears. Thus, apart from three particular hand basins, there is no noticeable difference between the two types.

available for the project, particular differences in hand washing techniques, and the difficulty of controlling the level of contamination of the hands through either preparation of foods or other food handler activities prior to washing.

As the legislative requirement to provide "hands free" wash hand basins has been in effect since 1984, the pilot study found it difficult to source manual wash hand basins to use as a comparison. Therefore, only a small sample size was available, which affected the ability to provide greater validity to the study. However, as a pilot study it has provided some base data, and suggested some other issues for consideration, which will be useful in planning further studies surrounding the washing of hands by food handlers.

The results indicated, particularly, that there was great variability in the microbial loads in the pre and post samples. Other studies involving hand washing found reduction with pre and post washing in a controlled environment of approximately 99% (Holt & Canard 2000; Paulson 1992), whereas in this study the reduction ranged from 4.2% to 100%. This could be attributed to differences in levels of dryness of hands, pre and post washing, frequency of washing by the food handler prior to the washing of hands, and the amount of mechanical pressure exerted during washing.

Hands which have more residual moisture have been shown to transfer a greater load of bacteria, thus differences in the amount of moisture remaining on hands after drying, depending on the techniques of the food handlers, could impact on the result (Patrick, Findon & Miller 1997). More frequent washing has been shown to result in a reduced bacterial load (Restanio & Wind 1990; Troller 1983), and other studies have found that the immediate antimicrobial effectiveness depends upon the amount of time spent washing hands, the mechanical pressure and friction exerted in the washing, and the temperature of the water (Paulson 1996). These factors might have impacted on the effectiveness of either of the two types of hand basins.

Even though the pilot study attempted to address these issues through the instructions in washing technique given to each food handler, the results indicated more rigorous techniques need to be put in place to control for these factors. This would include timing the length of hand washing, developing indicators to account for frequency of washing prior to swabbing as well as measuring the level of hand dryness pre and post washing. The evaluation also highlighted the fact that some proprietors had difficulty in understanding the procedures for hand washing due to language difficulties, which is another consideration in this type of research.

Even though it was outside the scope of the study, it would be useful to explore further the types of bacteria remaining on the food handlers hands post washing. The results did indicate the presence of Gram negative bacteria (data not shown), and, even though the loads were considerably reduced in some cases, it would be useful to investigate the relationship between hand washing technique and the types of remaining bacteria. One study found that even though "normal" washing of hands resulted in a lower number of transient microorganisms, it did not influence the resident flora organisms such as *Staphylococcus aureus* (de Wit & Kampelmacher 1994). It is also interesting to note that the mean percentage reduction for the hands free hand basin was slightly more than that of the manual hand basin. Even though this was not a significant reduction, the above factors such as frequency of washing, dryness of hands, and handwashing technique might have influenced these results.

While the pilot project was not designed specifically to explore the operating conditions of the wash hand basin, it is worthwhile noting that there were large temperature variations in the water applied to the hands. Standard 3.2.3 of the Australia

and New Zealand Food Standards Code, 15(4)(b)(2001) recommends the use of warm running water at around 40°C and not below 22°C to assist in the removal of grease and encourage food handlers to wash their hands. Our results indicated that in 16% of premises hand basins were not operating within this temperature range. Even though the variation did not impact on the effectiveness of either of the two facilities, further exploration into the impact of temperature on the use of either facility may be worthwhile.

The purpose of the research was to investigate the effectiveness of the two wash hand basins in a realistic food premises setting, and has explored a number of variables, which may have impacted on the study. The study revealed that there was great variability in the reduced microbial loads both pre and post washing for both types of wash hand basins. Without access to a larger number of manual wash hand basins and the provision of a more controlled experiment (which would have greater resource implications), the pilot study has highlighted that regardless of the type of basin available, strategies to promote proper hand washing techniques, including frequency of washing and the proper drying of hands should be explored. The message of proper and frequent hand washing regardless of the type of facility should be strongly promoted.

Recommendations for further studies of this nature include addressing issues such as:

(i) the availability of manual wash hand basins in food preparation areas to enable an increase in the study population;

(ii) investigating methods of controlling the frequency of hand washing and types of foods handled prior to the swabbing of hands, length of time of hand washing and amount of residual water left on hands post drying;

(iii) developing strategies for the education of food handlers on the correct temperature of the water for wash hand basins; and

(iv) investigating the types of microorganisms that remain after washing.

Conclusion

The results of the pilot study indicated that there was no difference between the use of either a manual or hands free wash hand basin taking into consideration a number of variables for a small group of food retailers in the City of Yarra. Consideration should be given to a range of factors which might have impacted on the study, including frequency of hand washing, types of foods handled, length of mechanical wash, and the number of manual wash hand basins available for the study. Education regarding the need to maintain the temperature of the wash hand basin water between 22-40°C should also be investigated among food retailers as well as strategies for the correct washing of hands.

Overall, the study provided a useful opportunity to investigate the effectiveness of the two hand basins in a realistic setting, and highlighted the challenges involved in conducting research of this nature and the need to encourage proper and thorough hand washing regardless of the facility available.

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Environmental Health: Victorian Anachronism or Dynamic Discipline?[1]

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For many years the profession of environmental health has been at a number of crossroads. We pass the crossroads and things have continued, but with perhaps a slightly changed role, a change of focus, or a change in technology. This paper reviews some of the changes and tries to answer some of the questions as to why it is where it is. Some key skills underpinning the profession and where it might go to from here are also examined.

Key Words: *Environmental Health; Skills' Development; the Environmental Health Role*

The Evolution of the Environmental Health Officer

The beginning: Victorian England 1837-1901

The Victorian era saw the rise of many scientists and reformers, including Charles Darwin, Charles Babbage, Sigmund Freud and Florence Nightingale. Collectively, these people contributed to the major transformation of the period, that is, how we perceived the world. The period saw a change from "natural philosophy" and "natural history" to "science", with a shift from gentlemen and clerical naturalists to, for the first time, professional "scientists". These professional scientists led the way for that era's outpouring of creative energies; with the Victorians seeing inventions such as dynamite, machine guns, typewriters, airships, light bulbs and telephones. Babbage had laid the foundations for the computer, and the motor car had been invented.

Dr John Snow

Victorian Britain gave rise to many reformers. At this time London was the largest city in the world and it was a focus for many of them. John Snow, Edwin Chadwick, and others inspected the districts in London by going on what were called "walking tours", making observations as they strolled along the streets and squares of the community. What they found was horrendous by our standards: disease and poverty were commonplace, and the stench of the streets was often unendurable. Chadwick commented that even in comparatively "healthy" districts, or parishes as they were called, heaps of rubbish lay decaying. It was under these conditions that the cholera epidemic broke out in the 1850s.

Dr John Snow is now well known as an epidemiologist. His classic work is that of the Broad Street pump, in Soho, in 1856. During Snow's preliminary survey of the community, he discovered that 500 deaths from cholera had occurred in a 14-week period. The signs and symptoms of cholera were too familiar to doubt the diagnosis; an epidemic existed in the area, and it was pervasive and spreading rapidly. The area of Broad Street was mainly residential although there was a percussion cap factory on the street and a church in the vicinity run by the Reverend Whitehead. The pump, located at an intersection in Broad Street, was the only supply of drinking water for the area. Snow investigated 89 fatal cases of cholera and found that 68 people who had died had drunk water from the Broad Street

pump. The story goes that he was convinced that there was something in the water from the pump, so he removed the handle. He then made his report and published it, mainly, as he said, to allay the fears of the people by demonstrating how he had controlled the spread of the disease.

The first environmental health officers

Two other Victorians, a lawyer, Edwin Chadwick (1800-1890) and the Reverend Henry Whitehead, were both contemporaries of John Snow. Edwin Chadwick's fame for us rests with his report, *An Inquiry into the Sanitary Conditions of the Labouring Population of Great Britain*, which he undertook as a Poor Law Commissioner in 1842, some 14 years before Snow's work. Chadwick eventually became the founding president of the Association of Public Sanitary Inspectors in 1883. An extract from the report is instructive (Box 1).

In the 1850s it was widely believed that disease was generated spontaneously from filth and transmitted by noxious invisible gas or "miasma". The conditions found by Chadwick in 1842 and his recommendations for improvements certainly appear to support the prevailing view of causation. So, according to Chave (1946), when Snow presented his theory to the General Board of Health of the parish regarding the cholera outbreak in Broad Street in 1856 it was rejected outright. However, they did vote to continue the investigation (passed by just one vote). Dr. Snow enlisted the support of the Reverend Henry Whitehead, the vicar of the church near Broad Street, and they conducted a thorough investigation.

There were three hypotheses:

- the epidemic of cholera was caused by something contaminating the water in the well (Snow's theory);
- the epidemic of cholera was caused by a diffuse agent in the atmosphere; and

Box 1

First, as to the extent and operation of the evils which is the subject of this inquiry:

That the various forms of epidemic, endemic, and other disease caused, or aggravated, or propagated chiefly amongst the labouring classes by atmospheric impurities produced by decomposing animal and vegetable substances, by damp and filth, and close and overcrowded dwellings prevail amongst the population in every part of the kingdom, whether dwelling in separate houses, in rural villages, in small towns, in the larger towns—as they have been found to prevail in the lowest districts of the metropolis.

That such disease, wherever its attacks are frequent, is always found in connection with the physical circumstances above specified, and that where those circumstances are removed by drainage, proper cleansing, better ventilation, and other means of diminishing atmospheric impurity, the frequency and intensity of such disease is abated; and where the removal of the noxious agencies appears to be complete, such disease almost entirely disappears.

That the expenses of local public works are in general unequally and unfairly assessed, oppressively and uneconomically collected, by separate collections, wastefully expended in separate and inefficient operations by unskilled and practically irresponsible officers.

That the existing law for the protection of the public health and the constitutional machinery for reclaiming its execution, such as the Courts Leet, have fallen into decrepitude, and are in the state indicated by the prevalence of the evils they were intended to prevent.

Second, As to the means by which the present sanitary condition of the labouring classes may be improved:

The primary and most important measures, and at the same time the most practicable, and within the recognised province of public administration, are drainage, the removal of all refuse of habitations, streets, and roads, and the improvement of the supplies of water.

That by the combinations of all these arrangements, it is probable that the full insurable period of life indicated by the Swedish tables; that is, an increase of 13 years at least, may be extended to the whole of the labouring classes.

That the attainment of these and the other collateral advantages of reducing existing charges and expenditure are within the power of the legislature, and are dependent mainly on the securities taken for the application of practical science, skill, and economy in the direction of local public works.

And that the removal of noxious physical circumstances, and the promotion of civic, household, and personal cleanliness, are necessary to the improvement of the moral condition of the population; for that sound morality and refinement in manners and health are not long found co-existent with filthy habits amongst any class of the community (Report from the Poor Law Commissioners on an Inquiry into the Sanitary Conditions of the Labouring Population of Great Britain, London, 1842, pp. 369-372).

- the epidemic was associated with stench or "effluvia" from drains in the streets.

They discarded using a questionnaire because most people in the parish around Broad Street could not read, so they conducted personal interviews, including with those who did not become ill, and with others who had moved away from the district. As a pastor, Whitehead was known and trusted by the local people, and they welcomed him as he went to see them repeatedly to make inquiries about the epidemic and confirm the information. Whitehead was a cautious investigator who documented as much information as possible, including the age, sex, and household position of the people occupying the houses of the deceased or ill. He categorised the sanitary arrangements and collected information on the sources of drinking water. He knew the number of persons occupying each residence and the hour of onset of illness. Chave (1946) reports that 497 people were interviewed.

Snow noted that there was a decline in cholera cases after the pump handle had been removed up to the time the pump handle was reconnected about a month later. After analysing all the evidence, Whitehead supported Snow's hypothesis and formulated a further hypothesis of intermittent contamination of the pump water in view of the fact that too many people drank water from the pump and survived. However, he still did not understand how contamination occurred. Two other Victorians, Pasteur and Koch, were important to that understanding.

In 1865, Pasteur began to study the silkworm diseases that were crippling the silk industry in France. He discovered the infectious agents and revealed the manner in which these agents were transmitted, and how to prevent them. Elaborating on his earlier study of fermentation, he could now confirm that each disease is caused by a specific microbe and not by some "miasma" then considered the prevalent cause. But it was not until 1876 that Robert Koch isolated the cholera bacterium, which actually caused the contagion. Koch postulated:

- that the organism could be discoverable in every instance of the disease;

- that, extracted from the body, the germ could be produced in a pure culture, maintainable over several microbial generations;

- that the disease could be reproduced in experimental animals through a pure culture removed by numerous generations from the organisms initially isolated;

- that the organism could he retrieved from the inoculated animal and cultured anew.

Snow and Whitehead identified cause and effect before Pasteur's theories could account for infectious disease, and before the causative cholera organism was isolated and identified by Koch.

To sum up the Victorian Era, there were:

- Dr John Snow, a general practitioner, and Henry Whitehead a vicar, who effectively founded the discipline of epidemiology in 1856;

- Lois Pasteur, a chemist, primarily interested in crystallography and who established microbiology in 1877;

- Robert Koch, a physician, who identified the cholera bacterium (among others) and devised Koch's Postulates for investigating disease;

- Edwin Chadwick, a lawyer, who became the first president for the Sanitary Inspectors Institute in 1884 (Mason 1998).

The "Sanitary Inspectors"

The history of Britain, Australia, New Zealand, and elsewhere are littered with stories of improper sanitation and epidemic disease. Colonial New Zealand in the 19th Century described by MacLean (1964) was no different from the London described by Chadwick, or Victorian Sydney described by George Dansey, the Chief Health Officer from 1870 to 1888 (Mayne 1982).

For example, Christchurch, a large metropolitan city in the South Island of New Zealand, has a river running through it, the Avon. When the first settlers arrived in 1843 they described it as "clearer than crystal" (MacLean 1964), but by 1876 the disposal of nightsoil, drainage and household refuse had so polluted the river and surrounding area that a sewerage scheme was commissioned. However, the ratepayers considered the use of underground sewers to be "unnecessary, expensive and dangerous to health" so the scheme was abandoned. MacLean (1964, p. 76) reports the then Health Officer, Dr Nedwill, as saying in 1879, "both the inspector and myself after a three hours' cruise on two successive days [were] feeling quite ill".

Following further evaluations the sewerage scheme was adopted and the first main was completed by 1882. However, in this growing town connection to the sewer was somewhat slow, averaging 89 households per year between 1883 and 1901, which was less than 2% of households per annum (Maclean 1964). However, increased interest in environmental health, stimulated by an outbreak of plague in Sydney, and a change in Council's attitude led to 791 houses being connected in 1902. In Auckland, the city's bulk food storage was primarily in the waterfront basements, which tended to flood with a mixture of sewage, seawater and rain when heavy rainfall coincided with high tide; the outfalls were located below the high water mark.

There was a desperate need to reform the public health legislation, and the disparate health administration and enforcement in New Zealand. The New Zealand Colonial Secretary, when introducing the Public Health Bill 1900, said "in any reform of the health laws it ... should remove from local public bodies the duty now devolving upon them which is never, or hardly ever carried out" (Maclean 1964, pp. 76). This Bill became the *Public Health Act 1900*, which created the first real Department of Public Health under the control of the first Minister for Public Health, Joseph Ward. This was the forerunner to the New Zealand Ministry of Health. The major role of this fledgling department and the *Public Health Act 1900* was that of preventative health, which included what we would now call 'environmental health'. Until that time, responsibilities had been left to local control, but because of poor performance the new Act entirely removed them from local authorities and vested them in the new Department of Health.

Sanitary Inspectors to Health Inspectors

Little seems to have been heard from Sanitary Inspectors from 1900 until the 1914-18 war, when environmental health issues became important, particularly burial of the dead (men and horses) which became a sanitary matter of the greatest importance. The stench would have been foul, and a further tribulation on the already overburdened soldiers. However, the worst feature would have been the spread of enteric disease. The bodies of both men and horses could easily become a mass of flies. The result was often widespread outbreak of disease. The situation is aptly described by the Chief Surgeon of the American Expeditionary Force in the following memorandum (Box 2).

After World War One, where other armies, as well as the American Expeditionary Forces (AEF), successfully dealt with the dead created by the Victorian inventions of TNT and machine guns, the Sanitary Inspector once again seems to fade, except for a few brief mentions, in various

Box 2

American Expedition Forces

France.

October 21, 1918

From: Chief Surgeon, First Army Corps, American E.F.

To: Chief Surgeon, S.O.S., American E.F.

Subject: Systematic Method for Burial of Dead

Attention is invited to the necessity for establishing for the entire A.E.F. a system for burial of dead during open operations.

2. It at once became evident that some systematic method of solving this problem must be adopted

(a) From a sanitary viewpoint, burials should be accomplished promptly. Fighting troops cannot be removed from the line for this purpose.

(b) After an engagement, combatant troops are exhausted and should not be called upon to perform manual labour, at least until they have been thoroughly rested.

(c) The effect upon the morale of combatant troops of being compelled to bury their own dead is very bad. During conditions such as they were at Chateau-Thierry when the bodies soon became black, swollen, discoloured remnants of humanity, literally covered with maggots, the effect is of course tremendously bad.

(d) If left to combat troops, each division will have its own method or no method at all and the results are bound to be unsatisfactory.

On his recommendation the AEF made the following arrangements:

One company of Pioneer Infantry (Corps Troops) is assigned to each division and is placed under the control of the Division Sanitary Inspector. They are to be used for no other purpose than burial of the dead - men and animals. They will follow up the advancing combatant troops as closely as possible and bury the dead as they find them. They shall be supplied with picks and shovels and rationed with the division (http://www.worldwar1.com/dbc/burial.htm).

histories such as MacLean's Challenge for Health (1964). Dow (1995), in his history of the New Zealand Health Department mentions them only four times. However, one exception to this is the report on the New Haven Health Centre's operations in the 1920s in the United States, where it appears the Sanitary Inspector was also a Census enumerator (Box 3).

A number of environmental health journals appear to have published memoir-type records of Sanitary Inspectors' activities. *The New Zealand Journal of Environmental Health* published the memoirs of William de Roo who worked as a Sanitary Inspector from the early 1900s through to the 1950s. Speaking about his milk

Box 3

Report On the New Haven Health Center

July 1920 - June 1923

By Philip S. Platt, M.A., C.P.H.

Among the several methods of public health administration that the Health Center desired to test out for the city was that of generalised inspection performed in a sufficiently small area to permit the establishment of a constant many-sided contact between the inspector and his district. The Health Center was particularly fortunate in the selection of the inspector detailed to the district by the Health Officer and in the wide latitude given to him and the Director to work out the details of his job. It was desired that all types of inspection should be performed by the one inspector instead of by five inspectors1 as in the other parts of the city, but exception was made of the somewhat specialised work of the milk and meat inspectors, while the special inspector whose duty it was to inspect and score restaurants and barber shops throughout the city was not interfered with. All other types of inspection were made by the Health Center inspector. These included inspection of apartments, houses, yards, barns, cinemas, push-cart peddlers, ice cream vendors, fruit and vegetable stands, grocery stores, harbour bathing, smoke nuisances, and the investigation of all complaints. But these represent only a part of the inspector's duties. Among special activities of particular value were his yearly house-to-house inspections. These were made in the belief that they would uncover many conditions and reveal much knowledge that would be of interest and value. In the course of the first of these inspections, the 1920 U. S. census was checked within 400, the number of adults, children and lodgers being enumerated. During the second of these inspections a census of unemployment in the district was made, which revealed significant information of considerable value to the Mayor, the Chamber of Commerce, and Mr Hoover's Committee on Unemployment. A third inspection, the results of which have been partially given in the discussion of the social conditions in the district, also provided much information regarding the sanitary conditions of each apartment and yard. A fourth inspection and census of the district was made in the spring of the present year.

He was always of assistance in the meetings of the Local Advisory Council and in the organisation and conduct of our various popular meetings, entertainment, parties and contests. Mr. O'Donnell's work has been a most successful demonstration of the value of generalised sanitary inspection, conducted in a modern educational spirit and is one of the distinct contributions, which the Health Center has been able to make to the Board of Health.

1. The five specialised inspectors dealt respectively with, tenements, unsanitary conditions, milk inspection, meat inspection and special inspections (restaurants, barbershops and barns) (http://info.med.yale.edu/newhavenhealth/documents/historical/center/san.html)

sampling work, which seemed to take a significant proportion of his energies working as a Sanitary Inspector in New Zealand in the 1930s. De Roo reports:

> *There were about three hundred vendors, excluding shops, and many of these were producer-vendors. Deliveries in the main were by horse float, and it was not uncommon to come across as many as six vendors at one time delivering in the same short street. Due to very keen competition and lack of agreement among vendors, there was much sly cutting of prices with its inevitable tendency to promote adulteration. Sampling control, no light task, while in the main my responsibility, also required the other inspectors at Christchurch Office to take a proportion of samples (de Roo 2001, p. 13).*

Box 4

In the tragic event of another war overtaking us, history seems likely to be repeated, so far as sanitary inspectors are concerned…

By 1941, there was an acute shortage of sanitary inspectors, which was accentuated by the reduction in the flow of new recruits. As a result, many local authorities found themselves with inadequate staff to maintain their public health services at a proper standard of efficiency.

In any future war the maintenance of the health and sanitary services will certainly be no less important that in 1939-1945 and with the development of atomic weapons and biological warfare there are good reasons for believing that unprecedented health hazards will face the country.

A number of departments have been approached, but the enquiries made have elicited very little information. The Ministry of Health has said that there is no intention at present of varying in wartime any of the statutory duties of the sanitary inspectors.

It is true that the memorandum referred to stresses the importance of environmental health services, but it does not appear to have been appreciated by the draftsmen that sanitary inspectors have some connection with these services, for it does not contain a single reference to them. This is quite incomprehensible (*Environmental Health Journal Online* 2002).

Except for memoirs, the Sanitary Inspector seems to disappear until immediately after World War Two. In the June 1952 issue of the *Sanitarian (Environmental Health Journal Online* 2002) the following article was published warning of the dangers of a shortage of Sanitary Inspectors (Box 4).

From after World War One to the mid-nineteen fifties the New Zealand Sanitary Inspectors' responsibilities were largely defined by the *Health Act 1920*, a direct product of the 1919 Influenza pandemic, an Act, however, that restored some health responsibilities to Territorial Local Authorities. In 1956 a new Act was created, *The Health Act 1956*, which consolidated the 1920 Act and generally followed its framework. Specific additions to the 1956 Act defined powers and duties of Local Authorities; defined powers and duties of the Department of Health, particularly with regard to Public Health; added further controls on infectious diseases; and provided for limited controls on air and water pollution. At that time a new *Hospitals Act* was also passed consolidating the responsibility of all funding of hospitals to the Government, and the Sanitary Inspector became the Health Inspector.

The *Health Act* also created the Board of Health, which, among other duties, had the responsibility of overseeing Local Authority accountability in health matters to prevent the mistakes of the past. A number of key reports were published, for example, "Health Responsibilities of Local Government" and "The Training and Employment of Health Inspectors in New Zealand". Both of these reports had a significant influence on the development, training and employment of Health Inspectors through the 1960s to the 1980s.

Recent decades have seen immense changes in every facet of New Zealanders' lives. Health Inspectors have become Environmental Health Officers, and the changes are significant, for example, the operational Health Department was transformed to a policy focused Ministry, some Public Health Services have been contracted out to private companies, others remain with the hospitals and continue to use the name Public Health Units. Services have become quite fragmented, with no

single agency in charge. The Ministry of Health does have overall responsibility, but is not an operational arm of government. Finally, in July 2002 the New Zealand Food Safety Authority took responsibility for food functions.

Local Authorities in New Zealand also underwent restructuring and reorganising. Small local authorities were amalgamated with each other, or swallowed by larger authorities to become more economic. This process was accelerated in the late 1980s to create the structures now in New Zealand. Like the health boards, many Territorial Local Authorities continue to investigate the most appropriate structures to meet their community's needs and the more efficient delivery of services.

The central theme running through is that the "Health Inspectors" and the skills they brought to the workforce were no longer domiciled in a single employer, as they had been at the beginning of the century. The fragmentation of employing authority, or employing agency, has accelerated. Combined with fragmentation has been an uncertainty about the future shape of the profession and employing agencies.

The Environmental Health Officer

The *Health Act 1956* still dominates much of the work of the New Zealand Environmental Health Officer irrespective of employer and political changes. However, the Ministry of Health is undertaking a review of the *Health Act 1956* and has projects under development on the preferred legislative approaches for:

- a risk management methodology for public health issues
- Maori issues as they relate to a public health risk management framework
- public health service delivery infrastructure.
- competencies, training, accreditation and appointment of public health officers (Ministry of Health 1999).

A new "Public Health Act" with a clear focus on public health/preventative medicine is expected in New Zealand. The new Act, with the change in food administration, will bring a new era for environmental health professionals. Environmental health is defined by Koren (1991, p. 1) "as the art and science of the protection of good health, the promotion of aesthetic values and the prevention of disease and injury through the control of positive environmental factors and the reduction of potential hazards – physical, biological, chemical and radiological". This is one definition of environmental health, there are others, but what is the difference between an Environmental Health Officer, a Sanitary Inspector, and a Health Inspector?

Chadwick and Snow, were none of these. Sanitary Inspectors barely rate mentions in the two books about New Zealand's early public health. Why? We can perhaps classify the work of the Sanitary Inspector and the Health Inspector as a job, although some would definitely have called themselves "professionals", but where is the evidence? The Concise Oxford Dictionary describes professionals as "…the body of persons that are engaged …in some branch of learning…". Research is learning, it contributes to the world body of knowledge, of understanding and underpins professional practice. What Snow and Chadwick accomplished was research. What Pasteur and Koch did was research. A recent review of the New Zealand environmental health knowledge base by Merrilees (1997) on behalf of the Ministry of Research Science and Technology, identified that the Environmental Health research that had been done to date tended to fall within other disciplines and "depended to some extent on the interests at the time of particular individuals". This situation is not unique to New Zealand.

In *Handbook for Research in the Health Sciences*, Minichiello et al. (2001) produce

four questions relating to the development of a health care discipline's knowledge base:

- To what extent have members of the discipline responded to the call to conduct research?
- Is the focus of research related to practice?
- What research methods have been employed?
- How oriented towards theory building is research?

These points could equally apply to the discipline of environmental health, even though its inclusion in the category of a "Health Care Profession" could be regarded as equivocal. So how have members of the environmental health discipline responded to the call to conduct research? What is the research base?

In New Zealand there is not yet a large, peer reviewed, body of evidence-based research. Most research originates overseas and tends to be published in a range of disparate journals depending on the specific topic area. The main peer reviewed journals for environmental health research are the *International Journal of Environmental Health Research* that has only been published since 1991, and *Environmental Health* introduced in 2001. A number of other professional journals exist for the environmental health discipline such as the *New Zealand Journal of Environmental Health*, however, these tend to act as a professional forum, rather than a repository of research and peer reviewed practice.

There is a need to develop a research culture within the profession to underpin professional practice. We need to publish and develop a body of knowledge. Environmental health is a diverse discipline and does not fit easily into a single research funding category so it is curently difficult to obtain research funds. This was one of the key findings identified by Merrilees (1997) who then identified the following as potential opportunities:

- Risk perception and priority setting
- The relationship between water and health
- Agricultural health
- Occupational health
- Housing and health
- Standard setting and policy making in environmental health
- Exposure assessment methodology development
- Occupationally and environmentally induced cancers
- Health impact of geothermal emissions
- Factors contributing to ethnic differences in disease rates.
- Environmental change and infectious disease.

This is an extensive list, but a start has been made to identify priorities for environmental health research. There have been significant changes in environmental health, from 1856 to 2000. One of the more noticeable ones has been a trend away from an inspection model to a permissive, risk-based model. For example, the *Food Hygiene Regulations 1974* where criteria are stipulated in legislation against which the officer notes compliance or non-compliance to the *Resource Management Act 1990*. In the following example from Section 17 (3) of *New Zealand's Resource Management Act 1991*, the enforcement officer is required to decide what is noxious, dangerous, offensive or objectionable:

…notice may be made or served under Part

> *XII to—- (a) Require a person to cease, or prohibit a person from commencing, anything that, in the opinion of the Planning Tribunal or an enforcement officer, is or is likely to be noxious, dangerous, offensive, or objectionable to such an extent that it has or is likely to have an adverse effect on the environment; or…*

It will be the officer's opinion in this instance that will determine the offence, but the officer will have a knowledge base on which to base his opinion. The problem is the methodology used to contextualise the scenario. Up to now this has been a skill demonstrated by officers in pursuit of their duty in an implicit fashion, probably to varying degrees of success. In the last 10 years there has been the development and introduction of Risk Assessment and Management techniques from the quantitative worlds of finance and toxicology into a wide range of areas. A useful review has been provided by Penny (1999), in which she covers the origins and definitions of risk assessment, its applications, and some issues. She suggests that "risk assessment is a generic tool that can be applied in many different fields". She further suggests that "…the process can be used as a tool to identify and evaluate risks in any environmental health setting…." (Penny 1999, p. 27). This is a useful premise and the use of risk assessment and risk management as an environmental health tool seems to be the link between an environmental health hazard and an appropriate intervention.

Environmental health references prior to 1990 make no mention of Risk Assessment and Management within the disciplinary context. The first mention is in Koren (1991) and in a two-volume text rates just over two pages (pp. 51-53). The focus in this text relates to the uses of risk assessment techniques primarily to determine toxic effects, or risk characterisation. This is the quantitative risk model. In his three paragraphs dedicated to risk management, he attributes most of the responsibility for this function to the United States Environmental Protection Agency –USEPA. He defines risk management as "the complex of judgement and analysis that uses the results of risk assessment to produce the decisions that are necessary to bring about and environmental action" (Koren 1991, p. 53).

In 1999, a joint Australian and Standards New Zealand standard was released, *AS/NZS 4360 Risk Management*. This document outlines, in a generic sense, the procedures to be used to identify, analyse, evaluate, and treat risks. The process outlined in the standard is:

- Establish the context
- Identify Risks
- Analyse Risks
- Evaluate Risks
- Treat Risks
- Monitor and Review
- Communicate and Consult

A review of the literature has indicated a paucity of research on the coherent and integrated use of Risk Assessment techniques in environmental health. Some research literature has been focused on the identification of a particular problem, particularly in the food area, such as Tebbutt (1993) and Toh, Birchenough, & Smalley (2000) where risk systems are enshrined in legislation (*Food Act 1981* and *Animal Products Act 1999*). There is literature that can be described as quantitative risk assessment, mostly in the toxicological area, such as Covello and Merkhofer (1993), and finally there is discussion material. Virtually none could be regarded as valid research in the area identified by Penny (1999), namely the generic use of Risk Assessment techniques in environmental health. Environmental health is a discipline that identifies, analyses, evaluates, and treats risk

to human health.

There have been other changes in environmental health – that of education. The qualification has evolved from a one-year training program through to an undergraduate degree. There are now postgraduate qualifications, such as Masters and PhDs. This change has introduced and prepared new graduates for the future. Students are introduced to methodologies such as Risk Assessment and Management and are spending more time being educated on process, rather than on content.

Risk Assessment and Management is the process that Chadwick, Snow and Whitehouse actually did in the 1850s even if they could not describe it as such; this process underpinned the work and their achievements. Even though they did not know the cause of cholera they had a strong methodology. It is not what they did, it is how they did it. They also published. The importance of publishing can apply equally to environmental health practitioners.

Conclusion

There is a difference between the Sanitary Inspector and Health Inspector and an Environmental Health Officer. The Sanitary Inspector and Health Inspector were employed to undertake certain functions. They barely exist in the literature. An Environmental Health Officer is a practitioner of the body of knowledge known as environmental health. It is a discipline, independent of the employer, like biochemistry, or anthropology. The challenges of colonial roots have made us an innovative and dynamic discipline. We must research what we do, to support and underpin practice, and it must be published, to aid others and to create a body of evidence.

Endnote

1. An earlier version of this paper was presented to the 29th National Conference of the Australian Institute of Environmental Health, Sydney, 20-25 October 2002.

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Housing for Health and Fixing Houses for Better Health[1]

Paul Pholeros

Healthabitat[2]

Connections between the living environment and health have been well documented over the last 150 years. Often hidden in the discussion are the detailed links between the living environment, the people who live in that environment, and their health. As an example, think about the ability to carry out the most basic of functions with significant health benefits - washing a young child. A tub is filled with warm water and the child is washed, dried, and put into a clean set of clothes. This appears to be simple. But what is involved in this apparently simple activity?

First, there is the need for water and if we assume a rural or remote setting this may be from a dam, bore, stream or river. The water needs to be pumped to a storage tank and then piped to the house. Once in the house a tap will be essential to turn the water on and off. Also essential are a tub, hot water system, plug, drainage, soap, shampoo, towel, and clothes. All these things need to be present and in working order simply to wash the child. To provide and maintain these services a large number of people need to have an ongoing interest in all the items and coordinate their work towards a common endpoint. The list would include the bore mechanic, engineer, house designer, plumber, electrician, store keeper, and of course the carers of the child. They are all working towards the simple goal of washing a child. Perhaps this means it is not so simple after all.

If the links between the chain of people and resources fail, more children will be attending the local health clinic. This negative outcome may not be immediately obvious to the providers of the services that maintain health, the water supply authority, housing providers, and environmental health officers. For the last 17 years, Housing for Health projects have been attempting to provide and maintain these types of links for improving the safety and health of the people living in the house and surrounding environment. The work started in Central Australia, in the north west of South Australia on the Anangu Pitjantjatjara Lands, where the then Director of Nganampa Health Council (NHC), Yami Lester, proposed a project to "stop people getting sick", or in the local language, Uwankara Palyanku Kanyintjaku (UPK).

The work started with Aboriginal workers and bosses and looked at around 90 houses with the aim of improving health through simple, immediate change to the living environment. The report of UPK came after some immediate change had been achieved, not before. It has remained a key principle of the work that followed, "no survey without service".[3] While the work has grown in scale and complexity the focus has remained the same.

In the last five years, 2042[4] houses have been repaired and made functional ("fixed"). The work has been funded from a variety of sources including ATSIC, the Commonwealth Department of Family and Community Services, State Housing and Health departments. The work has covered six regions (NSW, SA, WA, NT, Qld, and the TSI), and has involved suburban, rural and remote area housing. Urgent safety and health items only are targeted and local community teams are employed in the survey/fix process (approx. 520 local staff[5]). Over 75% of all staff are local Indigenous people. The work nationally is estimated to

have improved the living conditions of 14000 people.[6]

The housing for health process involves survey-fix sheets, which record over 230 items in each house; most of these items require testing by the local teams. Forty-eight items can be fixed immediately at the survey-fix stage by the local teams. Each team is provided with a tool kit with repair and testing tools and consumables (light bulbs, plugs, toilet rolls, coat hooks, shelves, toilet roll holders, shovels, buckets and so on) to leave in the house as required. The sheets are completed and taken to the project's portable computer where the data are entered into a custom designed database and worklists are produced for licensed trades, provided by the project, to carry out more extensive fix work on the same day as the work is commenced.

Training for the local teams is "hands on" with practical "training boards" used to give experience in testing and fixing in a safe, controlled environment and under close supervision. What gets tested and fixed follows a priority that was set during the original UPK project. The Healthy Living Practices (HLPs) define an activity that needs to be carried out to improve or maintain health. The Healthy Living Practices from most important to least important are as follows:

Safety

1. Washing people; particularly children
2. Washing clothes and bedding
3. Removing waste safely
4. Improving nutrition
5. Reducing the impact of crowding
6. Reducing the impact of animals; insects and vermin
7. Reducing the impact of dust
8. Temperature control
9. Reducing trauma

Each Healthy Living Practice has a number of components that have to be present and working to ensure satisfactory performance. An example of the items that make up one of the ways to wash people (using a shower) are listed below:

The shower area

1. Water in: hot water OK
2. Water in: cold water OK
3. Hot water temperature OK
4. Taps: hot OK
5. Taps: cold OK
6. Shower rose OK
7. Shower drainage OK
8. Diameter shower waste (mm)
9. Door &Lock (inside only) OK
10. Walls OK
11. Floor: floor waste OK
12. Floor: finish OK
13. Floor: grade OK
14. Ventilation OK
15. Shampoo/soap holder OK
16. Clothes hook/s OK
17. Towel rails/racks OK
18. Shelves OK
19. Lights working OK

In the above, list the first seven items are considered critical, that is they are an essential minimum for having a shower, the

others are desirable but NOT essential. The tests for these seven critical items give a "yes" or "no" answer only. There are no grey areas. A house is only said to pass the above test when ALL seven items are working.

A national project carried out over the last two years[7] on approximately 800 houses shows 33% of houses having a working shower when the teams arrived at the house. At the completion of the work of the project that number had risen to 74%. Why not 100%? The answer is that to get all parts of the HLP working is not simple. Some of the other results of the same national project are shown in Table 1.

Table 1: Critical Health Living Practice

Critical Health Living Practice	% of 792 houses functioning at the commencement of the project	% of 776 houses functioning at he completion of the project
Safety: Safe electrical system	13	64
Washing people: shower	33	74
Removing waste safely: WC	52	78
Improving nutrition: store, prepare and cook food	1	5

It is important to note that the above results were achieved with an average budget per house of approximately $3000. A common question about the figures is "why are the results so poor?" or more commonly a statement is made that "the results are to be expected because vandalism is a major problem in Indigenous housing".

Healthabitat ensures detailed records are kept by the licensed trades about the reason why the fix work was required. This information is recorded for every work item completed no matter how big (full electrical re-wire) or small (replace a tap washer). The categories are as follows:

Routine: the work was required due to normal day to day wear or what would be considered "normally required maintenance" in any house (replace hot water system element, replace tap washers, or septic tank pump out).

Faulty: work considered to be needed due to the initial work being poorly installed or against national or state standards or codes (electrical wiring incorrect, drainage pipes running up hill, or undersized septic tank)

Damage: work needed to fix items that have been damaged, overused or abused by people using the house (power point broken, or toilet bowl cracked or broken). The results from the Fixing Houses for Better Health project are shown in Table 2.

Table 2: Results from the Fixing Houses for Better Health Project

Reason given for repair by licensed trades Total items identified for work was 18,320	% of 792 houses fixed
Routine	72
Faulty	25.5
Damage	2.5 (460 items)

The above figures and proportions reflect figures collected on all projects over 17 years. Clearly, the house residents are not the problem. Lack of routine maintenance is the key issue followed by a significant number of problems being caused by poor initial construction.

The prime aim of Healthabitat and the Housing for Health types of projects is to improve the living environment, not to collect data, or write reports. However, the data collected as a tool to fix houses can also be used to inform new house design, services design, community planning, and to identify particular items within a house that fail regularly. There seems little point fixing poor quality houses if more poor quality housing is being built at the same time.

Data collected have been used by various design groups, organisations, and industry to improve the following (the corresponding Healthy Living Practice follows in brackets):

- find the best performing, most economical hot water system (washing people)
- improving tap performance (washing people)
- washing machine performance and minor modifications to improve longevity (washing clothes and bedding)

- better local waste water disposal system design with improved function and reduced maintenance (removing waste water safely)
- improved inspections during the installation of all in ground waste water systems (removing waste water safely)
- development of an alternate outside kitchen (improving nutrition)
- detailed intervention into the design of yard areas with outside cooking, secondary toilets, planting, re-use of waste water, use of rainwater, improving the amenity of the edge of the house for people to use as living space (reducing crowding)
- dog health programs (reducing the impact of animals, insects and vermin)
- dust mite reduction in communities where the problem exists (reducing the impact of animals; insects and vermin)
- reducing dust by detailed landscape works, fencing design, ponding banks, earth mounding and dust reducing sprays for roadways (reducing dust)
- detailed work on reducing house temperatures in summer and improving the general economy of heating and cooling houses (temperature control).

All of the above have been documented in the National Indigenous Housing Guide. Produced by the Federal Department of Housing (Pholeros 1999), the first edition was published and endorsed by all States in 1999. The National Indigenous Housing Guide takes Safety and the Nine Healthy Living Practices as the framework to examine how housing can be better designed, built and maintained to improve the health and wellbeing of the residents. It has an environmental health and wellbeing focus.

As described above, this work started with and for Aboriginal people in Central Australia. It has been expanded to involve Aboriginal and Islander people in a wide cultural and geographic area around the county. It is now clear that the key principles are universal. The general link between the living environment and health has been known for many years (McKeown & Lowe 1974; World Health Organization 1986). Great gains will be made in the improvement of people's health through the day to day attention to apparently minor detail that will allow health gains to be made. Wherever we work, we should consider:

- the link between how people live and health
- national housing policy now gives a strong emphasis to health as a key condition of house design, construction and maintenance. Specific links are described in the National Indigenous Housing Guide
- change is possible, the problem is not too difficult to make a difference.

Endnotes

1. An earlier version of this paper was presented to the 29th Australian Institute of Environmental Health National Conference in Sydney, 20-25 October, 2002.
2. Healthabitat has three directors, Dr Paul Torzillo, Stephan Rainow and Paul Pholeros.

3. First used by Dr Fred Hollows.

4. Detailed house numbers change almost daily due to the number of current projects.

5. Projects record accurate staff numbers, but at the time of writing many projects are underway and a specific figure would be changing almost daily.

6. Projects record accurate house populations, but at the time of writing many projects are underway and a specific figure would be changing almost daily.

7. Aboriginal and Torres Strait Islander Commission (ATSIC) funded the Fixing Houses for Better Health project.

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Environmental Tobacco Smoke in Hospitality Venues in South Sydney Council

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To determine the level of exposure to environmental tobacco smoke in a range of hospitality venues we undertook a cross-sectional survey of 15 venues measuring fine particles, carbon dioxide and carbon monoxide levels indoors and outdoors, and nicotine levels indoors. Weekly average levels of nicotine varied from 1 - 88µg/m^3. Fine particle levels measured as PM_{10} varied from 19 - 941µg/m^3. Nicotine and fine particle levels were strongly correlated. All venues except for two exceeded the PM10 standard (one of these was non-smoking). Contribution of fine particles from outdoors was minimal compared to indoor sources for most venues. Effective ventilation, as assessed by carbon dioxide, had no significant impact on levels of nicotine or fine particles. We have demonstrated that levels of environmental tobacco smoke encountered in hospitality venues without smoking restrictions are high. Such levels are associated with increased risks for ischaemic heart disease and lung cancer, particularly for employees. This study highlights the environmental health imperatives to eliminate smoking as an occupational health hazard in all buildings.

Key Words: *Tobacco Smoke Pollution; Environmental Exposure; Nicotine; Air Pollution; Indoor Air Pollutants; Occupational Social Control*

Passive smoking is increasingly recognised as a risk for both the health and amenity of non-smokers. Over the past two decades, increasing restrictions on indoor environments where smoking is permitted, such as bans on smoking in public transport, government offices and shopping centres, have resulted in hospitality venues being a principal source of exposure to environmental tobacco smoke (ETS) for non-smokers. In hospitality venues, exposure to ETS is a particular health risk for employees, and also non-smoking patrons.

There is little published documentation of pollutant levels associated with environmental tobacco smoke, particularly in an Australian setting. This lack of representative data makes any quantitative risk assessments of ETS exposure difficult to perform.

This study was conducted prior to the passing of the *Smoke-free Environment Act 2000* (NSW) which prohibited smoking in enclosed public places, including restaurants, from 6 September 2000. Eating areas of bars and clubs were exempted for 12 months. The timetable for its application to non-food service areas in these establishments has not been determined. Existing occupational health legislation provides a "duty of care" for employers to protect employees and patrons of their business from exposure to health hazards on their premises.

In 1997 South Sydney Council resolved to develop initiatives to promote South Sydney Council "as the place for smoke free indoor eating and drinking" and "to increase the number of smoke free venues to improve public health and satisfy community demand". This study was developed to raise awareness of indoor air quality issues with particular emphasis on environmental tobacco smoke. The awareness raising is

targeted at the general community, hospitality venues and Council itself with the overall aim of increasing the number of hospitality venues that are smoke free in South Sydney local government area.

Methods

We selected and approached around 30 hospitality venues in South Sydney local government area that represented a range of venue types and sizes. Fifteen agreed to participate in the study. There were six restaurants, six cafes and three bars located in the suburbs of Darlinghurst, Newtown, Surry Hills, Chippendale, Redfern and Camperdown. We collected basic information on the venue capacity, opening hours, means of ventilation and location.

We conducted all air monitoring during the warmer summer months (in November 1999), to represent a best case scenario for ventilation, with all available windows and doors open, or air conditioning operating. We used two methods of air monitoring: nicotine was measured by passive sampling, and fine particles, carbon dioxide and carbon monoxide were measured using handheld active logging devices.

Passive sampling

We measured nicotine by passive sampling. The passive samplers employed in this project were based upon the well-characterised design of Ferm as discussed in detail by Keywood and Ayers (Ayers 1998a; Keywood 1998). Passive gas samplers operate on the principle of molecular diffusion, the gas of interest being collected on a filter coated with a sorbent species, integrated over the time of exposure. The passive samplers consist of a short squat tube with a collection medium (chemically impregnated filter) at one end. The other end is exposed to the atmosphere, with a porous cover that ensures a well-defined diffusion length. The coating solution used in the nicotine passive samplers is a solution of sodium bisulfate. Glass fibre filters were soaked in coating solution and dried under clean conditions prior to use. After exposure, the collected nicotine was obtained as an aqueous solution by extracting each filter in 2 ml of Milli-Q grade water in polythene bags. Extraction was for one hour with periodic shaking. The nicotine concentration in the aqueous solution was determined by gradient ion chromatography as described by Ayers (Ayers 1998b). A blank concentration was assessed from the sampler that was exposed for one week in a non-smoking restaurant, with the blank nicotine level below the analytical detection limit of 0.1 μMol l^{-1} in this sample. Reproducibility of the passive samplers was assessed by deploying duplicates, and was on average 8%.

We visited the venues, and deployed a passive sampler on a column, shelf, or other suitable position, close to where the active sampling was performed. The samplers were left in place for one week, which included the time of the active sampling. Samplers were then sealed and returned to CSIRO Division of Atmospheric Research for analysis.

In two venues, selected for convenience to access at opening and closing times, passive samplers were also deployed for an eight-hour period that was expected to represent peak occupancy in an attempt to assess peak nicotine levels.

Active sampling

We performed fine particle measurements with a TSI DustTrak™ aerosol photometer (model 8520), with a cut-point for particles of less than 10 microns (PM_{10}). Carbon monoxide and carbon dioxide measurements were taken using a TSI Q-Trak™ indoor air quality monitor (model 8551). Simultaneous 15-minute samples were taken with time constant settings of one second and one minute logging intervals.

We visited each venue during a time when it was expected to be busy, either lunchtime, or Friday or Saturday evening. We recorded the occupancy level of the venue and the

number of active smokers at the time of sampling. The sampling points in all venues were as far as practicable located in the centre of the venue avoiding windows, doors, openings, supply and return air registers and concentrated gatherings of smoking patrons. We sampled at a point above the floor ranging from one to two metres, so as to be within the breathing zone of patrons.

Outdoor measurements were taken at similar heights immediately after the indoor samples were taken. An outside position was selected one to two metres from any open doors or windows to minimise contamination from indoor air.

We obtained average annual daily traffic volumes from the Roads and Traffic Authority for those venues located on roads where this data is recorded. The most recent available data (either 1996 or 1999) were used.

Analysis

Data were entered into Microsoft ® Excel 97, and analysed using the SAS System for Windows v6.12. Geometric means of pollutant levels were calculated as the measurements were non-normally distributed. Univariate analysis was performed for nicotine, PM_{10} and carbon dioxide levels. A variable representing the difference between outdoor and indoor PM_{10} levels (net PM_{10}) was created, and used to represent the contribution of environmental tobacco smoke to PM_{10}. Similarly we calculated netCO_2 the difference between outdoor and indoor CO_2. We undertook multivariate analysis for nicotine levels, net PM_{10} and indoor PM_{10}, using those variables that were significant in univariate analysis, and finding the best model by backwards stepwise elimination to achieve the best adjusted R-squared, with the least standard error. As residuals of the models fit the assumptions of normality, analysis using log-transformed variables was not required. We provide results for all analyses to enable readers to predict PM_{10} levels from measured nicotine levels and vice versa.

As it was logistically difficult to deploy and retrieve nicotine monitors during opening hours only in all venues, we made an estimate of exposure to ETS during the operating hours of the venue. We calculated "projected nicotine", by adjusting the measured weekly level of nicotine for the reported hours of opening, assuming that nicotine was only generated when the venue was open.

Results

Basic venue descriptions and monitoring results are in Table 1 overleaf.

Weekly average levels of nicotine, and 15-minute average indoor and outdoor PM_{10}, carbon dioxide and carbon monoxide levels were available for all 15 locations, except that the nicotine level in the non-smoking restaurant was below the detection limit.

In those venues above the detection limit, nicotine levels varied from 1µg/m^3 to 87.9µg/m^3, with a geometric mean of 17.4µg/m^3. Nicotine levels were strongly correlated with indoor PM_{10} and carbon dioxide levels (Pearson correlation coefficients were 0.91 and 0.67, P = 0.0001 and 0.007 respectively). Univariate analysis of nicotine levels found that significant predictors of nicotine levels were indoor carbon dioxide (40%) and the difference between indoor and outdoor carbon dioxide (net CO_2) (31%), indoor PM_{10} (81%) and the difference between indoor and outdoor PM_{10} (net PM_{10}) (80%). In multivariate analysis, 84% of the variability in nicotine levels were predicted using the variables net PM_{10} and hours per week the venues were open (Table 2).

In the two venues where nicotine was also monitored for 8 hours, one (venue 2) showed a level approximately twice the weekly average (47µg/m^3 compared to 25µg/m^3 for the week). In the other venue, however (venue 12), the 8-hour sample was below the detection limit. Projected nicotine levels varied from 0 to 160µg/m^3 (Table 1), with a geometric mean of

Table 1: Description of venues and monitoring results.

Venue	Hours open /week	Venue type	Venue capacity	Ventilation type	% of patrons smoking	Outdoor PM_{10} μg/m³	Indoor PM_{10} μg/m³	Carbon Dioxide ppm	Carbon monoxide ppm	Nicotine μg/m³	Projected nicotine μg/m³
1	56	cafe	32	A/C+fans	25	20	93	775	4	7.53	23
2	92.5	cafe	85	Windows+fans	12	43	101.5	638	4.5	25.33	46
3	72	non-smoking restaurant	35	Windows	0	16	19	537	4	0	0
4	168	dining area of bar	90	A/C+window	11	40	215	979	4	25.17	25
5	37.5	bar	200	A/C+windows	24	94	278	776	3	22.74	102
6	73	bar	100	A/C	3	24	97	919	4	19.22	44
7	46	restaurant	38	Windows+fans	3	20	39	556	3	1.0	4
8	78	cafe	30	Windows+fans	10	24	140	598	4	13.25	29
9	79	restaurant	50	Windows+fans	50	47	82	614	4	10.43	22
10	94	bar	45	Windows+fans	22	40	133	600	6	31.48	56
11	73.5	cafe	30	A/C+fans+windows	22	33	428	842	6	20.29	46
12	84	cafe	45	A/C	7	25	204	847	5	22.70	45
13	103	cafe	40	Windows	25	43	306	668	5	29.14	47
14	92.5	bar	200	A/C+windows	8	49	941	1106	5.5	87.89	160
15	87	restaurant	25	A/C+fans+windows	20	19	141	608	5	22.14	43

38μg/m³. The projected nicotine level for venue 2 during opening hours was 46μg/m³; this is very similar to the actual measured 8-hour level of 47μg/m³.

Indoor PM_{10} levels varied from 19μg/m³ to 941μg/m³, with a geometric mean of 143μg/m³. All except two venues exceeded the National Environment Protection Measure (NEPM) for PM_{10} of 50μg/m³ (24-hour average), one of which was the non-smoking restaurant (venue 2), and the other a well ventilated restaurant with few smokers apparent (venue 7) (NEPC 1998). These venues also had the lowest average nicotine levels in the study (undetectable and 1μg/m³). Outdoor PM_{10} levels varied from 16μg/m³ to 94μg/m³, with a geometric mean of 32μg/m³. Only one outdoor measure exceeded the NEPM standard. The net PM_{10} ranged from 3μg/m³ to 892μg/m³, with a geometric mean of 95μg/m³.

Indoor PM_{10} levels were strongly correlated with indoor carbon dioxide and nicotine levels (Pearson correlation coefficients were 0.71 and 0.91, P = 0.003 and 0.0001 respectively). We found that indoor PM_{10} levels were significantly predicted by nicotine (β = 10.1, R^2 = 0.82) (Figure 1), and indoor carbon dioxide and carbon monoxide, but not by outdoor PM_{10} levels. We also performed univariate analysis of the net PM_{10}. Significant predictors of net PM10 were nicotine (80%), indoor carbon dioxide (48%) and indoor carbon monoxide (31%). We found that the best model in multivariate analysis predicted 83% of the variability of netPM_{10}, using the exposure variables nicotine and net CO_2 (Table 2).

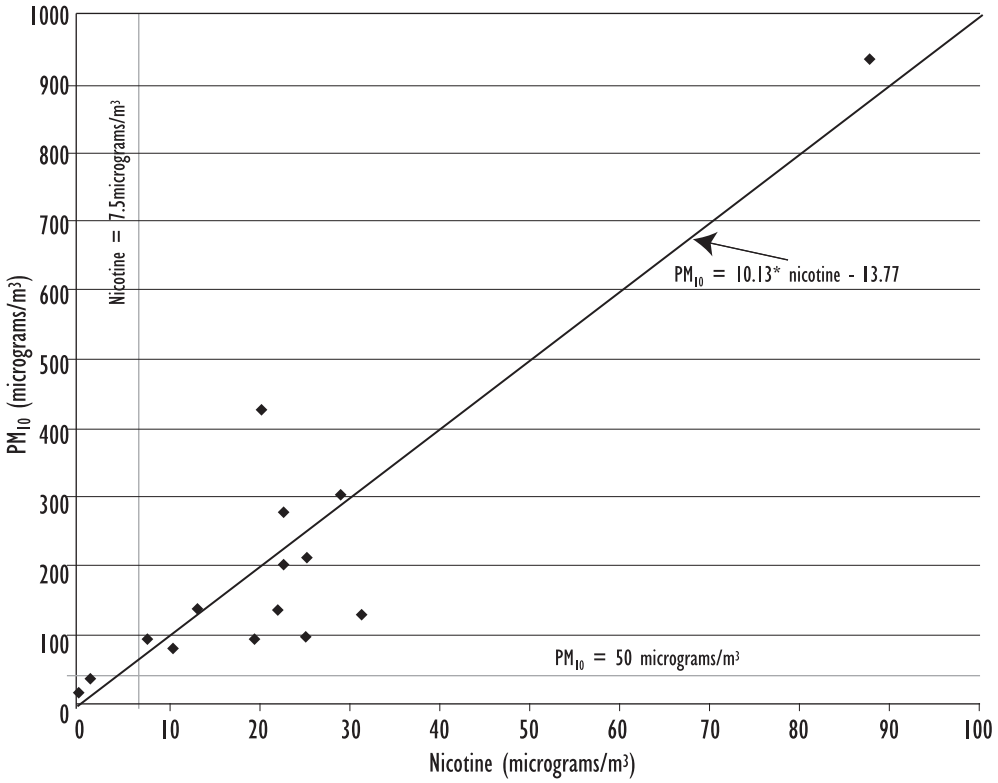
The regression equation describing the relationship between net PM_{10} and nicotine was highly leveraged by one observation where both nicotine and PM_{10} levels were extremely high. While there was no reason

Table 2: Linear regression outcomes - variables influencing weekly nicotine and15-minute average PM10 levels (mg/m3).

Outcome	Predictor	Estimate (β)	SE	t-statistic	*P* value
Nicotine	Net PM10	0.080	0.010	7.34[a]	0.0001
R^2 =0.84	Hours open	0.112	0.081	1.38[a]	0.1927
	Intercept	-1.065	7.044	-0.15	
Net PM_{10}	Nicotine	8.623	1.587	5.43[a]	0.0002
R^2 =0.83	Net CO2	0.226	0.182	1.24[a]	0.2390
	Intercept	-65.21	42.93	-1.52	
Indoor PM_{10}	Nicotine	10.13	1.310	7.73[b]	0.0001
R^2 =0.82	Intercept	-13.77	39.28	-0.35	

a. t-statistic on 12 degrees of freedom
b. t-statistic on 13 degrees of freedom

Figure 1: Relationship between weekly nicotine and indoor PM10 levels



to suspect that this observation was erroneous, we refit the model without this observation. The resulting equation:

$$net\ PM_{10} = nicotine*5.7 + 25$$

explained less of the variability between PM_{10} and nicotine, while predicting values in a similar range to that predicted by the model using all observations.

Indoor carbon dioxide levels (15-minute average) varied from 537ppm to 1106ppm, with a geometric mean of 720ppm. Outdoor carbon dioxide levels varied from 465 to 621ppm and only correlated with outdoor PM_{10} levels (Pearson correlation coefficient was 0.61, $P = 0.01$). Carbon monoxide levels showed little variability, from 3 – 6ppm indoors, and 2 – 8 ppm outdoors. Indoor carbon dioxide levels were categorised as less than or greater than 750ppm (Table 3) to provide an indication of the effect of adequate ventilation on pollutant levels. While mean PM_{10} and nicotine levels tended to be higher with the higher level of carbon dioxide, there was no significant difference between the groups.

Table 3: Geometric mean weekly nicotine and 15 minute PM_{10} by carbon dioxide level

Carbon dioxide	<750ppm	>750 ppm	
N	8	7	
Nicotine (mg/m³)	10.9	22.9	T=-1.23, P=0.24
PM_{10} (mg/m³)	91.7	238.8	T=-1.74, P=0.13

Discussion

We have documented exposure to fine particle and chemical pollution from environmental tobacco smoke in hospitality venues where smoking was allowed in South Sydney local government area. Peak (PM_{10}) and weekly averaged (nicotine) measures of

exposure to ETS were highly correlated and indicate significant exposure, particularly for the employees of these establishments.

The nicotine levels measured in these hospitality venues are similar to those found in studies of smoking workplaces in the United States (Hammond & Sorenson 1995; Miesner 1989). Reported studies of hospitality venues have usually used a shorter averaging period, but have found similar nicotine levels to those we measured over a week, ranging for example from 0.1 to 35µg/m^3 in North Carolina restaurants (Oldaker 1990). A study of hospitality venues in Perth, using peak nicotine and PM_{10} measures also showed a similar range of results, with nicotine levels from 0 - 53µg/m^3 and PM_{10} levels from 13 - 1625µg/m^3 (Western Australian Taskforce on Passive Smoking in Public Places 1997). The nicotine levels found in venue 14 in this study exceed by at least 50% maximum levels found in these previous studies. Our method of calculating predicted nicotine levels during opening hours is similar to the one used by Hammond (Hammond & Sorenson 1995. In this office setting the 90th percentile value of predicted nicotine was 34µg/m^3 whereas our 90th percentile projected nicotine was 84µg/m^3. The apparent exposure to ETS by this measure is much greater in the study, presumably as the smoking rate is greater in hospitality venues than other workplaces where smoking is permitted.

We have demonstrated a highly significant relationship between the difference of indoor and outdoor fine particles (net PM_{10}) and nicotine. This indicates that netPM_{10} is most likely attributable to ETS rather than other indoor sources such as cooking fumes or candles. In most venues where smoking occurred, the contribution of ETS to fine particle exposure is high compared to outdoor exposure.

We found that only two venues, one non-smoking and the other with few smokers and open only 6 hours a day, had PM_{10} levels that were below the health-based standard, and these acceptable PM_{10} levels corresponded with very low nicotine levels.

The validity of the different sampling methodologies is demonstrated by the high correlation between indoor carbon dioxide, PM_{10} and nicotine. The relatively high levels of carbon dioxide in some venues indicate that ventilation rates are inadequate for the number of patrons and level of smoking inside. However, even in venues where ventilation rates could be considered adequate (that is indoor carbon dioxide is similar to outdoor levels), nicotine and PM_{10} levels are still of concern, and not significantly different from those venues with higher indoor carbon dioxide levels.

A review of predictive modelling of the relationship between weekly averaged nicotine levels and fine particles in ETS determined a ratio of 10:1 for respirable particles (fine particles < 3.5microns) and nicotine (Repace & Lowrey 1993). We found a similar relationship in this study, although we measured the total PM_{10} fraction averaged over 15 minutes.

Previous modelling of workplace exposure to ETS and risk of lung cancer and heart disease mortality has predicted a 1/1000 risk for lung cancer and a 1/100 risk for heart disease in workers exposed to 7.5µg/m^3 nicotine (8-hr time weighted average) over 40 years (Repace 1998; Repace & Lowrey 1993). In our study we have assessed weekly average nicotine levels. An 8-hr measure in these venues is likely to be higher than the weekly level, but this has not been confirmed in this study. We found only two venues had nicotine levels below 7.5µg/m^3. Using the conservative assumption that weekly and 8-hr average levels are similar, the maximum exposure to ETS in our study would correspond to predicted risks of lung cancer and heart disease mortality of around 1/100 and 1/10 respectively for employees exposed over their working life. By comparison, Repace and Lowrey predicted a 2/100 risk of lung cancer death due to ETS for the most-exposed bar worker.

This level of occupational exposure to a known carcinogen can be compared to that

of occupational exposure to asbestos. In the case of asbestos acceptable occupational exposure is associated with a 1/100,000 excess risk of mesothelioma.

Conclusion

Levels of fine particles experienced by patrons and employees in hospitality venues where smoking occurs greatly exceed health-based goals, and are likely to be associated with significantly increased risk for respiratory and cardiovascular disease, particularly in employees. It is anticipated that our findings will support recent NSW government initiatives to prohibit smoking in all public places.

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Legislation

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Helminth Infection, Human Waste and Appropriate Technology: An Indonesian Case Study

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The World Health Organization has indicated that parasite infection, as the number one cause of diseases among 5-14 year-old children, should be one of the first problems addressed to enhance the quality of life, health and productivity of children throughout the world. A large proportion of the pollution problems causing morbidity and mortality in developing countries arise as a result of the failure to deal effectively with human waste. Efficient and effective latrines, essential for limiting helminth infection, have been the subject of campaigns in many developing countries, but have often failed to address critical cultural, social and behavioural issues as well as resource, environmental and technology issues. Based on data from two villages in Central Java, this study presents information and specifications for a latrine (BALatrine) that is designed for construction by local people using local materials in the villages of less developed countries. This latrine considers users' habits, resources and environment. It has two methods of use that make it possible to be used whether water is available or not. It is inexpensive and can be copied by people with low incomes, or by government, or private bodies. It is argued that the BALatrine decreases the risk of morbidity and mortality caused by helminth infection, gastroenteritis or similar diseases. Appropriate technology, combined with comprehensive health promotion in the village setting, gives hope for achieving improved results from latrine campaigns and reduction in helminth infection.

Key Words: *Helminth; Developing Countries; Latrines; Human Waste; Appropriate Technology; Indonesia*

The World Health Organization (1996) has indicated that sanitary interventions help to control a wide range of infections. Disposal of human waste, creation of safe water supplies, and personal and food hygiene have all been identified as key contributors to the reduction of disease, particularly those spread through human faeces. As a recent Information Series indicates (WHO 1996, p. 5) "an essential barrier to most helminths is to prevent human faeces from polluting the ground or surface water".

Gastroenteritis is a major problem in developing countries (Keen 2000) and because young people and children are generally the most affected, this results in a significant subsequent decrease in human resource capacity (Kilgoore et al. 1995). High prevalence particularly threatens those living in rural areas and is frequently associated with malnutrition (Jelliffe & Jelliffe 1989). In Indonesia, for example, gastroenteritis is one of the main causes of death and sickness (Suyudi 1999). The kinds of gastroenteritis that most commonly affect poorer rural populations in developing countries are diarrhoea, typhoid fever, cholera, dysentery and helminthiasis (Jacob 1984).

Intestinal helminths (parasitic worm disease), such as roundworm, whipworm and hookworm are understood to infect about 400 million school-age children globally (WHO 1996) and these parasites particularly affect people in developing countries (Arfaa 1999). In Indonesia the

prevalence of helminthiasis is high, particularly among school age children and official reports note that parasitic worm disease is a major source of morbidity (Health Department of Republic Indonesia 1994). The prevalence of helminth infection represents a major issue not only for the health system, but in broader national terms, since the wellbeing and learning potential of millions of children is involved and it is these very children who must be counted on to achieve national progress in the future.

The economic crisis over recent years in Indonesia has decreased the adequacy of calorie and protein intake in children. While efforts to increase family food sufficiency have been undertaken by government, it is also vital to decrease nutrient output caused by disease. A hookworm is able to suck blood at a rate of 0.38-0.48 cc each day and anaemia often affects people because of hookworm infection. This becomes more severe if the individual concerned eats insufficient iron. Albumin loss can occur both by bowel loss and worm suction. While roundworm (*Ascaris Lumbricoides*) causes bowel discomfort it also affect nutrition and growth as the worm takes up carbohydrates at a rate of 0.14 g each day (Lokolo, 1993). The Indonesian Health Department estimates that about 117.6 tons equivalent of rice and 8000 litres of blood each day are lost through parasitic worm disease in Indonesia (Health Department of Republic Indonesia 1994).

Helminth infections are typically contracted through consumption of contaminated water and food (Jelliffe & Jelliffe 1989). Unhygienic eating habits feature among the most probable methods of transmission, such as the common practice of not washing hands before eating or cleaning utensils in contaminated water. Human faeces contaminate many water sources in developing countries and thus water supply is of major concern. In Indonesia, almost all of the waterways in rural regions are used for sanitary purposes and reports have indicated that many wells are contaminated (Health Department of Pekalongan District 1998). Adding to the incidence of highly contaminated water sources is the low number of latrines in people's houses.

There are various reasons why many people do not have latrines in their homes, including those associated with human and material resources, environmental issues and technology. For example, poverty may lead a local community to view latrines as non-productive investments. The perceived need for latrines may be low due to lack of exposure and experience and the unappealing aesthetics of local examples. This may be associated with low levels of education and a failure to understand the impact of a poor environment or living conditions on health.

Environmental issues such as climate and geographical location are also important factors. In some places, for example, fresh well water is not available throughout the year and while this may not be one of the main causes of the lack of latrines, the lack of available fresh water during the dry season means that conventional latrines cannot be used. With little fresh water to use for family purposes, people typically choose alternative places for their daily bodily functions, namely waterways, plantations and rice fields.

In Indonesia, substantial efforts to introduce latrines have been made by health and other government officers and this has undoubtedly provided examples that can be copied by the community. Also, the erection of public latrines has been a step forward. Nevertheless, the impact of these efforts is restricted because the technology that is introduced, or proposed, is too expensive or advanced for the village people (Laksono 2000). For example, usually the latrines are squat latrines surrounded by masonry walls, but this latrine construction is too expensive for people to copy and needs water to operate. Also, custom, habits and tradition

are difficult to change and because people have familiar and convenient places for excreting body waste, it is not easy to introduce new latrines that demand new discipline and toileting habits.

A Community Analysis

Pekalongan, the site selected for this study, is a typical Indonesian district in Central Java. Industrialisation is growing, but agriculture is still dominant. Although the foundation for a modern infrastructure is in place, healthy habits and hygiene are limited by such factors as the lack of economic progress, low education levels and lack of health promotion. The prevalence of parasitic worm disease is high, particularly in school age children. While parasitic worms are infectious to people at all ages, it is children under 15 years old who are at the highest risk. Oediarso et al.'s (1977) research conducted in the Pekalongan district, found that 87% of school children were infected by worms (*Ascaris lumbricoides*, *Enterobius vermicularis*, and *Tricuris trichiura*). Moreover, 54% were infected with more than one kind of worm. While children tend to be infected with *A. lumbricoides*, the older people tended to be infected with *T. trichiura* (Oediarso et al. 1977). Partono (1984) noted that worms infected 95% of students in his study and that those living in villages have higher risks than do people in the city.

Official data from the Indonesian Health Department indicate that 40% of families in Indonesia have latrines (Suyudi 1999). However, such an average may conceal substantial variations across sub-populations. Laksono's survey in Kedungwuni, a subdistrict in Pekalongan, for example, indicates that 90.1% of families do not have latrines (Laksono 1995). Under such circumstances, soils surrounding the latrines, waterways and waste places are more highly contaminated than other places (Mutholib & Suzuki 1981).

This study used data relating to the existence and use of latrines as well as related knowledge and attitudinal issues from two school communities in the subdistrict of East Kedungwuni, Pekalongan district, in order to provide a community context for the proposed technological intervention. The school community diagnosis related specifically to 80 participants from two elementary schools. They were in fifth grade and had an average age of 11.25 years, with 49 females and 31 males. The children came from relatively large families with the average number of children being five. The majority of the children's parents' formal education level was elementary school and the majority of their occupations were as low-skilled workers. Parents gave about 300 rupiah (AUS $0.08) pocket money to their children per day. Many families did not have cement floors in their houses, and almost 19% lived with a soil floor in the guestroom. Slightly more than a third (37.3%) of the children's households had a family latrine. Over 91% (73) of the students were infected with parasitic worm disease.

All families in both groups used a well as their water source, but this did not ensure access to clean water. The Health Department of Pekalongan District (1998) reported that 86% of wells in the District contaminated were by *Escherichia Coli*, indicating the wells as a source of pollution. The low proportion of latrines in students' families indicates that there were many potential pollution sources. Moreover, the number of students and their families who excrete in the bush and in waterways suggests that the cycle of parasitic worm diseases was likely to be perpetuated in their environment.

Table 1 indicates a number of hygiene-related student behaviours, for example, the number of students who wash their hands before eating; the use of sandals or shoes among students; those who use a spoon when eating (rather than their fingers); those who used toilets; and those who had clean nails.

Table 1: Personal hygiene and latrine habits of students (N = 80)

Clean hands after excretion	Use sandals or shoes	Use spoon when eating	Clean nails	Use toilet
52 (65%)	39 (49%)	71 (89%)	27 (34%)	43 (54%)

Implications for Technical Assistance

Based on the village circumstances described above, some reasons for the lack of success of many latrine campaigns conducted in Indonesia become apparent and a number of critical characteristics to improve the potential success of such campaigns can be proposed:

- there must be flexibility regarding the availability of water. A latrine must be capable of efficient and effective use both in wet and dry seasons, whether or not water is available;

- there must be reasonable cultural familiarity and ease of use. Those who do not use latrines are familiar with the ease of defecating in the general environment. This means that if the latrine design is simple, people will be more likely to adopt required changes leading to the use of healthy latrines;

- the proposed intervention must be inexpensive to allow for fluctuating and difficult economic circumstances. Latrines must be affordable so that total populations, regardless of income, can build them. Low-income families need to see the value in building latrines and thereby forgo some alternative investment.

Although the latrine must be inexpensive, it must, however, also be effective in terms of health considerations. Health promotion and the recognition of environmental pollution must be developed in conjunction with appropriate technology in order to stop the cycle of gastrointestinal communicable diseases. Although not ideal, latrines built according to the specifications outlined below are preferred to rivers and other natural waterways being used for sanitary purposes.

Specifications have been developed for a latrine, Budi's Amphibious Latrine (BALatrine), the technical design of which relates previous (non-latrine) habits to new healthier sanitary toilet habits. The BALatrine has flexibility with regard to water availability, users' discipline and budget and is proposed as an alternative latrine for the community.

The BALatrine Technology[1]

Many of the tools required, such as mattock, crowbar, wood handsaw and trowel, and many of the materials for the BALatrine are typically available in the village setting. Moulding and building materials, such as pieces of bamboo tree, cement, sand and split stone, or a piece of PVC pipe are also relatively easily available, although they may form part of a supporting government or agency supply system. Experience indicates that the overall cost of materials and labour amounts to about Rp. 62.000 and, while exchange rates fluctuate, with the Australian dollar at a value of 4600 Indonesian Rupiah, to make the BALatrine would cost about AUD$13.50.

The construction method of the BALatrine is relatively simple, with a septic tank of two or more meters (in areas where water levels fluctuate widely this would be deeper to avoid contamination). The bottom of the hole should be above the local water table and the minimum distance from a well should be 20 meters. If the land is easily eroded, it would need to be strengthened with bamboo or cement.

When the concrete is strong enough, the mould can be carefully moved and placed above the hole at the top of the septic tank. The positioning of the closet must take into consideration the interior of the tank, with local habits or customs also dictating placement directions. The amphibious (water) closet should be positioned on the

latrine's plate. Before use, the owners can construct walls from readily available materials, for example, plaited palm leaves or bamboo strips, plastic or weatherproof paper.

The use of this latrine is the same as that of the usual squat latrine. The major difference, however, relates to the availability or lack of water. It is also low maintenance, as far as cleaning is concerned. The water closet may be removed when matter is deposited directly into the septic tank hole. As a precaution against flies and other insects, the hole must be secured with a wooden cover.

Some advantages and disadvantages of the BALatrine

There are both advantages and disadvantages of the BALatrine. The major advantage relates to its functioning in both wet and dry conditions. If the latrine uses the water closet it is the same as the usual latrine typically recommended by health officers, emphasising the major purpose of latrine campaigns. This method will help to cut the infectious cycle of parasitic and gastrointestinal diseases. Nevertheless, as indicated, campaigns conducted using this method have experienced high rates of failure in many places. The main reason for failure has been the lack of available water for flushing the toilet during dry seasons, resulting in blocked pipes and failure to keep the latrine clean.

The second method, removal of the water closet, provides flexibility as opposed to the permanent method. When individuals or communities are not ready to receive a permanent latrine for whatever reason, including water restrictions, habits, culture, lack of social and environmental awareness and lack of enforcement of regulations, the 'dry' option of the BALatrine can be used. Since the latrine does not need water for cleaning and is positioned in a familiar setting people can leave after use, ensuring that the lid is replaced, and the latrine will not be plugged or stopped. Although this method is less hygienic and may emit odours, it is an improvement on polluted waterways or land.

The two options available with the BALatrine can be selected by families and the community, and, while both options have disadvantages and advantages, these options mean that risk of the failure of latrine distribution will be minimised. Although people will choose the method most suited to them, a concurrent health promotion initiative should be mounted to increase the general awareness of the need to make informed decisions for their own health.

A water reservoir is not included in the BALatrine method largely because a permanent water reservoir often raises new problems of mosquitoes in the environment. The use of pails is preferred due to their availability or ease of purchase. Also, pails are better than a permanent water reservoir for rural communities because they are removable and can be used for a number of other domestic or agricultural purposes. This means, however, that the water pail must be cleaned after each use and if this procedure is not adhered to, infection problems may well arise.

Although the BALatrine is designed for collective community use, the best choice, that is the "U" bend latrine, is more likely to be selected when individual families use the latrine. Success is anticipated when a family makes the decision and the financial investment to build a family latrine, as the owner will choose to build it near the house and personal ownership and investment will mean better maintenance. This in turn will mean better hygiene and better health.

There are a number of additional features of the BALatrine. For example, the septic tank and water absorption well are together, which means a reduced budget. Also, if the septic tank is full, the latrine can easily be moved to another hole. If moving the latrine, the septic tank needs to be cleaned out or closed and this closure must be governed by a clear yet simple protocol. As

part of an on-going development, an additional input of cement will allow the BALatrine to become a permanent healthy toilet. Finally, the BAL Latrine closet is heavy enough to be relatively stable and the latrine can be maintained in an appropriate position.

Conclusion

Bundy and de Silva (1998) ask: "Can we deworm this wormy world?". They indicate that new, broad spectrum, low-cost anthelmintics and new understanding of epidemiology have led to more cost-effective and sustainable strategies. They indicate that there have been great improvements using new approaches to infection control. Nonetheless, morbidity and mortality from parasitic worm disease, gastroenteritis and associated communicable disease remain a major problem in developing countries. At the local level, latrine campaigns have a history of failure, often due to the technical design of the latrine not being suitable for people living in a poor rural environment. Budi's Amphibious Latrine provides an alternative and an opportunity to reduce the problems of such latrine campaigns.

It should be clearly noted, however, that to maximise the benefits of the BALatrine, social and behavioural interventions are also required. Thus, the need for effective hand washing, for example, remains critical, as does the need for the water pail to be regularly cleaned to avoid cross-contamination. The protocol for closure must be closely adhered to, and regular monitoring of levels of liquid and solid material in the tank must take place.

A strength of the BALatrine concept is that it recognises the significance of previous habits which allows it to be more acceptable to village people whatever their level of education. Also, it takes into consideration the availability of water and thus has no seasonal restrictions. It is inexpensive and so is cheap enough to be easily copied and the low cost also makes it easier to include in government or foundation projects. Field experiments over the last five years in Pekalongan indicate that the BALatrine is a useful adjunct to latrine campaigns. However, additional research is required to establish clear health benefits arising from this intervention. Future studies should also undertake both economic evaluations and comparisons of the BALatrine with other septic tank models.

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The BALatrine (Budi's Amphibious Latrine) was created in Pekalongan, 1997, and has been developed from early experiments since that time. The authors thank the villagers of Pekalongan, Central Java province, Indonesia, who participated in the research and helped to construct some of the latrines.

Endnote

1. Details and instructions regarding components, construction, and design plans for the BALatrine are available from the authors.

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Environmental Noise: Part 1[1]

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In an attempt to protect those people most exposed to noise and to its effects government bodies have increased their efforts in environmental noise control. Noise is fortunately measurable, but it is important to understand its complexity and for its measurement to be carried out accurately under different circumstances before the noise can be controlled. However, establishing broad-based and effective noise-control programs for industry has been a difficult and contentious matter. This has been partly because of economic conflicts created by noise control programs and regulations but mainly due to the enormously wide variation in the human reaction to and acceptance of noise. Other conflicts arise when industrial or commercial developments are to be built near to existing housing or when permission is given to build housing close to existing noisy industry. The citizens whose health is affected may then have a justifiable complaint against the industry that is then responsible for reducing the noise. The issue subsequently becomes who should be liable for paying for the noise control, the industry or the local government authority that permitted the building.

Key Words: *Noise Pollution; Noise Control; Measurement; Industry*

The Effects of Noise

Noise pollution

As the extent of noise and its effects on people have become measurable, private and government bodies have increased their efforts on environmental noise control in an attempt to protect those people most exposed. However, establishing broad-based and effective noise-control programs for industry has been a difficult and contentious matter. This has been partly because of economic conflicts created by noise control programs and regulations but mainly due to the enormously wide variation in the human reaction to and acceptance of noise.

Another conflict over noise control in communities involves noises that do not, at any one time, reach a large number of people and are more private than public. These noises are from neighbours, from barking dogs, from amplified music, from gatherings of people, and from frequent use of noisy gardening equipment or power tools.

There is a conflict between the advantages of modern travel and the movement of goods, with the increasing use of motorcars, motorcycles, aircraft, trains and trucks, and the increasing demand for noise reduction. Measures such as aircraft curfews, roadside noise barriers, and government grants for home insulation are examples of compromises. These are often unsatisfactory to all of those concerned.

Other conflicts arise when industrial or commercial developments are to be built near to existing housing or when permission is given to build housing close to existing noisy industry. The citizens whose health is affected may then have a justifiable complaint against the industry that is then responsible for reducing the noise. The issue subsequently becomes who should be liable for paying for the noise control, the industry or the local government authority that permitted the buildings.

Exposure to noise, in the environment has a number of physiological and psychological effects. The main causes for concern are:

- stress and annoyance
- speech interference and reduced concentration

- sleep disturbance, and, in extreme cases,
- acoustic violence.

Stress

In the animal kingdom a loud noise signifies danger. Our bodies are geared to increasing blood pressure and heart rate in the presence of sudden or high noise levels. This is an involuntary reaction and causes stress. The number of mistakes, for example, made by operators entering production statistics into a computer in a noisy environment, can be reduced significantly by lowering the noise. Truck drivers in quiet cabs have fewer accidents than those in noisy cabs as it is less stressful and therefore less tiring. Prolonged exposure to noise commonly has two very different effects on different people: a reduction in stress with time or an increase in stress with time. Human response to all sensory stimuli is highly variable and the response to noise is no exception. What is important is that all of these responses are "normal". There seems to be at least two main types of person. One who "learns to live" with the noise and gradually adapts to it, and the other type who becomes progressively more disturbed by it and could be said to be sensitive to noise. In one case a person who strongly objected to a low-level (30 dBA), low frequency, tonal noise from a centrifugal fan still heard the noise after a week, even when he was on holiday. In another case a woman, who was normally exposed to regular coal train noise at indoor levels of about 50 dBA, stated that she could not sleep during a train drivers' strike because of the lack of sound.

In summary, there is nothing extraordinary about people becoming highly stressed by the presence, in their own home, of low-level noise that is audible. This occurs particularly when that noise is unwanted, uncontrollable, has an unpleasant character, and when the home provides no refuge from it.

Annoyance

Noise annoyance may be defined as a feeling of displeasure evoked by noise. It is not only the amplitude or level that causes annoyance, it is also the type or character of the noise or the psychological message that the noise relays. The character will include how the level changes with time (the temporal structure) and the frequency content (i.e. whether the noise energy is concentrated in discrete frequency bands (tonal) or over a wide frequency range (broadband). The lower the levels of the sound, the more dominant the character will become in the annoyance perception.

Examples of the psychological message that the noise relays are:

- the sound of a distant gun shot may not annoy a keen shooter but may infuriate a person who has lost a loved one in a shooting accident;
- the noise from aircraft may not annoy a regular air traveller but annoy a person who has fears of an aircraft crash or is strongly concerned about aircraft pollution.

Speech interference, reduced concentration and audio alarms

Noise can interfere with auditory communications in which speech is one of the most important types of signal. Detailed communication is one of the fundamental attributes that set humans apart from others in the animal kingdom. One essential part of good sound communications is a high level of wanted sound (signal) as compared to the ambient sound (noise). This is often called the signal-to-noise ratio and is the reason for the usual inclusion of the existing background noise in environmental noise assessments. Speech interference level starts at around 50 dBA for octave bands centred on the main speech frequencies 500 Hz, 1 kHz and 2 kHz.

For normal speech communications at a distance of approximately 1 metre, a

background noise of no more than 45 dBA is preferable, 55 dBA is just acceptable and 65 dBA will require extra vocal effect to be understood. Good communication in rooms will also depend on the amount of acoustic absorption in the room. The modern day aesthetic trend in restaurants and bars to have all 'hard' surfaces and no acoustic absorption (e.g. carpets and curtains) make them acoustically poor and requiring a strained vocal effect to communicate.

For audio alarms (from alarm clocks to fire alarms) the signal should be set at 5 dB over the ambient noise level to be heard, 15 dB over the ambient noise level to attract attention, and no more than 25 dB to prevent startle.

Sleep disturbance

We close or eyes when we sleep but we do not close our ears. The restoration theory of sleep maintains that sleep serves as a curative function as well as a replenishing function. It restores bodily processes that have deteriorated during the day and replenishes and renews brain processes through the stimulation of protein synthesis.

Noise can prevent sleep and awaken people from sleep. This has been demonstrated by electrophysiological and behavioural methods. Sleep disturbance can be due to continuous as well as intermittent noise and a measurable effect starts at about a LAeq of 30 dBA. The prevention of adequate sleep can cause people to be irritable, nervous and unable to concentrate and therefore can be described as a form of torture.

Environment Protection Authority Criteria

The Environment Protection Authority (EPA) recognises that many short-term high-level noises which occur at night may comply with criteria for continuous noise and yet be undesirable because of the sleep disturbance or arousal effect (NSW EPA 1994, 2000).

Sleep arousal is a function of both the noise level and the duration of the noise. Not all people are affected to the same degree by noise, and at different times, a person will be more or less affected by the same noise. Even in cases where a person is not awoken by noise that person's sleep may be affected. The effects of noise cannot be predicted with any degree of accuracy.

Noise control should be applied with the general intent to protect people from sleep disturbance. To achieve this, the noise level that is exceeded for 1% of any one-minute period ($L_{A1,1\ min)}$ of any specific noise source should not exceed the background level ($LA_{90,\ 15min}$) when the source noise is not present, by more than 15 dB when measured outside of the bedroom window.

WHO Criteria

The World Health Organization ([WHO] 1993, 2001) has stated that for a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10–15 times per night, and most studies show an increase in the percentage of awakenings at sound exposure levels (L_{AE}) of 55 to 60 dBA. For intermittent events with an effective duration of 10 to 30 seconds, L_{AE} values of 55 to 60 dBA correspond to a L_{Amax} value of 45 dB. Ten to 15 of these events during an eight-hour nighttime implies an $L_{Aeq,8h}$ of 20 to 25 dB. This is 5 to 10 dB below the $L_{Aeq,8h}$ of 30 dBA for continuous nighttime noise exposure, and shows that the intermittent character of noise has to be taken into account when setting nighttime limits for noise exposure. For example, this can be achieved by considering the number of noise events and the difference between the maximum sound pressure level and the background level of these events.

If negative effects on sleep are to be avoided the equivalent sound pressure level should not exceed 30 dBA indoors for continuous noise. If the noise is not continuous, sleep disturbance correlates best with L_{Amax} and effects have been observed at 45 dB or less. For sensitive people an even lower limit would be preferred. It should be

noted that it should be possible to sleep with a bedroom window slightly open (a reduction from outside to inside of 15 dB). This gives an external noise L_{Amax} limit of 60 dBA and an $L_{Aeq,8h}$ limit of 45 dBA.

To prevent sleep disturbances, the equivalent sound pressure level and the number and level of sound events should be considered. Mitigation targeted to the first part of the night is believed to be effective for the ability to fall asleep.

Noise and acoustic violence

Acoustic violence is violence exercised by means of sound. Such sound does not have to be loud, it is a noise that causes unrest or harm to the receiver. The receiver often has no control over the duration or the amplitude of the noise. Here acoustic violence can lead to physical violence. In extreme cases noise annoyance has been the cause of neighbourhood violence and even suicide and murder.

How to Measure Noise

Decibels

Noise can be defined as an unwanted, inharmonious or harmful sound. Sound is a form of energy and the decibel scale can be used in any field where the measurement of the flow of energy (power) is required. It has the advantage of compressing a very wide range of numbers into a more manageable scale. The human ear is very sensitive to energy flows and it can detect a power per unit area (Watts/m^2) as small as:

$$\frac{1}{1{,}000{,}000{,}000{,}000}$$

This is used as a value for the threshold of human hearing. In everyday life, values in the range of 0.000,000,000,001 to 0.01 (Watts/m^2) may be encountered. To measure such a wide range is like trying to measure one millimetre and the diameter of the earth (12,600 km) on the same scale. It is difficult to take in such a wide range of numbers and it is often better to simply "count the noughts" to get "a feel" for the problem.

First, we divide all the numbers by the threshold of human hearing, that then gives everyday noise values of about 100 to 1,000,000,000. Then we "count the noughts" and call them Bels (after Alexander Graham Bell 1847-1922). So 100 becomes 2 and 1,000,000,000 becomes 9. Unfortunately, this scale is compressed slightly too much for our liking so we use a tenth of a Bel (called a deci-bel, deci meaning tenth as in decimetre). Therefore, 100 becomes 2 Bels or 20 decibels and 1,000,000,000 becomes 9 Bels or 90 decibels. We then have a convenient and manageable range of numbers.

Sound pressure

Ears and microphones sense the fluctuating air pressure in their vicinity rather than the flow of energy. The eardrum and similarly the diaphragm of a microphone, is moved to and fro (vibration) by sound pressure waves with successive crests and troughs. Pressure is measured in many units such as bars, atmospheres, pounds per square inch (psi) and newtons per square metre (which is now known as the Pascal (after Blaise Pascal 1623-1662) abbreviation Pa). Pressure is related to the flow of energy. Unfortunately, trying to measure pressure directly suffers from the same wide range of numbers problem, as does energy flow. We fall back to the dB to give a convenient scale.

Decibels addition

Although we have developed a convenient scale we have also given ourselves a problem with the addition (and subtraction) of the numbers. For example one person speaking in a room may produce 60 dB at your ear level. If two people are speaking at the same time you would not expect the sound to be 120 dB which is the level 50m from a jet aircraft take-off. So:

60 dB plus 60 dB does NOT equal 120 dB

We can find from measurement (or theory) that 60 dB plus 60 dB equals 63 dB. This is known as the 3 dB Rule and it applies regardless of which part of the scale is being

assessed. For example, 100 dB plus 100 dB equals 103 dB and 20 dB plus 20 dB equals 23 dB, and so on.

When two sounds are added that are very different in volume, say 60 dB and 75 dB, the energy at 75 dB is so much more than that at 60 dB that the smaller sound becomes inaudible and insignificant. In practical terms:

60 dB plus 75 dB equals 75 dB

The general procedure for adding dBs is:

(i) find the difference between the two values, and

(ii) add a factor to the higher value.

The factors are shown in Table 1.

Table 1: Factors used for dB addition

Difference in dB value	Add to the higher value
0	3
1	2.5
2	2
3	2
4	1.5
5	1
6	1
7	1
8	0.5
9	0.5
10	0.5
11	0.5
12	0.5
13 or more	0

For example, 60 dB plus 53 dB. The difference is 7 dB from the table you need to add 1 dB to the higher value (60 dB). Hence 60 dB plus 53 dB equals 61 dB.

Ambient noise subtraction

When a noise source is measured in the environment it almost always includes some degree of ambient noise. To evaluate correctly the source noise, the ambient noise level must be subtracted from the total noise level measured. This is particularly important in the assessment of, for example, fans, air conditioners, or swimming pool pumps. It becomes crucial when the source noise is only just above the ambient noise. See Box 1.

Box 1

In an air conditioner noise and swimming pool pump assessment the ambient (i.e. with air conditioner and swimming pool pump turned off) a was found to be 47 dBA (this was measured before and after the source noises were switched on). The total noise with the A/C noise on was 52 dBA and the total noise with the pool pump noise on was 49 dBA. (See Table 2 below).

Table 2

Plant Noise	L_{Aeq}, 15 minutes
All off	47
A/C on	52
Pool Pump On	49
All off	47

What are the actual noise levels of the A/C and the pool pump alone? The ambient noise cannot be switched off, but it might be possible to measure the source noise when the ambient is very low (e.g. 3 am). However, this is not usually a popular idea with any of the parties concerned. Fortunately, there is another method to find the correct answer. The values can be calculated using the decibel addition method (3 dB Rule) in reverse. First, find the difference between the value, i.e. A/C – Ambient = 52 – 47 = 5 dB. Look up 5 dB in left-hand column of Table 1 above. The right hand column gives 1 dB to subtract from the total noise level measured. The A/C noise alone is 51 (i.e. 52 –1). The pool pump is 49 – 47 = 2 (left hand column of Table 1) = 2 (right hand column of Table 1). Hence the pool pump noise alone is 45 (i.e. 47 –2).

The 'A' weighting

The origins of the 'A' weighting

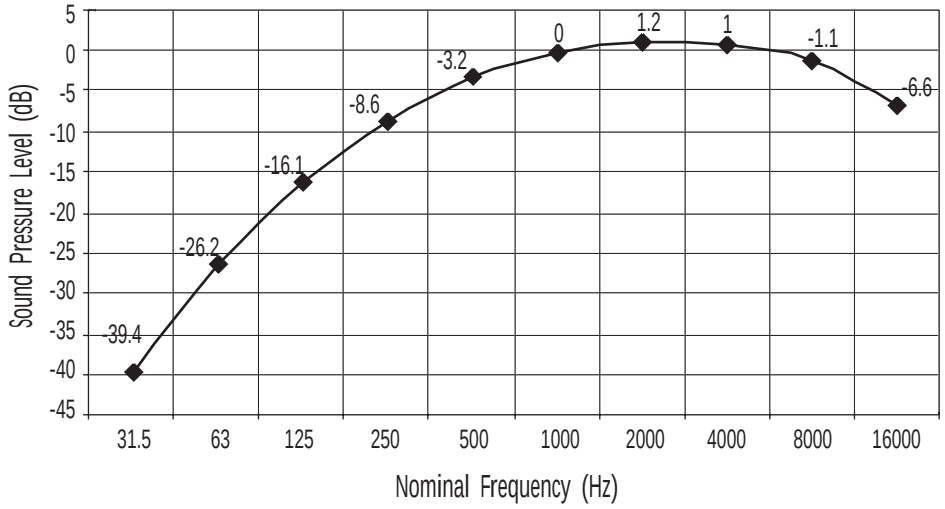
The human ear is not as sensitive to all sounds if they vary in pitch or frequency. Generally, speaking the low frequency bass tones sound slightly quieter than the tones in the mid-frequency range (i.e. 2000 to 5000 Hz). Experiments were carried out in the early 1930s to find out how loud tones of different frequencies sounded subjectively. A series of curves on a graph were drawn which become flatter with higher levels. These are known as equal loudness contours. From these contours, three curves known as A, B, and C frequency weightings were developed for use in sound level meters. The common abbreviation for the 'A' weighted level when measured in decibels is dBA (see Figure 1 overleaf).

The limitation of the 'A' weighted sound pressure level as a measure of loudness or annoyance

Due to its simplicity and convenience, the 'A' frequency weighting has become a popular and often used frequency weighting for all types of noise sources. It is also used for all types of noise assessments from occupational noise, building acoustics, loudness assessments and annoyance. The World Health Organization (WHO 1993, 2001) has recognised that the 'A' frequency weighting is an overall value, which may simulate neither the spectral selectivity of human hearing nor its non-linear relation to sound intensity.

Wrong and misleading definitions are commonly given for the 'A' weighting, such as "The 'A' frequency weighting adjusts the noise level to the subjective response of the human ear". Confusion over the 'A' frequency weighting comes from the two sets of equal loudness contours – one from Fletcher and Munson (1933) and another from Robinson and Dadson (1956). The 'A' weighting frequency filter can be regarded as a high-pass filter with a cut-off frequency (10 dB down point) at about 250 Hz. It was specified in an American Standard for sound level meters as long ago as 1936 and derived from work by Harvey Fletcher at the Bell Telephone Laboratories in New York, using only 11 observers who listened to pure tones through headphones. The 'A' weighting approximately follows the Fletcher and Munson 40 phon curve (± 3 dB).

Figure 1: The 'A' weighted frequency filter relative to 0 dB at 1 kHz



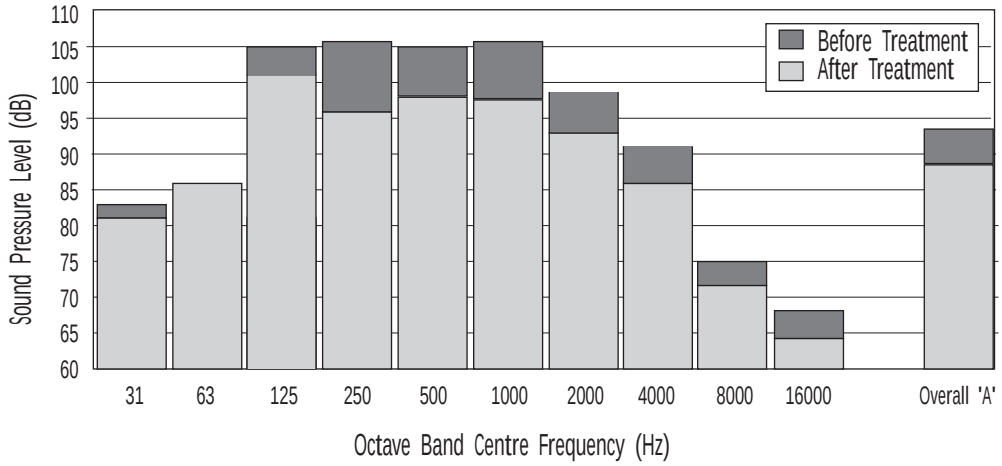
However, the equal loudness contours were redetermined under more stringent conditions in 1955. Here 90 subjects were used and the loudness level for the 40-phon curve shows that the 'A' weighting under - estimates the loudness of low frequencies by 6 dB to 8 dB. Even if the 'A' weighting was a good universal predictor of loudness it is not a good predictor of annoyance for complex sounds.

Noise annoyance is multi-dimensional, in fact, at low sound pressure levels the character of the noise (e.g. temporal structure and frequency content) can become, by far, the dominant factor in the annoyance perception. This was clearly

shown in research carried out by Scannell (1988) where subjects compared a low frequency repetitive impulse noise to pink noise for both loudness and annoyance.

He found that for annoyance, any penalty added to the objective measurement for a source with unpleasant character must be level dependent with a higher penalty for lower sound pressure levels. The fact that character is more important than the level is L_{eq} or L_{Aeq}. This average is an average of the energy (3 dB Rule) rather than an average of the decibels. For example the decibel average of 70 dB and 50 dB is 60 dB whereas the energy average is 67 dB (half of 70 dB using the 3 dB Rule). An example of a series of 15-minute L_{Aeqs} together with the cumulative L_{Aeqs} for day, evening and night are shown in Figure 3.

Figure 2: An example of where an 'A' weighted level is reduced but loudness is increased



can be realised by considering the simple case of a "dripping tap" noise when trying to sleep.

Figure 2 gives an example of where noise control for occupational reasons was successful with a reduction in the 'A' weighted sound pressure level by 6 dB, but the treatment increased the subjective loudness of the forklift.

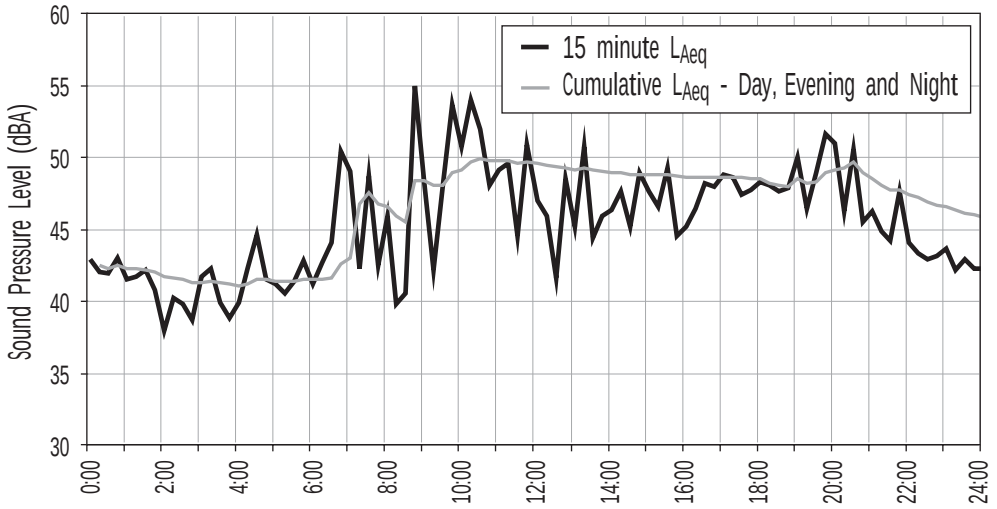
Average noise levels (L_{eq})

The noise level can, and often does, vary from instance to instance during a measurement period. In this case it is better to use a sound level meter that has an averaging function built in. This is also called an integrating function or an equivalent continuous level and the symbol

Sound exposure level

The symbol for the 'A' frequency weighted sound exposure level is L_{AE}, the abbreviation is SEL. The symbol should be used in preference to the abbreviation. Sound exposure level is a summation of the sound energy rather than an average as is the L_{Aeq}. The L_{AE} is used where the noise source is an intermittent event rather than a continuous noise. Common examples are aircraft, trains and trucks. The advantage of using the L_{AE} metric as opposed to the L_{Aeq} metric for intermittent noise events is that the overall results are fundamentally unaffected by the start and stop times. This is provided of course that the measurement captures the highest levels during the event. An example is shown in Figures 4 and 5.

Figure 3: An example of a sound level trace with the energy average (L_{Aeq}) indicated

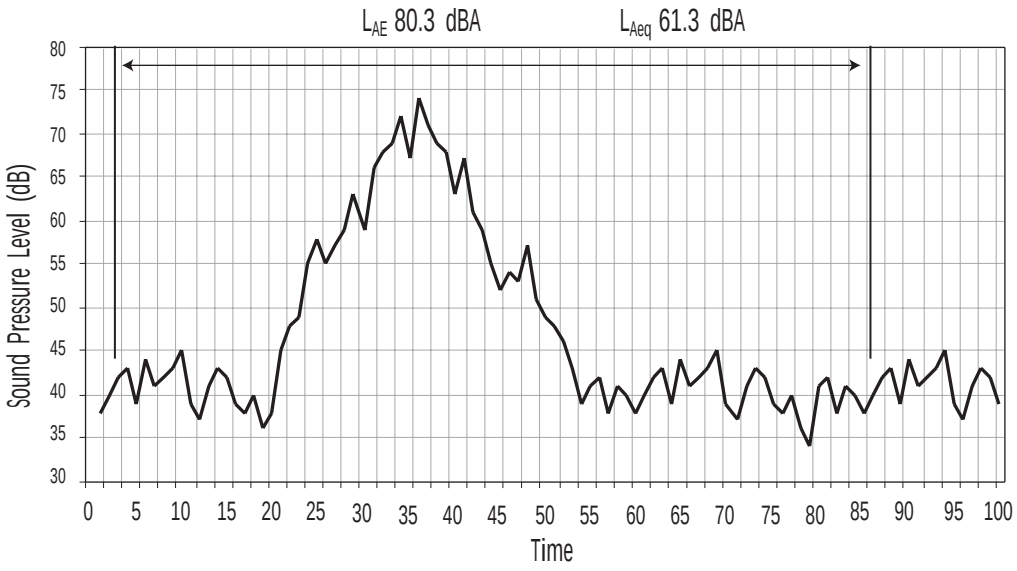


It is quicker, better and more acuate to measure L_{AE} rather than L_{Aeq} directly as it has the advantage of eliminating extraneous noise, which would evidently occur during long term measurements.

Where

't' is the time period of interest (in seconds) and 'n' is the number of similar noise events.

Figure 4: An example of a sound level trace with the L_{AE} and L_{Aeq} values



The problem is, once the L_{AE} is found how do you compare it with any criteria, which is usually given in terms of L_{Aeq}? Fortunately, there is an easy formula to convert. It is:

$L_{Aeq,}\ t = L_{AE} + 10 \log10\ n - 10 \log10\ t$

To make life simple, some values of $10 \log_{10}$ t commonly used are given in Table 3 below (to the nearest whole decibel). An example is given in Box 2.

Figure 5: The same sound level trace as Figure 4 but here the measurement is taken over a much shorter time frame. The L_{Aeq} value is reduced by over 6 dB but the L_{AE} value is not significantly changed.

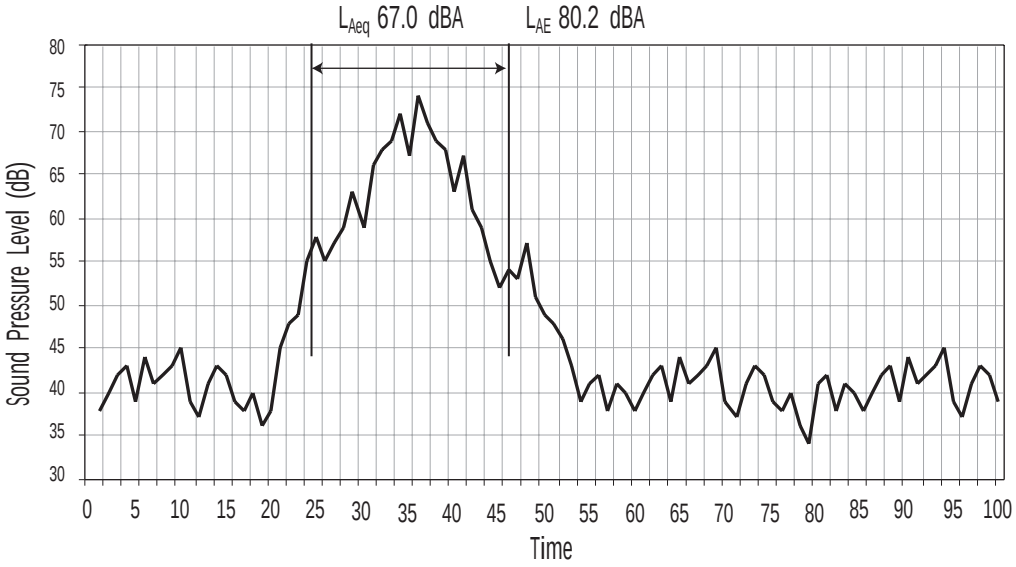


Table 3

Time (t)	10 log10 t (dB)
1 Hour	36
4 Hours	42
8 Hours	45
9 Hours	45
15 Hours	47
16 Hours	48
24 Hours	49

Statistical values

In addition to the energy average, environmental acousticians are often interested in the level that a continuous noise is exceeded for a certain time period. Some examples follow:

- the noise level that is exceeded for 90% of a certain time period is a good approximation to the background noise.
- the noise level that is exceeded for 10% of a certain time period is a good approximation to the average maximum noise.
- the noise level that is exceeded for 1% of a certain time period is often used as an indication of sleep disturbance for impulsive noise.

Figure 6 illustrates these and other common statistical noise values.

Figure 7 shows an actual trace of road traffic noise over 24 hours. This shows the typical clear drop in the background noise level (L_{A90}) during the early hours of the morning. This indicates that the road traffic flow is not constant. Between 6 am and 10 pm the L_{A10} is about 2 to 3 dB higher than the L_{Aeq}. This is typical of constant road traffic noise. In some cases the L_{Aeq} values are higher than the L_{A10} values. This is typical of intermittent truck movements.

Box 2

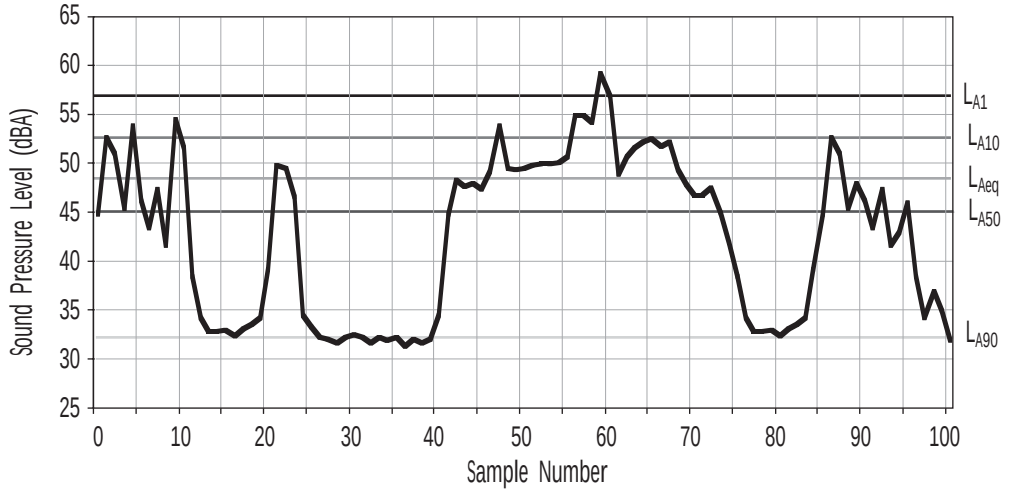
A transportation company wants to send 100 trucks past a dwelling at night. The EPA criterion for nighttime road traffic noise is L_{eq} (9hr) 50 dBA. You have measured a representative sample of the trucks at the some distance and conditions as those that will occur. The L_{AE} was found to be 81 dBA (the L_{eq} 10 sec was 71 dBA). Does the noise comply with the EPA criterion?

$$L_{Aeq}\ (9hr) = 81 + 10\ \log_{10}\ 100 - 45$$
$$= 56\ dBA.$$

How many trucks can be used at night to meet the criterion? Use the 3 dB rule. Half as many trucks (i.e. 50) would give 53 dBA and a quarter the number of trucks (i.e. 25) would give 50 dBA and meet the criteria.

$$L_{Aeq}\ (9hr) = 81 + 10\ \log_{10}\ 25 - 45$$
$$= 50\ dBA.$$

Figure 6: An example of a sound level trace with the statistical functions indicated

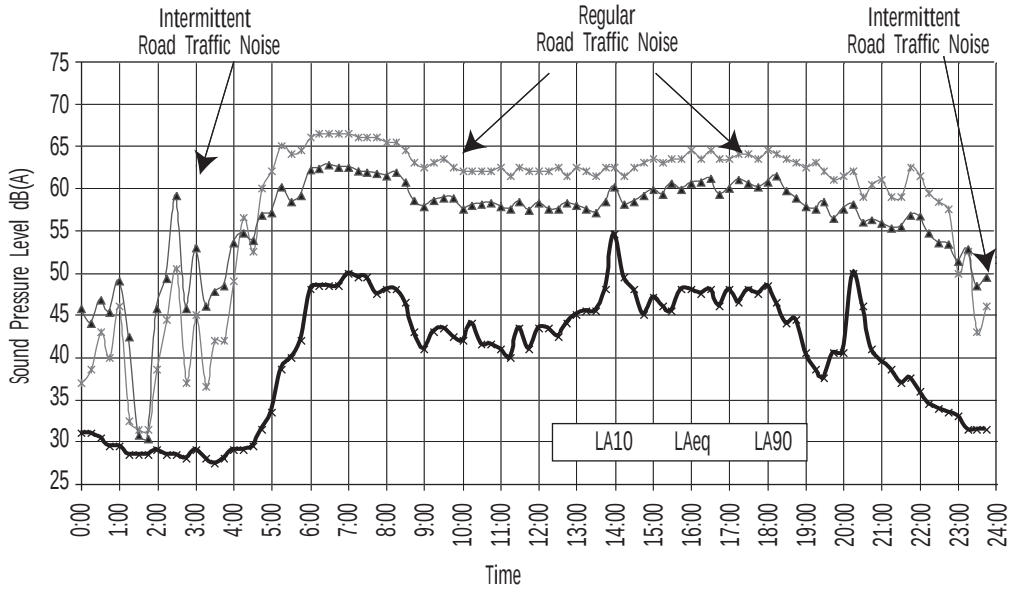


Octave bands and one-third octave bands

Octave bands

The whole frequency range can be divided into segments known as octave bands, and by switching the appropriate filters into the sound level meter circuit, the noise level at each octave band can be measured. Sound propagation with distance is highly frequency dependent, hence some sound (low frequency) will travel much further than others (high frequency). Octave band

Figure 7: An example of the statistical noise levels in a rural area near a road that is busy during the daytime



levels are used to define the performance of acoustic materials and constructions, walls, enclosures, mufflers and hearing protectors. This is because the overall performance of all of these items is highly dependent on the frequency spectrum of the noise source.

Generally, acoustic materials provide a better noise reduction (attenuation) at higher frequency. For example, an enclosure may reduce one noise source by 20 dBA but the same enclosure will only reduce another noise source by 12 dBA. This arises because the second noise is predominantly low frequency.

One-third octave bands

One-third octave bands provide three levels for each octave band giving a better frequency resolution but with more data to handle as shown in Figure 8. In environmental acoustics, one-third octave bands provide a better indication of tonality than octave bands, which are generally considered too "broad" for this purpose. For example, a noise may be considered to be tonal if the level of a one-third octave band exceeds the level of the adjacent bands on both sides by 5 dB or more as in the example shown in Figure 8.

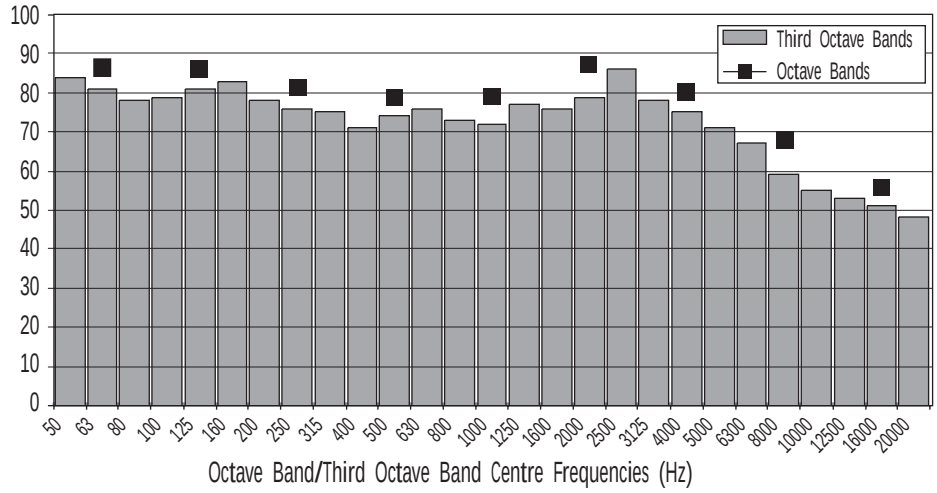
Narrow band frequency analysis

One problem with objective judgements of tonality could occur when, in the unusual case, a tone is exactly midway between two one-third octave bands. Here the 5 dB greater than the neighbouring bands rule would break down. To overcome this problem subjective judgements could be used but where objectivity is still required narrow band frequency analysis will be required. Where greater detail of the frequencies is required for noise control narrow band frequency analysis also proves extremely useful.

Masking

Masking is the process where the human "threshold of audibility" of a sound is raised due to the presence of another sound, which is simultaneously created. Masking is the reason that the ambient or the background noise levels are taken into account in many noise policy criteria. Even if a source noise is below background it does not necessary mean that it is inaudible. It may be possible to hear a tone, for example, even if it is 10 dB to 20 dB below the existing background.

Figure 8: An example of an octave band and third octave band spectrum. Here the sound pressure level in the 3125 Hz 1/3 octave band exceeds the neighbouring bands by more than 5 dB and hence the noise could be considered to be tonal



Conclusion

The importance of noise to environmental health means that understanding its effects and its correct measurement in different circumstances is critical for decision making by government and industry. The diversity of the source, its context, and the reception leads to a need for relevant and accurately measured data in the pursuit of noise control.

Endnote

1. An earlier version of this paper was presented to the 29th Australian Institute of Environmental Health National Conference, Sydney, 20-25 October, 2002.

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It's Not What You Know, but What You Can Prove[1]

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The paper outlines the basic elements of what evidence is and how a court accepts evidence to make a finding in a dispute brought before it. It is not intended to be an exhaustive exposition of the law of evidence but is rather a guideline for council officers, and other people who act as investigating officials in the course of their duties. For example, council officers should thoroughly acquaint themselves with their respective powers of entry, search parameters, limitations and their obligations to give official warnings so as to avoid any risk of having primary fact evidence ruled inadmissible.

Key Words: *Evidence; Local Government; Council Officers; Environment*

The purpose of this paper is to outline the basic elements of what evidence is and how a court accepts evidence to make a finding in a dispute brought before it. It is by no means intended to be an exhaustive exposition of the law of evidence but is rather a guideline for council officers, and other people who act as investigating officials in the course of their duties.[2]

The paper examines briefly several key areas to illustrate some of the fundamental aspects of evidence in a local government context and what controls are placed on evidence when it is presented to a court. Part of this exercise is devoted to some of the exclusionary rules under the *Evidence Act 1995* (NSW) which are applicable to council officers. Finally, a brief comparison is made between the Local Court and the Land Environment Court of NSW in relation to jurisdictional preferences.

What is Evidence?

Evidence is something that touches our lives daily. In very simple terms, if 'A' says something to 'B' then 'A' is asserting a fact. 'B' is entitled to test the assertion made by 'A' to determine whether the fact (as asserted by 'A') is true or actually did happen.

The test to prove whether the fact did or did not happen would require 'B' to find and evaluate evidence to support the asserted fact by 'A'. 'B' could accept the assertion on face value or make further inquiries whether 'A' saw, heard, touched or smelt the thing (or event). By making these inquiries 'B' is carrying out an investigation of A's knowledge and recollection of the asserted fact. The same type of evidentiary inquiry would apply if, for example, 'A' expressed her/his opinion about something. 'B' could once again accept A's opinion or look for some source of reliable information (evidence) to support the opinion made by 'A'.

A legal definition of evidence is as follows:

> *Any statement, record, testimony, or other things, apart from legal submissions, which tends to prove the existence of a fact in issue. Evidence adduced at trial is subject to a number of tests to discern its admissibility, relevance and weight to be accorded to it.*

Evidence is relevant and admissible information that is placed before a court that simply tells a story of an event that occurred in the past. Evidence can be used in the positive sense to prove a fact in issue or it can be used in a negative sense to disprove a fact in issue.

Evidence is presented to a court in a variety of ways but usually through:

- Witness statements, written (e.g. affidavit) or oral (e.g. testimony);
- Documentation (e.g. consents, notices, photographs, maps or plans and so on); or
- Physical evidence such as objects (e.g. water samples).

What Types of Facts Need to Coincide?

There are two types of facts that need to coincide to prove a cause of action or criminal charge. These facts are:

- *factum probandum* or facts in issue which are the ingredients of the cause of action in a civil case or the elements of the crime in a prosecution. These are essential ingredients/elements of the substantive law that must be proved by the plaintiff/prosecution; and
- *facta probantia* or primary facts, which are the facts, used (evidence adduced) by the plaintiff/prosecutor to prove the *factum probandum* or facts in issue.

The whole concept of the rules of evidence is based on four distinctive principles, which can be summarised as follows:

(1) the trial takes place on the facts in issue;

(2) the plaintiff in a civil proceeding or the prosecutor in criminal trial must prove the facts in issue;

(3) the facts in issue must be proved by adducing evidence; and

(4) the evidence, as adduced, is subject to quality control (governed by the *Evidence Act 1995* (NSW).

Direct evidence

In order to convince a court one way or another that a particular event in the past happened, or did not happen, a party must provide evidence to the court. The party does this by tendering evidence in the nature of oral statements and/or written documents and/or physical objects. All of this type of evidence is referred to as 'direct evidence'.

Circumstantial evidence

There will be times where no direct evidence can be adduced. A good example of this is in a criminal trial where the onus is on the prosecutor to prove that the defendant, at the time of committing an alleged offence, possessed the requisite *mens rea* (intention or guilty mind). Relevantly, Tier 1 offences under the *Protection of the Environment Operations Act 1997* (NSW) requires the prosecution to establish the existence of *mens rea*.

Because the defendant's subjective mind is unobservable, the prosecution must then rely on evidence circumstantially to prove primary facts (*facta probantia*) by way of inference. The prosecution would endeavour to show such an inference by adducing evidence of circumstantial facts. Examples of circumstantial evidence might be the existence of an elaborate underground pipe system to discharge raw effluent into a watercourse, or skid marks on the road to show that a car was on the wrong side of the road when the collision occurred.

The Burden of Proof

The "burden of proof" relates to the obligation of the party asserting the existence of a fact to prove the facts in issue. Therefore, in a criminal trial the burden of proof rests with the prosecutor to prove the defendant guilty. Similarly, in a civil proceeding, the onus is on the plaintiff to prove that the respondent was, for example, negligent for failing to discharge a duty of care, which was owed to the plaintiff.

Legal burden of proof

In addition to the general presumption above, it is also important to recognise that in order for a substantive law to become operative, the law imposes a burden upon the party seeking to rely on the substantive law to adduce evidence to satisfy the facts in issue (e.g. a provision of a statute creating an offence which is formulated into the facts in issue).

Evidential burden of proof

The evidential burden of proof relates to the onus or obligation of a party to adduce sufficient primary evidence to justify the existence of the facts in issue (*factum probandum*).

The standards of proof

The standards of proof only apply to the deliberations of the "tribunal of fact" (this is either a jury or in most cases the Judge or the Magistrate) when it is assessing whether the primary facts, adduced as relevant and admissible evidence, give rise to the occurrence or existence of the facts in issue.

These standards as developed by the common law are as follows:

- Civil proceedings – "Balance of Probabilities"
- Criminal proceedings – "Beyond Reasonable Doubt"

There is no obligation for a tribunal of fact to be absolutely persuaded by the primary facts to make a finding of guilty or not guilty. Approximate truth is what the common law strives to achieve as the absolute truth is rarely attainable due to time constraints and the methods of investigation available to the parties. The standard of proof for the prosecutor in criminal proceedings is higher than that of a plaintiff in a civil case.

The Proof Making Model

The idea of having rules of evidence is to ensure, first, that the type of information (adduced evidence) which is placed before a court is regulated; and second, the manner in which the evidence is presented to the court is also regulated. It is therefore important to adhere to some basic principles when considering what the facts in issue (*factum probandum*) are and what pieces of primary facts (*facta probantia*) are needed to prove the facts in issue to the tribunal of fact (jury/judge) trying the case. This analysis must always be considered in context of the burden of proof and the corresponding standard of proof that applies to a plaintiff or prosecutor.

One method of analysing the elements of a civil "cause of action" or "criminal prosecution" is to test the strength of the case using the "proof making model".

The Model

The steps that need to be taken in analysing a matter using the proof making model may be summarised as follows:

Level 1 Research the law to find out the body of law which is the source of the legal rights. In virtually all regulatory matters this source will be from an Act, regulation or statutory rule;

↓

Level 2 translate that legal right into a "cause of action" or "charge" and identify the particular jurisdiction in which that claim can be made and the formal requirements needs to make such a claim (i.e. summons, application, or information);

↓

Level 3 Establish with precision the facts in issue (*factum probandum*) which require proof in the claim. These matters are commonly referred to as the elements of the cause of action or charge and are also called the ingredients (Scenario 2);

↓

Level 4 Identify the propositions of fact (the theory) in the particular case which need to be advanced to support the elements referred to in Level 3; and

↓

Level 5 Marshall the individual items of relevant evidence or primary facts (*facta probantia*) with respect to the each proposition of fact or theory that is developed.

↓

The Admissibility of Evidence

The rules that govern the admissibility of evidence can be categorised as follows:

(a) the evidence adduced must be factually and legally relevant;

(b) relevant evidence must be legally admissible; and

(c) the evidence must be tested in court.

Relevance

Section 55 of the *Evidence Act 1995* (NSW) states:

Relevant evidence

(1) The evidence that is relevant in a proceeding is evidence that, if it were accepted, could rationally affect (directly or indirectly) the assessment of the probability of the existence of a fact in issue in the proceedings.

(2) In particular, evidence is not taken to be irrelevant only because it relates to:

Scenario 1: Civil proceedings - Breach of conditions of development consent. Restaurant operating beyond 12.00 midnight.

Level 1 Source of the council's rights.		Administrative Law	
Level 2 Cause of action (*factum probandum* – 'facts in issue')		*Environmental Planning and Assessment Act, 1979 (NSW)* S 123 EPAA – restraint of breach of the Act. This will be the conditions of consent which will be the basis for the facts in issue	
Level 3 Elements the council must prove	A valid development consent was granted for the use of the premises as a restaurant.	Conditions were imposed on the development Consent regulating the hours of operation until 12.00 midnight.	The restaurant trades beyond 12.00 midnight.
Level 4 Propositions of fact. (Council's theory)	There is a valid development consent.	Consent condition No. 5 requires the restaurant to cease operating at 12.00 midnight.	The restaurant trades beyond 12.00 midnight.
Level 5 Evidence – primary facts. (*facta probantia*)	Written evidence #1: The development consent. Written evidence #2: Officer's instrument of delegation.	Written evidence #3: The development consent indicating condition no. 5 which states 12.00 midnight restriction. Written evidence #4: Letter to restaurant operator advising of the restriction.	Written evidence #5: Contemporaneous field/inspection notes (breach report) following an inspection of the restaurant. Written evidence #6: Letter of complaint from adjoining neighbour. Oral evidence #1: Conversation between council officer and restaurant operator. Oral evidence #2: Conversation between council officer and adjoining neighbour.

Scenario 2: Criminal prosecution – Pollute waters – Sump oil in Botany Bay

Level 1 Source of the council's rights.		Administrative Law	
Level 2 Charge / 'The Crime'. (*Factum Probandum* Or 'Facts In Issue')		*Protection of The Environment Operations Act,* 1997 (Nsw). s 120 POEA (1) A person who pollutes any waters is guilty of an offence; (2) In this section:'pollute waters' includes cause or permit any waters to be polluted.	
Level 3 Elements the council must prove	A person (which includes a corporation).	Polluted, or caused or permitted waters to be polluted.	Waters were polluted.
Level 4 Propositions of fact. (Council's theory)	There is was a person and/or a corporation.	A pollution incident (as defined in the PEOA Dictionary) occurred.	Botany Bay was polluted.
Level 5 Evidence – primary facts. (*facta probantia*)	Oral evidence #1: The council officer saw Mr 'X' pour sump oil from a container into a stormwater pit located on general Holmes Drive, Brighton-le-Sands. Oral evidence #2: Council officer asked Mr 'X' a series of questions and ascertained that Mr 'X' is an employee of 'ABC Pty Ltd' (caution must be administered) Documentary evidence #1: company search under S 1247b of the *Corporations Act, 2001* (CTH) indicates the company name, its directors & registered office. (The Defendant)	Physical evidence #1: A sample of the sump oil collected by the council officer immediately after the pollution incident from the stormwater pit where Mr 'X' poured the sump oil. Documentary evidence #2: photograph taken by the council officer depicting the residue sump oil in the stormwater pit. Physical evidence #2: A sample of the sump oil at the point where the pipe discharges into any waters. Documentary evidence #3: A photograph of the oil discharging from the pipe into any waters.	Oral evidence #3: The council officer statement that the water was botany bay. Documentary evidence #4: Analysis report from a registered laboratory verifying that the substance discharged into Botany Bay was sump oil.

(a) the credibility of a witness; or

(b) the admissibility of other evidence; or

(c) a failure to adduce evidence.

It is of utmost importance to appreciate that evidence is either 'relevant' or 'irrelevant'. If evidence is found to be irrelevant to the facts in issue then it is inadmissible per se. In *Smith v The Queen* (2001) HCA 50, the majority of the High Court of Australia said that:

> *[E]vidence is relevant or it is not. If the evidence is not relevant, no further questions arise about its admissibility. Irrelevant evidence may not be received. Only if the evidence is relevant do questions about its admissibility arise. These propositions are fundamental to the law and well settled.*

The remarks by the High Court of Australia are manifested in s 56 of the *Evidence Act 1995* (NSW) which states:

> *56. Relevant evidence to be admissible*
>
> *(1) Except as otherwise provided for by this Act, evidence that is relevant in a proceeding is admissible in the proceeding.*

(2) Evidence that is not relevant in the proceeding is not admissible.

In the context of ss 55 & 56 of the *Evidence Act 1995* (NSW) relevant evidence may be generally characterised as information that assists the court with its inquiry as to the existence of the facts in issue. There is no test to determine the degree of relevance though relevant evidence can be evaluated on a degree of probative value (persuasive weight).

There can be many reasons why a particular piece, or pieces, of evidence will be considered relevant. This will largely depend on the circumstances of each individual case and the facts in issue.

Admissibility of Relevant Evidence and Related Matters

Even though evidence may be considered relevant to the facts in issue, it may nonetheless be excluded on a numerous number of grounds. For the purpose of this overview the exclusionary rules looked at are limited to those commonly applicable to council officers engaged inspectorial duties.

Discretion of the court

It is vital to note that the reception of evidence is always at the discretion of the court. Sections 135 & 136 of the *Evidence Act 1995* (NSW) confer upon a court a general discretion to exclude any evidence that it sees fit. These sections state as follows:

135 General discretion to exclude evidence

The court may refuse to admit evidence if its probative value is substantially outweighed by danger that the evidence might:

(a) be unfairly prejudicial to a party; or

(b) be misleading or confusing; or

(c) cause or result in undue waste of time.

136 General discretion to limit the use of evidence

The court may limit the use to be made of evidence if there is danger that a particular use of evidence might:

(a) be unfairly prejudicial to a party; or

(b) be misleading or confusing.

Hearsay rule

The hearsay rule is perhaps the best known exclusionary rule with respect to allowing evidence to be admitted. In general, hearsay is evidence that is not its original form. A simple definition of hearsay is *what someone else heard or saw* and so on. Section 59 of the *Evidence Act 1995* (NSW) describes hearsay and limits its operation as follows:

59 The hearsay rule – exclusion of hearsay evidence

(1) Evidence of a previous representation made by a person is not admissible to prove the existence of a fact that the person intended to assert by the representation.

(2) Such a fact is in this Part referred to as an asserted fact.

(3) Subsection (1) does not apply to evidence of a representation contained in a certificate or other document given or made under regulation made under an Act other than this Act to the extent to which the regulations provide that the certificate or other document has evidentiary effect.

A "representation" for the purposes of the *Evidence Act 1995* (NSW) is defined under the dictionary of the Act, which states:

Previous representation means a representation made otherwise than in the course of giving evidence in the proceeding in which evidence of the representation is sought to be adduced.

(Note that the word "representation" is also defined in the dictionary to the Evidence Act 1995 (NSW)).

Although there are many exceptions to the hearsay rule under the *Evidence Act 1995* (NSW) the position is that the hearsay rule is limited to express or implied "intended" assertions of a fact. Any representation that was unintended to be made to assert a fact is not excluded under s 59.

The hearsay rule must also be understood in the context of s 60 of the *Evidence Act 1995* (NSW) which states:

> *60 Exception: evidence relevant for a non-hearsay purpose*
>
> *The hearsay rule does not apply to evidence of a previous representation that is admitted because it is relevant for a purpose other than proof of the fact intended to be asserted by the representation.*

The effect of s 60 means that hearsay evidence, which has been admitted with respect to some other related matter of the trial, can be used in relation to the facts in issue. Essentially a party may be entitled to rely upon hearsay evidence to prove its case by utilising s 60 as the "back door" to evidence that is in admissible under s 59.

Use of hearsay evidence in interlocutory applications

When interlocutory applications are brought before a court s 75 of the *Evidence Act 1995* (NSW) allows a party to use hearsay evidence provided the "source" of the information is provided. This is of particular relevance to council officers especially when it is necessary to approach the court for injunctive relief to restrain a breach of the law when the only eye witness is a neighbour (e.g. pollution incident/ removal of protected trees and vegetation).

Illegally obtained evidence

Of utmost importance to council officers who perform inspectorial duties and detect unlawful conduct in the course of their daily duties is the exclusionary rule that relates to illegally obtained evidence.

In addition to the general discretions mentioned above (ss 135 & 136 of the *Evidence Act 1995* (NSW)), the court may avail itself of s 138 of the Act in situations where a party seeks to adduce evidence that has been illegally obtained. Section 138 of the *Evidence Act 1995* (NSW) states:

> *138 Discretion to exclude improperly or illegally obtained evidence*
>
> *(1) Evidence that was obtained:*
>
> *(a) improperly or in contravention of an Australian law; or*
>
> *(b) in consequence of an impropriety or of a contravention of an Australian law is not to be admitted unless the desirability of admitting the evidence outweighs the undesirability of admitting evidence that has been obtained in the way the evidence was obtained.*
>
> *(2) Without limiting subsection (1), evidence of an admission that was made during or in consequence of questioning, and evidence obtained in consequence of the admission, is taken to have been obtained improperly if the person conducting the questioning:*
>
> *(a) did, or omitted to do, an act in the course of the questioning even though he or she knew or ought reasonably to have known that the act or omission was likely to impair substantially the ability of the person being questioned to respond rationally to the questioning; or*
>
> *(b) made a false statement in the course of the questioning even though he or she knew or ought reasonably to have known that the statement was false and that making the false statement was likely to cause the person who was being questioned to make an admission.*
>
> *(3) Without limiting the matters that the court may take into account under subsection (1), it is to take into account:*
>
> *(a) the probative value of the evidence; and*
>
> *(b) the importance of the evidence in the proceedings; and*
>
> *(c) the nature of the relevant offence, cause of action or defence and the nature of the subject-matter of the proceedings; and*
>
> *(d) the gravity of the impropriety or contravention; and*

(e) whether the impropriety or contravention was deliberate or reckless; and

(f) whether the impropriety or contravention was contrary to or inconsistent with a right of a person recognised by the International Covenant on Civil and Political Rights; and

(g) whether any other proceedings (whether or not a in court) has been or likely to be taken in relation to the impropriety or contravention; and

(h) the difficulty (if any) of obtaining the evidence without impropriety or contravention of an Australian law.

Note: The International Covenant on Civil and Political Rights is set out in Schedule 2 to the Human Rights and Equal Opportunity Commission Act 1986 (Cmwlth).

Exercise of discretion by the High Court of Australia to exclude illegally obtained evidence

In the decision of *Bunning v Cross* (1978) 141 CLR 54 the High Court of Australia looked at the issue of whether a Magistrate could be precluded from exercising discretion to exclude evidence that had been unlawfully obtained by a police officer in the course of administering a breath test to a motorist. In doing so, the court importantly examined the broader issue of preserving the rights and liberties of citizens when charged as a consequence of illegally obtained evidence.

In a joint judgment Stephen and Aickin JJ in finding that the illegally obtained evidence was not procured in reckless disregard for the law, held that as a matter of public policy, the nature of the discretion to exclude any evidence that has been obtained illegally depends primarily on whether such evidence "[i]s the product of unfair or unlawful conduct on the part of the authorities" and that "[I]t is not fair play that is called into question in such cases but rather society's right to insist that those who enforce the law themselves respect it, so that a citizen's precious right to immunity from arbitrary and unlawful intrusion into the daily affairs of private life may remain unimpaired".

In *Ridgeway v The Queen* (1995) 69 ALJR 484 (a case concerning entrapment) the High Court of Australia once again looked at the above exclusionary principle. Mason CJ, Deane and Dawson JJ held that:

> [T]*he basis in principle of the discretion lies in the inherent or implied powers of our courts to protect the integrity of their processes*.

Their Honours went on further to say:

> [M]*ore importantly, the consideration of "high public policy" which justify the existence of the discretion to exclude particular evidence in the case where it has been unlawfully obtained are likewise applicable to support the recognition of a more general discretion to exclude any evidence of guilt in the case where the actual commission of the offence was procured by unlawful conduct on the part of law enforcement officers for the purposes of obtaining a conviction*.

Who is an "investigating official" for the purposes of the Evidence Act 1995 (NSW)?

The Dictionary of the *Evidence Act 1995* (NSW) defines an "investigating official" to be:

(a) a police officer (other than a police officer who is engaged in covert investigations by a superior); or

(b) a person appointed by or under an Australian law (other than a person who is engaged in covert investigations under orders of a superior) whose functions include functions in respect of the prevention or investigations of offences.

Does definition (b) above include council officers? Ostensibly it would appear that it does, however, to ascertain whether the role or function that a council officer performs is *in respect of the prevention or investigations of offences* and part of her/his duties, it would be necessary to look at the officer's

statement of duties (job description) and importantly the officer's delegated authority granted to her/him by the general manager under s 378 of the *Local Government Act 1993* (NSW).

Administering the "caution"

One area that council officers consistently fail to do properly (or simply forget to do) is administer a caution when they are questioning an alleged offender. In the "pollute waters" scenario 2 mentioned above it would be most unfortunate for a council to commence a criminal prosecution only to find when the council officer is being cross-examined by Mr X's barrister who poses leading questions like:

> *Defence Barrister: "Before you questioned my client about the sump oil in the stormwater pit did you form the view that an offence had been committed?"*
>
> *Council Officer: "Yes I did think an offence had been committed."*
>
> *Defence Barrister: "You didn't advise my client of his right to remain silent did you?"*
>
> *Council Officer: "No, I didn't."*

that the caution had not been administered.

At this point, Mr X's barrister makes an application to the judge/magistrate to have the evidence struck out. If the inadmissible evidence just happened to be the best, and indeed the only, primary fact evidence in your case then chances are that the defendant (who now has a huge "smirk" on her/his face) will get off scot-free, and the council will have to pay many dollars in costs. Moral of the story – never, never, never forget to administer a caution!

Section 139 of the *Evidence Act 1995* (NSW) provides that:

> *139 Cautioning of persons*
>
> *(1) For the purposes of paragraph 138(1)(a), evidence of a statement made or act done by a person during questioning is taken to have been obtained improperly if:*
>
> *(a) . . . . . .*
>
> *(b) . . . . . .*
>
> *(c) before starting the questioning the investigating official did not caution the person that the person does not have to say or do anything but anything the person does say or do may be used in evidence.*

One of the most fundamental and basic individual rights of a person suspected of having committed a crime is the "right of silence", which is based on the common law principle that a person does not have to say anything that would incriminate herself/himself.

Thus the salutary lesson to be learned each time an investigating officer is confronted with a situation where she/he believes a breach of the law is unfolding before their very eyes, is to always remember to administer the "caution" to the alleged offender which should be along the following lines:

> *"Excuse me madam/sir I'm Billy Bloggs from the local council I am going to ask you certain questions. I must caution you that you are not obliged to say or do anything, but anything you may wish to say or do may be used in evidence. Do you understand that?"*

The last sentence is extremely important. In the sump oil scenario above, after learning that the investigating council officer omitted to administer a caution, it would be open to the defendant's barrister to make an application to have the conversation between his client and the council officer excluded on the grounds set out in s 139(1)(c) of the *Evidence Act 1995* (NSW).

Anunga Rules

Another point that needs to be made in relation to administering the caution is in situations where the alleged offender is either an Indigenous Aboriginal/Torres Strait Islander or a person from a Non-English Speaking Background (NESB). The above caution is not sufficient to safeguard against self-incrimination.

In the decision of *The Queen v Angus Anunga* (1976) 11 ALR 412 Foster J developed what is known as the "Anunga Rules" which require extra care to be taken when administering the caution to Indigenous Australians or a person from a NESB.

His Honour held that it was simply not adequate that investigating officials administer the caution in the usual way by saying, "do you understand". The caution must be explained slowly and carefully before any questioning takes place and it is imperative that the person being questioned appreciates her/his right to remain silent. The investigating official should seek the aid of an interpreter if in any doubt.

Power of entry

Another key aspect that council officers need to pay particular attention to is the disparity between Acts with respect to the power of entry onto land/premises. To illustrate this point under the *Local Government Act 1993* (NSW) and the *Environmental Planning and Assessment Act 1979* (NSW) authorised council officers must give notice to the occupier/owner of the land prior to their entry. This is subject to the exceptions prescribed in the Acts, such as inspections carried out in an emergency or during the course of authorised building works being undertaken. Nothing authorises council officers to enter residential premises (the house) though they may do so with consent of the occupier/owner or a search warrant issued under the *Search Warrants Act 1985* (NSW).

Under the *Protection of the Environment Operations Act 1997* (NSW) the powers to enter and search premises are far more broad and inquisitorial in nature (see Chapter 7 ss 184-212 inclusive). Council officers should thoroughly acquaint themselves with their respective powers of entry, search parameters, limitations and their obligations to give official warnings so as to avoid any risk of having primary fact evidence ruled inadmissible.

Jurisdictional Preferences

Under the many NSW environmental laws that local government agencies administer it is possible, more often than not, that a council may choose to commence civil or criminal proceedings in either the Local Court or Land and Environment Court of NSW. Both jurisdictions are efficient with respect to timeframes to have matters heard and disposed of. Informations and summonses in the Local Court only take, as a rule, about 2-3 months to complete. Civil claims and criminal prosecutions in the Land and Environment Court of NSW take about 4-5 months for a final determination to be made.

Perhaps the best method of determining the appropriate court is to evaluate the type of matter to be tried. For example breaches under the *Food Act 1989* (NSW), *Noxious Weeds Act 1993* (NSW) and other minor regulatory matters under the *Local Government Act 1993* (NSW) or the *Roads Act 1993* (NSW) are best commenced in the Local Court.

Matters of a more serious nature such as Tier 2 pollution offences under the Protection of the *Environment Operations Act 1997* (NSW), and removal of trees preserved under the *Environmental Planning and Assessment Act 1979* (NSW) are best commenced in the Land and Environment Court of NSW. This is because the court is a specialist superior court of record of equal status to the Supreme Court of NSW, and it has a greater capacity to impose punitive sanctions and higher pecuniary penalties than the Local Court. Further, the Land and Environment Court can grant equitable relief in the form of injunctions to compel things to be done or prohibit things to be done. Regardless of the venue the rules of evidence apply throughout both jurisdictions and will be administered with equal rigour. Therefore it must be remembered that it is *not what you know but rather what you can prove* under the rules of evidence that is important.

Endnotes

1. An earlier version of this paper was presented to the 29th Australian Institute of Environmental Health National Conference, Sydney, 20-25 October, 2002.

2. The author has made all reasonable efforts to ensure the content of this paper is current and accurate. Before relying on the information provided users should carefully evaluate its accuracy, currency, completeness and relevance for their circumstances. The paper is not intended to be relied upon as legal advice. Any issues or questions arising from this paper should be referred to the author for express consideration.

References

Legislation

Evidence Act 1995 (NSW)
Environmental Planning and Assessment Act 1979 (NSW)
Food Act 1989 (NSW)
Human Rights and Equal Opportunity Commission Act 1986 (Cmwlth)
Local Government Act 1993 (NSW)
Noxious Weeds Act 1993 (NSW)
Protection of the Environment Operations Act 1997 (NSW)
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Cases

Bunning v Cross (1978) 141 CLR 54
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Professional Development for Environmental Health Officers: Issues in Responsible and Accountable Observation

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It is hoped that the following "case" will be of particular interest and assistance to student environmental health officers, and those who are re-entering the profession. The aim of the small study is to make a contribution to the building up of knowledge and skills relating to inspectorial practice relevant to food premises. The following observation took place in November 2002 in a butcher's shop located in southern Tasmania.

The Case

An observation

A customer in a butcher's shop requested some diced casserole meat. There was insufficient diced meat to meet the customer's needs so the butcher proceeded to cut up some more in front of the customer. The customer then asked for four thin slices of cooked ham off the bone. Without washing his hands, the butcher located the ham, placed it on the same chopping block that had been used for dicing up the meat, and proceeded to slice the ham using the same implements that had been used for the previous task without first washing them.

Self-help questions

The above observation raises a number of questions. The questions, which relate to law, health, and professional responsibility, are presented in a logical order; an order facilitating the decision making which necessarily would accompany the observation, if an officer had made the observation. Some of these questions could be expected to arise during the course of litigation also, or as part of an Ombudsman's inquiry into the administrative actions (or non-actions) of an environmental health officer involving an incident of this nature.

1. Which elements of this observed incident were wrong?
2. Why were they wrong?
3. What evidence have you used to support your opinion?
4. Is there any legislation in your State or Territory covering this matter?
5. Are there any common law considerations?
6. What are the risks to persons who consume ham served in this way?
7. How would you rate the risks – minimal, moderate or high?
8. Have you read any cases, medical or legal, that are germane to this small case study?
9. How could you use such cases to help you deal with this problem?
10. What are the options open to an environmental health officer in your State or Territory when butchers engage in this observed practice?
11. How did you determine those options?

12. Which option would you choose and why would you choose it?

13. Did your choice take into account your risk assessment?

14. Would this observation alert you to other possible issues or practices in a butcher's premises where this type of practice occurs? If so what are they?

15. In which other types of food premises might similar practices occur?

Critical skills

Observation, and the accompanying contemporaneous recording of matters noted, are critical tasks during an inspection of premises. It is also critical to develop the skill of raising and answering your own questions regarding those observations. All of these activities are a necessary part of inspectorial practice and the associated decision making.

Conclusion

If you have addressed the above questions, you will have recognised that although the incident was straightforward it was far from being a minor breach of sound food hygiene practice and the law. An environmental health officer would be professionally obligated to deal with it in an appropriate way; a way that would stand up to possible subsequent scrutiny.

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AUSTRALIA

Hepatitis C Virus and Body Piercing

A report on infection control practices and knowledge of hepatitis C virus among body piercing practitioners in Victoria.

Margaret Hellard. Campbell Aitken, Andrew Mackintosh, Allison Ridge, Scott Bowden and Nick Crofts

Investigators

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Mr. Andrew Mackintosh, Ms. Allison Ridge: Australian Institute of Environmental Health (AIEH)

Dr. Scott Bowden: Victorian Infectious Diseases Reference Laboratory (VIDRL)

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The Department of a Human Services Ethics Committee provided ethics approval for the study.

Glossary

BPE - body piercing establishment
BPP - body piercing practitioner
Burnet Institute - Macfarlane Burnet Institute for Medical Research and Public Health
Ear Piercing Guidelines - Standards of Practice for Ear Piercing: pursuant to Part 6 of Health (Infectious Diseases) Regulations, 1990
EHO - environmental health officer
HBV - hepatitis B virus
HCV - hepatitis C virus
HIV - human immunodeficiency virus
RNA - ribose nucleic acid
RT-PCR - reverse transcription-polymerase chain reaction (RT-PCR)
Tattooing and Body Piercing Guidelines - Standards of Practice for Tattooing and Body Piercing: Health pursuant to Part 6 of Health (Infectious Diseases) Regulations1990
VIDRL - Victorian Infectious Diseases Reference Laboratory

Introduction

The hepatitis C virus (HCV) is a major public health threat in Australia. The primary health concern with HCV infection is the development of chronic HCV that can lead to cirrhosis, liver failure and hepatocellular carcinoma. It is estimated over 210,000 Australians have been exposed to HCV (1% of the population), 157,000 are chronically infected, and that more than 16,000 new infections every year (1). The cost of HCV to the public health system and the community is enormous; recent estimates of the combined health related and

social costs are $74.6 million per annum (2). Improved monitoring, preventative and treatment programs need to be implemented to reduce morbidity and further spread of the virus.

HCV can be transmitted in any situation in which infected blood is transferred between individuals, but most commonly occurs when the skin is pierced. It is well recognised that within health care settings, HCV can be transmitted from client to staff, from staff to client and between clients. In addition HCV may be transmissible following contamination of equipment and other surfaces that come into contact with infected blood.

HCV RNA has been detected on various pieces of equipment used in parenteral procedures and on surfaces in the immediate environment. Italian researchers reported on the detection of HCV RNA by reverse transcription-polymerase chain reaction (RT-PCR) in dental surgeries. The study found extensive HCV contamination of dental surfaces and equipment after treatment of patients who were seropositive for HCV (3). Environmental and equipment contamination of HCV most likely arose from dispersion of aerosols of saliva and blood during dental treatment; HCV has high average transmission efficiency (relative to HIV) and can be transmitted in tiny amounts of blood (4). More recently, research conducted at the Burnet Institute demonstrated that HCV RNA was detectable by RT-PCR on equipment - including syringe barrels, spoons, swabs and filters - used to inject illicit drugs (5). The results of these studies of dental surgeries and equipment used to inject illicit drugs suggest that HCV contamination is a distinct possibility in other practices that (potentially) involve the release of body fluids and blood into the environment or onto equipment.

Body piercing

Body piercing is a common practice; approximately 50% of all Victorians have at least one piercing, most frequently of one or both ears (6). In recent years, piercing of body parts other than the ears has markedly increased in popularity; 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. A survey in 1998 reported 31.5% of Australian had their ears pierced; 6.7% had their body pierced in their lifetime (7). Body piercing was more common among the younger Australians particularly younger women with one in five women aged around 20 reporting body piercings. The figure declined to half this proportion in women only ten years older. One in eight younger men reported body piercings. The 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 (7). This is important when considering the high prevalence of HCV amongst injecting drug users.

Any procedure that involves piercing the body or a mucous membrane carries potentially serious health complications. Multi-use devices are used for many piercings creating the potential for the spread of blood borne viruses. Increased demand for piercing has induced new people to enter the industry, many of whom are not primarily trained as piercers. Some come from what might be described as a traditional and committed body piercing culture and only provide body piercing services, but many have a background in tattooing, and others are beauticians, and provide body piercing as a sideline. It is plausible that people who offer piercing as a secondary service are insufficiently aware of infection control procedures, increasing the possibility of virus transmission via body piercing.

Study Rationale

The increasing popularity of body piercing has led to concern about the increased risk

of spread of blood borne viruses, in particular HCV. Many people have recently become involved in the industry but little is known about their level of training and their understanding of the risk associated with the spread of blood borne viruses. Therefore, the body piercing practitioners' knowledge about HCV and infection control needs to be assessed, along with the extent of HCV contamination in body piercing establishments.

Study Aims

- To assess the current state of knowledge about HCV and infection control of Victorian body piercing practitioners
- To determine the extent of HCV contamination of equipment and environmental surfaces within Victorian body piercing establishments.
- Where necessary, to use the results to make recommendations about updating of standards of practice for body piercing (Department of Human Services, 1990) (8) with relation to prevention of HCV infection.

Methods

The study was a collaboration between the Macfarlane Burnet Institute for Medical Research and Public Health, the Australian Institute of Environmental Health (AIEH), and the Victorian Infectious Diseases Reference Laboratory (VIDRL).

Thirty-five body-piercing establishments (BPEs) were recruited. The owner or manager of each establishment answered a questionnaire about blood borne viruses, in particular HCV. Environmental swabs were collected from all premises.

Selection of body piercing establishments

Environmental Health Officers (EHOs) throughout Victoria were invited by the Australian Institute of Environmental Health to help with this study. In consultation with the relevant shire and city councils, the EHOs recruited BPEs from their area. The criteria for selection was the establishment had to perform body piercing and should include piercing sites other than just the earlobe, e.g. ear cartilage, nose, navel, genitals. Where necessary, study investigators used random number generation to select BPEs within an area.

EHOs visited participating establishments with a letter of introduction from the investigators. Participants were given a plain language statement that outlined why the study was being performed, the study objectives and the study methodology. If the manager (or appropriate surrogate) agreed to participate in the study they were asked to give written informed consent to participate in the study, meaning they would complete the questionnaire and allow collection of the environmental specimens. BPEs received $25 compensation for loss of income incurred as a result of participating in this study.

Questionnaire

The EHO administered the questionnaire to the manager or owner of the BPE or his or her proxy.

The questionnaire collected the following information:

- Client throughput (average per day, number in past week and month)
- types of piercing conducted and frequencies over time
- frequencies of use of equipment
- pre-processing procedures employed
- practitioners' knowledge of HCV and BBV infection control
- possession/availability of and familiarity with Standards of Practice for Tattooing and Body Piercing: Health pursuant to Part 6

of Health (Infectious Diseases) Regulations 1990 (Tattooing and Body Piercing Guidelines) (8).

Reprocessing of reusable equipment was defined as appropriate if it complied with the Tattooing and Body Piercing Guidelines. Manual cleaning followed by autoclaving is needed for instruments used during body piercing that are contaminated with blood (8).

Reprocessing of piercing guns was defined as appropriate if it complied with the Standards of Practice for Ear Piercing: pursuant to Part 6 of Health (Infectious Diseases) Regulations, 1990 (Ear Piercing Guidelines). The guidelines require manual cleaning of ear piercing guns followed by wiping their surfaces with wipes containing 70% isopropyl alcohol (9).

Collection of environmental swabs

Up to ten environmental swabs were collected from each body-piercing establishment. Swabs were taken from the following items of piercing equipment and environmental surfaces:

- three workbenches; the "clean" preparation bench, the bench the practitioner uses when performing the piercing and the area where the worker places contaminated materials due for cleaning.
- chairs used by the worker and the chair or bench of the person who was pierced.
- two pieces of multi-use piercing equipment that had been reprocessed and two pieces of multi-use equipment that were due to be reprocessed.
- two pieces of single-use piercing equipment before and after use.

Depending on the premises and the equipment used not all swabs were collected at all sites.

Swabbing Technique

For each swab, the EHO used a sterile disposable Pasteur pipette to place 100ul of phosphate buffered saline on the surface to be swabbed. He or she then used a sterile dry swab to work the saline solution over the bench and absorb the solution and any contaminating virus particles. The tip of the swab was placed in a sterile container. The container was labelled with the code for the study site and the name of the equipment that was swabbed (eg. cleaned multi-use piercing equipment, contaminated multi-use piercing equipment, preparation bench, workbench, cleaning bench). Swabs were transported to VIDRL where PCR analysis was performed.

Testing of the environmental swabs

All samples were tested for HCV RNA by the COBAS AMPLICOR HCV test (Roche Diagnostic Systems, Branchburg, NJ). In brief, swab tips were soaked and vortexed in 500 ul sterile saline and then 140 µl of eluate removed and processed by the protocol described for serum samples in the QIAGEN QIAamp Viral RNA kit (QIAGEN, Australia). Any RNA present was eluted from the QIAGEN column in a final volume of 50 ul. To make the extraction procedure compatible with the COBAS AMPLICOR HCV test, a volume of 20 µl of the QIAGEN eluate was mixed with 180 µl of the HCV test specimen diluent after which the manufacturer's protocol was followed.

Assay Validation

A sample of known HCV viral load (as determined by the quantitative Roche HCV MONITOR assay) was serially diluted to concentrations of 106, 105 and 104 copies/ml. Aliquots of 50 µl were dispensed onto plastic dishes in a biosafety cabinet and sampled with a swab at 0, 7, 24 and 48 hours. For the all time points, 100 µl of phosphate buffered saline was added to the sample spot and absorbed with the dry swab. Swabs were processed as outlined. HCV RNA was detected for all sample dilutions.

Data Management

Data from the questionnaires were entered into an access database at the Macfarlane Burnet Institute, as were the results of the environmental swabs. The data were stored in a password secure computer database. Hard copies of the questionnaires were stored in a locked filing cabinet. No individual identifying data was attached to the questionnaires or the computer data set. Hard copy and computer copies of the data shall be stored for seven years at the MBI.

Statistical analysis

Statistical analysis was performed using CIA and SPSS. The Chi square statistic or Fisher's Exact test was used to compare groups categorical data. The Mann-Whitney test was used to compare continuous non-parametric data.

Results

Body piercing establishments were recruited between July and October 2001. Thirty-five body piercing establishments (BPEs) located in 12 metropolitan, rural and regional councils participated in the study (Table 1).

Table 1: Participating councils and the number of body-piercing establishments (BPEs) recruited from their area.

Council	Number of *BPEs
Whittlesea	3
Port Phillip	4
Latrobe	1
Swan Hill	1
Frankston	3
Stonnington	4
Yarra	4
Cardinia	4
Casey	1
Melbourne	2
Geelong	3
Banyule	5

**BPE - Body piercing establishment*

Body piercing was the main activity for ten of the establishments. Tattooing (10), hairdressing (6), beautician (5), and chemists (4) were the major activities of 25 remaining establishments. The median period the establishments had been operating was 36 months (range 1 - 204). The median number of piercings in the last week was 5.5 (range 0-80) and in the last month was 20 (2-360). The most common piercings performed by people who identified body piercing as their primary activity were navels, eyebrows and tongues. The most common piercing by those whose primary activity was not body piercing was earlobes followed by navels and tongues (Table 2).

Table 2: Comparison of the mean number of piercings by body site performed at locations primarily identified as body piercers establishments compared with locations identified as tattooist, hairdressers beauticians and chemists.

Site	Body piercing the main activity	Mean number of piercings	Mean Rank	Significance
Earlobe	No	204.85	15.05	*P*=0.60
	Yes	128.13	13.13	
Ear cartilage	No	86.84	11.13	*P*=0.002
	Yes	257.75	20.81	
Nose	No	85.13	9.59	*P*=0.003
	Yes	403.50	18.31	
Lips	No	54.47	8.87	*P*=0.001
	Yes	271.25	17.88	
Eyebrow	No	83.75	8.94	*P*<0.001
	Yes	546.63	19.63	
Tongue	No	149.33	8.70	*P*=0.001
	Yes	517.13	18.19	
Skin	No	36.80	5.60	*P*=0.35
	Yes	45.25	7.88	
Navel	No	192.28	10.61	*P*=0.003
	Yes	829.25	20.00	
Nipple	No	71.78	10.19	*P*<0.001
	Yes	480.00	20.94	
Male genitals	No	25.00	5.93	*P*=0.16
	Yes	63.43	9.07	
Female genitals	No	14.29	6.43	*P*=0.23
	Yes	51.38	9.38	

Use of piercing equipment

Practitioners used a variety of equipment to perform or assist them with their piercing. Single use needles were used, as were metal

or plastic forceps or tongs, clamps, small pliers and guiding equipment. Guiding equipment consists of a small plastic or metal tube, through which the practitioner would pass the piercing needle. Some practitioners use piercing guns. The most common piercing guns used were *Studex* and *Caflon* brands.

Twenty practitioners reported using piercing guns. Of the practitioners who used piercing guns all used them on earlobes. Twelve of the 20 reported using piercing guns on ear cartilage and 6 reported using piercing guns on the nose. Piercing guns were not used at any other sites.

Twenty-nine practitioners used single-use needles for piercing on some occasions.

Reprocessing of equipment

The reprocessing of forceps (or clamps or tongs) varied. Seven did not reprocess their forceps as required by the *Tattooing and Body Piercing Guidelines*. One practitioner reported only manual cleaning, three only autoclaved, one manually cleaned and soaked the forceps in disinfectant and two soaked the forceps in disinfectant and sterilised them but did not manually clean them. All other practitioners manually cleaned and autoclaved the forceps with or without first soaking them in disinfectant. A similar pattern was apparent for reprocessing of guiding equipment used during piercing. One practitioner soaked the guiding equipment in disinfectant only, three only autoclaved and one soaked the equipment in disinfectant and autoclaved without manual cleaning.

Of the 20 practitioners that used piercing guns 14 did not follow the *Ear Piercing Guidelines*. Eight reported manual cleaning only, three soaked the gun in disinfectant only, and two only autoclaved without manual cleaning (Table 3).

All practitioners who used needles reported using single-use disposable needles.

Table 3: Methods of cleaning piercing equipment

	Needles (*n*=33)	Forceps (*n*-33)	Guiding Equipment (*n*-32)	Piercing gun (*n*=27)	Jewellery (*n*=30)
Single Use Disposable	29	0	0	0	3
Never Use	4	4	8	7	1
Cleaned manually	0	1	0	8	
Disinfect**	0	0	1	4	2
Autoclave	0	3	3	2	12
Clean*, disinfect**	0	1	0	4	1
Clean*, autoclave	0	10	9	1	2
Disinfect**, autoclave	0	2	1	0	3
Clean*, disinfect**, autoclave	0	12	10	1	5
Other	0	0	0	0	1

**Clean - cleaned manually after use using water*

***Disinfect - soaked in disinfectant*

Disposal of Equipment

All 29 practitioners who used needles disposed of them in sharps containers. One practitioner reported disposing of bloodied swabs in a normal rubbish bin and three reported disposing of bloodied gloves in normal rubbish bins in contravention of the *Tattooing and Piercing Guidelines*. Seventeen practitioners reported disposing of used but non-bloodied swabs in normal rubbish bins and 15 reported disposing of used but non-bloodied gloves in normal rubbish bins. The guidelines state such material can be disposed of with the normal rubbish.

Use of protective equipment

Only one practitioner did not comply with the *Tattooing and Body Piercing Guidelines* by piercing customers without using gloves. The other 34 practitioners used new gloves for each customer. The majority of practitioners never wore aprons or protective eyewear when piercing a customer. Four practitioners reported not wearing gloves when cleaning equipment. The majority did not wear an apron or protective eyewear

when cleaning equipment as suggested in the guidelines.

Training

Thirty-one practitioners had undertaken some form of body piercing training. The median length of training was 15 days and the mean length of training was 8.5 months. Of those who gave details, the shortest period of training was one hour and the longest period was 6 years. Of the four who reported no training, two reported many years of experience as body piercers before formal training was available. The other two practitioners who reported no training described hairdressing and pharmacy as their primary business and only performed ear piercing.

The most common forms of training reported were informal apprenticeships and private training courses (Table 4).

Knowledge of hepatitis C virus

Table 4: Training as body piercers

	Number	Median (days)	Range (days)
Formal apprenticeship	3	122	6-240
Informal apprenticeship	15	120	1-2190
TAFE or university	2	190	20-360
Private body piercing course	15	3	1-15
Beautician course	3	1	1-14
Other	6	1	1-5
No training	4		

Knowledge of HCV was assessed by asking practitioners to answer true or false to a series of statements about HCV. All practitioners reported having heard about a disease called hepatitis and HCV specifically. Sixteen practitioners reported having knowingly pierced someone with hepatitis.

A lack of knowledge about how HCV is transmitted was apparent. Of particular concern was the fact that four practitioners did not know HCV could be contracted by sharing injecting drug equipment and five did not know HCV could be contracted from body piercing. Eight incorrectly stated it was possible to contract HCV by being coughed upon by an infected person and nine did not know if this was possible. Seven stated it was possible and 11 were unsure if HCV could be contracted from eating contaminated food. Thirty practitioners correctly said it was possible to contract HCV from body piercing, one said it was not possible and four did not know (Table 5).

Thirty-one practitioners correctly believed people with HCV could be infectious for years and 30 correctly stated people with HCV did not look ill. Twenty practitioners correctly stated people with HCV did not usually have yellow eyes and skin. Twenty-one practitioners were aware there was no vaccine available for HCV.

Despite the majority of practitioners being aware that people with HCV did not always look ill, 19 practitioners stated they performed extra cleaning before their next customer if they know the person they have pierced is HCV positive. This response contradicts the universal precautions for blood and bodily substances. Two people said they would not pierce a person they knew to be HCV infected and another stated they would contact a medical doctor to gain information (Table 5).

Standards of Practice for Tattooing and Body Piercing

Thirty-four practitioners were aware of the *Tattooing and Body Piercing: Health Guidelines*. Thirty-three had a copy of the guidelines, of which 27 had read all of the guidelines and six had read part of the guidelines. Of the 33 who had read the guidelines 24 found it useful, four found part of it useful and five found it of no use. Twelve said that reading the guidelines had changed their work practices. The respondents gave several reasons why the guidelines were useful. Eleven said they improved their set up and cleaning procedures. Three stated the guidelines

they improved the information they gave to their customers (Table 5).

Table 5: Practitioners' knowledge and understanding of HCV

	Yes	No	Unsure/ don't know
Heard about a disease called hepatitis?	35		
Heard about a disease called hepatitis C?	35		
Knowingly pierced anyone with hepatitis?	16	19	
Pierced anyone who had yellow jaundice?	0	31	3
Can contract hepatitis C by eating contaminated food	7	17	11
Can contract hepatitis C by sharing injecting drug equipment	31	0	4
Can contract hepatitis C from a blood transfusion	30	2	3
Can contract hepatitis C by being coughed on by a person with hepatitis C	8	18	3
Can contract hepatitis C during skin piercing	30	1	4
HCV can be found in the blood of an infected person	35	0	0
Hepatitis C can be infectious for many years	31	1	3
People with hepatitis C look sick	2	30	3
People with hepatitis C usually have yellow skin	5	20	10
If a customer is hepatitis C positive - do extra cleaning before the next customer	19	13	
Vaccine is available for hepatitis C	8	21	4
Aware of the Standard of Practice booklet	34		
Have a copy of the Standard of Practice booklet	33	2	
Have read the Standard of Practice Booklet	33	1	
Found the guidelines useful	29	5	
Did reading the guidelines change your work practices	12	21	

**HCV - hepatitis C virus*

Impact of training and the primary activity of the body-piercing establishment.

We examined the relationship between practitioners working in and trained in establishments that reported the establishment's primary activity as body piercing or tattooing (Group 1) with those who had not been trained in a piercing establishment or who worked in establishments where the primary activity was otherwise (chemists, hairdressers, beauticians etc) (Group 2). We compared piercing equipment used by the groups, the cleaning and disposal of equipment and the knowledge and understanding of HCV.

Use and cleaning of equipment

Sixteen practitioners in Group 1 used needles to pierce customers compared with 13 practitioners in Group 2 (p=0.022). Only four practitioners in Group 1 ever used piercing guns compared with 15 practitioners in Group 2 (p=0.001). All practitioners who used needles in both groups disposed of the needle into a sharps container.

One of the four practitioners in Group 1 who used a piercing gun, used the gun to pierce ear cartilage compared with eleven out of 15 practitioners in Group 2 (p = 0.117) who used piercing guns. Two out of four practitioners in group1 used the piercing gun to pierce the nose compared with four out of 15 in Group 2 (p=0.57).

Three out of 16 practitioners in Group 1 did not clean the forceps as recommended in the Tattooing and Body Piercing Guidelines compared with four out of 13 in Group 2 (p=0.68). Four out of 16 practitioners in Group 1 did not clean their guiding equipment as recommended in the *Tattooing and Body Piercing Guidelines* compared with four out of ten in Group 2 (p=0.37).

Disposal of equipment and materials

Disposal of used gloves and swabs varied between Group 1 and Group 2. All 16 practitioners in Group 1 disposed of their bloodied gloves and swabs in a contaminated materials container. One practitioner from Group 2 disposed of their bloodied swabs in the normal rubbish and three disposed of their bloodied gloves in the normal rubbish. Neither of these finding was statistically significant. Twelve practitioners out of 16 in Group 1 compared with five of 18 practitioners in Group 2 disposed of used but

not bloodied swabs in the contaminated materials bin; the remaining practitioners disposed of the used non-bloodied swabs in a normal rubbish bin (p=0.015). Thirteen of the 16 practitioners in Group 1 compared with five of 17 practitioners in Group 2 disposed of used gloves in the contaminated materials bin; the remained disposed of used non-bloodied gloves in a normal rubbish bin (p=0.005) (Table 6).

Use of protective equipment

All practitioners reported wearing gloves when piercing a customer except for one practitioner in Group 2. Approximately equal percentages in Groups 1 and 2 always wore aprons and protective eye equipment. All Group 1 respondents reported they always wore gloves when cleaning the equipment compared with Group 2 where 12 of 16 respondents reported always wearing gloves (p=0 024). Eight of the 14 respondents in Group 1 always or sometimes used protective eyewear when cleaning equipment compared with two of 17repsondents in Group 2 (p=0.018) (Table 6).

Knowledge and understanding of hepatitis C virus

There were differences in the two groups' knowledge and understanding of HCV. All 16 practitioners in Group 1 were aware that HCV could be contracted by body piercing or by sharing injecting drug equipment. Five of the nineteen in Group 2 did not know that HCV could be contracted through body piercing (p=0.049) and four did not know that HCV could be contracted using contaminated injecting drug equipment (p=0.11) (Table 7). A similar percentage of practitioners in both groups 1 and 2 stated it were possible to contract HCV by eating contaminated food or being coughed upon.

Practitioners in Group 1 were more likely to pierce a person known to have hepatitis (p=0.012) but not when they had yellow jaundice (p=0.57). All 16 practitioners in Group 1 were aware that people infected with HCV could be infectious for many years; four of the 19 practitioners in Group 2 did not know this was possible. 15 out of 16 practitioners in Group 1 and 15 out of 19

Table 6: Comparison of practitioners working primarily working as body piercers or tattooist and trained as such (Group 1) compared with non-primary activity practitioners (Group 2).

		Group 1*	Group 2**	Odds ratio (CI) (P value) ***
Wear gloves when piercing	Never		1	
	Always	16	18	p = 0.1
Wear aprons when piercing	Not always/never	13	15	1.2 (0.2 - 6.7)
	Always	3	3	p = 1.0
Wear eye protection when piercing	Notalways/never	11	15	2.27 (0.45 - 11.59)
	Always	5	3	p = 0.43
Wear gloves when cleaning instruments	Notalways/never		6	
	Always	14	12	p = **0.024**
Wear protective eye wear when cleaning instruments	Notalways/never	8	15	5.6 (0.91 - 34.57)
	Always	6	2	p = 0.1
Disposal of bloodied swabs	Cont. materials bin*	16	12	
	Normal rubbish bin		1	p = 0.26
Disposal of bloodied gloves	Cont. materials bin*	16	11	
	Normal rubbish bin		3	p = 0.09
Disposal of used/non bloodied swabs	Cont. materials bin*	12	5	0.13 (0.03 - 0.50)
	Normal rubbish bin	4	13	p = **0.015**
Disposal of used/non bloodied gloves	Cont. materials bin*	13	5	0.10 (0.02- 0.49)
	Normal rubbish bin	3	12	p = **0.005**

**Group 1 - primary activity is body piercing or tattooing and had apprenticeship training*

***Group 2 - untrained body piercer or tattooist or primary activity of establishment not body piercing or tattooing*

****Significant differences between groups shown in bold*

practitioners in Group 2 said that people with HCV did not look sick. Interestingly eleven of Group 2 either did not know or thought people with HCV usually had yellow eyes and skin compared with only 4 practitioners from Group 1 (p=0.05). Eight of 15 practitioners in Group 1 and 11 of 17 practitioners in Group 2 said they would do extra cleaning before the next customer if they knew someone was HCV infected. Three did not respond (Table 7). This practice of "extra cleaning" goes against universal precautions, which recommend that all blood and body substances should be considered as infectious and that routine cleaning must be adequate to ensure a safe environment.

Table 7: Comparison of knowledge and understanding of HCV in practitioners who primarily work as body piercers or tattooist and have been trained (Group 1) compared with non-primary activity practitioners (Group 2).

		Group 1*	Group 2**	Odds ratio (CI) P value***
Knowingly pierced someone with hepatitis	No	5	14	6.16 (1.41 - 26.78)
	Yes	11	5	p = **0.012**
Contract hepatitis C by sharing injecting drug equipment	No#	0	4	
	Yes	16	15	p = 0.11
Contract hepatitis C during skin piercing	No#	0	5	
	Yes	16	14	p = **0.049**
Hepatitis C can be infectious for many years	No#	0	4	p = 0.11
	Yes	16	15	0.24 (0.06 - 1.04)
People with hepatitis C have yellow eyes/skin	No	12	8	p = 0.087
	Yes#	4	11	0.62 (0.15 - 2.58)
Extra cleaning after piercing someone with hepatitis C	No	7	6	p = 0.51
	Yes	8	11	

**Group 1 - primary activity is body piercing or tattooing and had apprenticeship training*

***Group 2 - untrained body piercer or tattooist or primary activity of establishment not body piercing or tattooing*

****Significant differences between groups shown in bold*

 # includes people who stated they did not know or were unsure.

There was no difference between the two groups in regards to having an awareness of the Standards for Tattooing and Body Piercing, in having a copy at the premises or in having read all or some of the standard.

Environmental Swabs

Three hundred and twenty-three environmental swabs were collected from preparation, work and clean up benches, clean and used multi-use equipment, practitioners' chairs, and the clients' chairs or benches of 35 establishments (Table 8). EHOs occasionally swabbed sharps containers, infectious waste bins, disinfectant bottles and hand wash basins. HCV RNA was not detected on any swabs.

Discussion

Body piercing has become popular in Victoria and Australia with increasing social acceptance over the past decade. At the same time several studies have reported body piercing as a risk factor for contracting a hepatitis and HIV (10) (11). It has also been reported that body piercing is more common amongst injecting drug users (7), a high percentage of whom are infected with HCV. For this reason it is important to that people working in the body piercing industry understand the issues and risk surrounding the spread of blood borne viruses.

This study was performed to ascertain if there was evidence of contamination of HCV in BPEs in Victoria and simultaneously measure practitioners knowledge of HCV and infection control. The results of this study confirm that body piercing practitioners' have a limited

Table 8: The number of environmental swabs collected and the type of swabs taken.

Site of swabs	Number
Preparation bench	39
Work bench"	38
Cleaning area bench	37
Chair - body piercer	23
Chair/bench - customer	43
Clean multi-use piercing equipment	40
Contaminated multi-use piercing equipment	22
Clean single-use piercing equipment	31
Contaminated single-use piercing equipment	11
Piercing gun	24
Other	15

35 premises were studied. Some premises had multiple swabs taken from certain sites.

understanding of infection control and their knowledge of HCV and the risk factors leading to its spread are poor. This is despite all practitioners being aware of the *Tattooing and Body Piercing Guidelines* and the majority having read part or all of the guidelines. The study reveals that training for body piercers is varied and often very limited and that some practitioners receiving no training in infection control procedures.

Use of piercing guns

Confusion surrounds the appropriate use of piercing guns with the study results suggesting that guns are not being used correctly. There are no specific recommendations in the Ear Piercing Guidelines but it is generally accepted that the piercing guns can be used to pierce earlobes. Controversy surrounds what other sites can be pierced with a piercing gun. The literature provided by manufacturers of the two most commonly used piercing guns varies in regards to the piercing of ear cartilage. One manufacture states that piercing of the ear cartilage is possible but inadvisable (12). The other states special care must be taken when piercing the cartilage but the instructions in the booklet are ambiguous. Practitioners are advised "do not pierce through the curled "edge" of the ear" but following sentence says "when piercing the cartilage around the edge of the ear...". The illustration provided in the manual indicating what area of the cartilage can be pierced is not particularly instructive (13).

Twelve of the 19 practitioners who used guns pierced the ear cartilage and six practitioners used guns to pierce the nose. The confusion in the instructions combined with the overall lack of training of many practitioners suggests customers are at risk of having an inappropriate piercing performed. It is important that clear guidelines be developed about the use of piercing guns.

Reprocessing of equipment

The study revealed a frequent lack of adherence to the *Tattooing and Body Piercing: Guidelines, 1990* with respect to reprocessing of equipment such as forceps and clamps and guiding equipment. Instruments that are contaminated with blood require manual cleaning followed by sterilising. The only method of sterilising considered appropriate is autoclaving (8). The most common mistake was practitioners did not manually clean the instruments before sterilising them. Unless an instrument has been manually cleaned the effectiveness of the sterilisation process cannot be guaranteed.

Inappropriate or inadequate reprocessing of ear piercing guns was also common. The *Ear Piercing Guidelines* advise that piercing guns must be cleaned after each use by thorough scrubbing with detergent and then all surfaces of the gun should then be cleansed with wipes containing 70% isopropyl alcohol swabs and allowed to dry (9). It is of concern that the literature provided to practitioners by the manufacturers of the two commonly used piercing guns does not give clear instructions as to how to reprocess the guns. One gives no specific instructions but discusses the relevant by-laws of the Local Government Act in the UK (12). The other advisers practitioners to cleanse the area of the clasp retainer by wiping it with a cotton ball or

swab moistened with alcohol or an ear care solution (14) (13).

Disposal of materials

The Tattooing and Body Piercing Guidelines require different methods of disposal for infectious and non-infectious waste. Infectious waste should be placed in an infectious waste bin and non-infectious waste can be placed in a normal refuse bin (8). A few practitioners disposed of obviously bloodied material incorrectly into a normal refuse bin in contradiction to the guidelines. Some practitioners disposed of used but non-bloodied swabs and gloves into an infectious waste bin; this was more likely to occur with practitioners in Group 1 (practitioners for whom piercing was their primary activity) compared with Group 2. Use of the contaminated materials bin is unnecessary from an infection control and health perspective and also leads to an additional cost to the practitioner.

Use of protective equipment

All but one practitioner reported wearing gloves when piercing; a surprising number did not always wear a protective apron or eyewear, which puts the practitioner at risk if there is a blood splash during piercing. There was no significant difference in use of protective wear between Group 1 and Group 2. A number of practitioners did not use adequate protective equipment to reduce the risk their own risk of infection when cleaning piercing equipment. The guidelines recommend the practitioner wear heavy-duty rubber gloves when washing contaminated instruments and that care should be taken to prevent penetration of the skin or splashing of the mucous membranes such as eyes (8). The guidelines for ear piercing do not make a recommendation regarding use of protective clothing when cleaning piercing guns but it would be reasonable to wear gloves because of the potential for blood to contaminate equipment.

Knowledge and understanding of HCV

Practitioners knowledge and understanding of the spread of HCV was less than optimal; of particular concern was the fact that five of the 35 practitioners were unaware or uncertain as to whether HCV could be transmitted through body piercing. Practitioners in Group 2 appeared to have less understanding and knowledge of the virus and be less likely to follow the guidelines in regards to cleaning equipment compared to practitioners in Group 1. Nevertheless, even the "primary piercers" group had significant deficits in their understanding of HCV and universal precautions when dealing with blood product.

Inadequate understanding of infection control procedures was common. A major concern was many practitioners did not understand the concept of universal blood and body fluid precautions. Under universal precautions blood and certain body fluids of all patients are considered potentially infectious for HIV, hepatitis B, HCV and other blood borne pathogens (15) (16).

Practitioners from both groups stated they would do extra cleaning after piercing someone who told them they were infected with HCV, despite the majority of practitioners being aware that many people infected with HCV did not look sick. This suggests practitioners were not confident that their normal infection control procedures were adequate. There are two explanations: practitioners were aware of lapses possible in their infection control procedures, or they did not understand that if correct procedures are followed the risk of viral transmission is extremely small. Training in the concept and implementation of universal precautions is required.

Environmental swabs

Although the environmental swabs were all negative for HCV RNA, the possibility of environmental contamination with the HCV should not be discounted. A dozen or fewer swabs were taken at each establishment and on only one occasion;

these limitations, plus the fact that only around 1% of the Victorian population is likely to be infected with the HCV, means the probability of detecting any HCV RNA was always low. Also it is possible that practitioners took extra cleaning precautions before environmental health officers visited their premises.

Main Conclusions

The results of our study are disturbing because they reveal a lack of training and knowledge amongst Victorian body piercing practitioners in regards to the spread of blood borne viruses, in particular HCV. Our results also show that many Victorian body piercers' have inadequate procedures for reprocessing piercing equipment.

Practitioners working in establishments that perform body piercing as a secondary activity appear to have less understanding and knowledge of the virus compared to practitioners for whom piercing or tattooing is a primary activity. They were less likely to follow the body piercing and ear piercing standards for reprocessing equipment and disposing of waste. Nevertheless, the "primary piercer" group also had significant deficits in their understanding of HCV and the concept of universal precautions.

The study's demonstration of body piercing practitioners' limited understanding of how HCV is transmitted, inadequate knowledge of universal precautions, and failure to follow standards of practice is a grave concern. There is potential for HCV to be spread through body piercing in Victoria unless improvements are made to the regulation of this industry and training of practitioners.

11. Recommendations

All people who perform body piercing, regardless of whether it is the primary activity of the work place, should

1. Undertake certified infection control training. This may be part of a body piercing training course or be stand-alone course in infection control. If infection control training is incorporated into a body-piercing course it must be a dedicated and compulsory section of the course. This course should involve:

   - Information about the major blood borne viruses, including modes of transmission, natural history, and interpretation of test results
   - Information about the risk and management of wound infections
   - Universal precautions for prevention of blood-borne virus transmission
   - Methods of reprocessing equipment
   - Methods of disposal of equipment
   - Use of protective equipment

   It is not the role of the reporting group to determine the length of the infection control course but the five and six-day courses offered in Victoria in HIV test counselling is a reasonable guide to length of such courses. Practitioners should be required to undertake a (shorter) refresher course every three years.

2. Undertake a certified body-piercing course. The course should cover:

   - The appropriate use of piercing equipment, including piercing guns
   - Information on the type and positions of piercing and the potential short term and long term health issues associated with piercing at specific sites.
   - Information of the jewellery used in piercing and the type of

jewellery suitable for specific sites.

- Information about the risk and management of wound infections
- Guidelines of Practice for Tattooing and Body Piercing, and for Ear Piercing.

Practitioners who only use piercing guns to pierce earlobes (such as occurs at a number of chemists and beauticians) should be required to undertake a one day training course (as well as the infection control course) on the use of piercing guns.

Practitioners who pierce other body sites should be required to undertake a minimum of a five-day training course in body piercing.

3. All body piercing establishments and or practices shall be registered/renewed with local government council as the responsible approving authority.
4. It shall be mandatory that the proprietor of every body piercing/practice shall be required to provide the following information upon registration/renewal of registration to the responsible approving authority
   - The names of all body piercing practitioners (together with copies of certificates or statements of attainment against the proscribed competencies) whom are engaged within the establishment to undertake body piercing practices to the public.

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