

Cluster Investigation into Motor Neurone Disease Nelson

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Dr E Kiddle
Medical Officer of Health
Public Health Service
Nelson Marlborough District Health Board
Nelson

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Dr Ed Kiddle
BSc, MBChB, FAFPHM.
Medical Officer of Health
Nelson.

Executive Summary

A cluster investigation was undertaken in response to concerns about a possible link between cases of motor neurone disease (MND) that had occurred in people who had worked in the Port Nelson area and the fumigant methyl bromide. The fumigant is used for biosecurity purposes particularly for timber exports and is used at a number of ports around the country.

In addition work is being undertaken with agencies such as the Occupational Safety and Health Service to ensure best possible process is in place around fumigation operations.

The cluster investigation process involved finding cases of MND that have occurred in the region and then determining the presence of any cluster or increase in cases over that number expected to occur. Information on the cases was then obtained including any possible exposure to methyl bromide.

Sixteen cases of MND were identified as having lived in Nelson / Tasman and been diagnosed with MND since 1995. This is consistent with the expected incidence of the disease. Six cases gave a history of having worked in the Port Nelson area. Three of these cases could have had episodes of exposure to methyl bromide through proximity to timber fumigation sites. No definite exposure could be confirmed. No evidence was found in the medical literature of methyl bromide being linked with MND. No cluster could be identified based on rates of MND for the Nelson population.

Disease rates for the worker population in the port area have not been calculated as there was no data available for the denominator population in this area.

The most likely explanation for the group of cases who had a work history involving work sites in the Port Nelson area is chance.

A number of recommendations have been made relating to the fumigation process and to assessing any risk to the health of workers in the area or the public in general.

Background

Introduction – the situation in Nelson

This cluster investigation into cases of motor neurone disease (MND) has been carried out in response to the concern raised by four women from the Nelson community. This concern was that the deaths of their husbands from MND in the period 2002 - 2004 could be associated with work in and around the Port Nelson area and exposure to the fumigant methyl bromide.

At the same time there were also concerns being raised locally by members of the public about the risk to human health through workplace exposure to methyl bromide and about environmental impacts of the fumigant.

Methyl bromide is used in the port area for biosecurity purposes on both imported and exported goods. Fumigation of export sawn timber and logs accounts for most of the methyl bromide used.

The purpose of this cluster investigation was to address the concern around the apparent cluster of deaths from MND in Nelson in people who had worked in the Port Nelson area by:

- Confirming the number of cases of MND in the region over the time period 1995 - 2005 and the presence of any cluster.
- Seeking further information about the cases of MND.
- Investigation of any history of possible methyl bromide exposure that may have occurred for any of the cases.
- Recommending any further actions that may be necessary to minimise any risk to health including the need for research into the issue.

All cases of MND in the Nelson Tasman region (Nelson province), that could be identified since 1995 were investigated looking for any features in common and for possible risk factors for MND. In particular the possible role of methyl bromide in MND cases who had worked in the Port Nelson area was explored.

Other work in relation to fumigation processes in the workplace has been undertaken, particularly by the Occupational Safety and Health Service (OSH), a division of the Department of Labour. The Nelson Marlborough District Health Board (NMDHB) Public Health Service (PHS), the fumigation companies, stevedoring companies, and Port Nelson Ltd have assisted in this work. This includes reviewing the timber fumigation process at Port Nelson, further measurements of the levels of methyl bromide occurring around timber fumigation and investigation into biological monitoring of workers for methyl bromide exposure. A code of practice for timber fumigations at Port Nelson has been developed¹ and there has been input into a draft national code on the control and safe use of fumigants.²

In addition further work is planned in relation to measurement and monitoring of methyl bromide and other volatile chemicals associated with timber and the fumigation process. This work is being undertaken by specialists in air science, industrial science, occupational hygiene and public health. This investigation will assist in addressing any risk to public health as a result of methyl bromide releases to air for both port workers and also for people beyond the port workplace boundary.

It should also be noted that the Nelson City Council (NCC) is currently finalizing an air plan for the city which includes proposed rules around fumigations such as the need for a resource consent.

Clusters of Disease

A cluster is used to describe a grouping or aggregation of some uncommon disease or event³ Such aggregations may be a time cluster, when an unusual number of cases of disease occur within a defined period of time. It may be a space cluster where the unusual number of cases of the disease occurs in a defined area or it may be a time – space cluster where the unusual number of cases occurs in a defined time period and area⁴.

Clusters occur by chance and indeed this is the most frequent explanation of clusters⁴. Some researchers have stated that clusters can be better defined by acknowledging “that aggregations can occur by random process but cluster investigations seek to identify excessive aggregations.”⁵ A particular difficulty in cluster investigations is that identifying excess aggregation can depend on the denominator population chosen. That is the population that the cases are occurring in. For this cluster investigation the smallest unit that included the entire group of cases and for which statistical information was available was the Nelson population. Denominator population numbers were not available for the worker population of the Port Nelson area which also varies over time.

A further difficulty with this type of retrospective investigation is raised by the lack of information about time delay (latency periods) that may be relevant between the time of exposure and the time of disease onset and diagnosis (assuming that a causal association does indeed exist between the exposure and disease).

Whilst acknowledging that most clusters arise as a chance finding it is still appropriate to investigate clusters of disease in response to public concern about possible links between the disease and some exposure to a substance in the work place or the environment. Also cluster investigations have a place in raising hypotheses that can be tested if necessary by using more rigorous study processes.

The cluster investigation method used in this investigation is outlined in the ‘Guidelines for Public Health Services Investigating Clusters of Non Communicable Disease’⁴.

The investigation process was as follows:

1. Case definition
2. Case finding
3. Data collection around the cases, including confirmation of diagnosis, medical and occupational history, any exposure to methyl bromide and to other reported possible risk factors for motor neurone disease
4. Exposure clarification by mapping work history against fumigation site history and the possibility of exposure to methyl bromide.
5. Analysis of results.
6. Review of available health data on national MND rates and rates for Nelson Tasman. Also information was sought on MND rates in other regions of New Zealand where fumigation activities occur.
7. Literature review on MND focusing on possible links with methyl bromide.
8. Conclusions and recommendations regarding any further action or research in relation to methyl bromide fumigation and possible risk to public health.

Motor Neurone Disease

Motor neurone disease is a neuromuscular disease where the motor neurones, the nerve cells from the brain and spinal cord to muscle tissue, are progressively destroyed. As the motor neurones deteriorate nerve impulses are not transmitted, leading to wasting and paralysis of the affected muscles.

Motor neurones occur in the brain and spinal cord. Upper motor neurones are in the motor cortex area of the brain and lower motor neurones in the brain stem and spinal cord.

The type of MND can be defined by the pattern of the pathological change in the motor neurones and the symptoms of MND are largely dependent on the degree and order in which upper and lower motor neurones are affected. This varies from person to person. Early symptoms may include weakness, cramps, fatigue, muscle wasting, a slurred voice, and muscle twitches (fasciculations). For most people the arms and legs are affected first. Muscle weakness and wasting generally progresses and the disease eventually affects swallowing and breathing. For about 25% of people the throat is affected first causing difficulty in swallowing and speaking. This is called bulbar onset where involvement of the nerves to the tongue and pharynx gives a form of MND called pseudobulbar palsy. Amyotrophic lateral sclerosis (ALS) is the most common form of MND and is characterised by degeneration of both upper and lower neurones⁶.

In MND only motor neurones are affected and other functions of the nervous system such as sensation and thinking are not affected.

Diagnosis can be difficult, particularly in the earlier stages of the disease and there is no definitive test. Other similar diseases need to be ruled out by various investigations before a diagnosis can be made.

The incidence of MND is about one to two new cases per 100,000 population per year worldwide.⁷ About 80% of people with MND die within 2-5 years of diagnosis.

Epidemiologically MND is distributed into three groups, Sporadic, Familial and Western Pacific⁸.

Sporadic MND

This occurs for over 90% of cases and there is no family history of MND⁸. The risk increases with age with the mean age of onset being 55 years⁷. The incidence in men is about 1.5 to 2 times greater than in women⁶. Genetic factors may play a part in sporadic MND. As is the case for many diseases research is looking at the role of gene – environmental interactions, that is, the role of environmental triggers amongst genetically susceptible individuals. Various hypotheses have been put forward as to how the motor neurones are damaged in MND. Examples are the concept of damage from neuronal excitotoxicity and the role of oxidative free radicals.^{7,9} It is possible that these damaging processes are stimulated and then enhanced by specific chemical exposures of sufficient dose and duration.

Methyl bromide has not been reported as a chemical associated with MND.^{8,9,10,11} However the possibility of a mechanism whereby with sufficient exposure to methyl bromide free radicals could be generated, overcome body defences and then damage neurones has been raised¹².

Familial MND

Between 5% and 10% of cases of MND are familial where two or more cases have occurred in one family.⁸ For this group there is an equal sex distribution. Most of these cases are inherited through an autosomal dominant gene inheritance mechanism and a number of different gene defects have been identified⁷.

Western Pacific MND

A much greater incidence of MND like illness has been recorded in certain areas of the Pacific (Guam, Western New Guinea and Kii peninsula of Japan) However in the last 40 years this high incidence has decreased and is now similar to the rest of the world⁸. This incidence pattern suggested that environmental risk factors may have accounted for the greater incidence and remains in area of active research although familial clustering is now also reported to be a factor¹³.

Risk factors for MND

Only three factors have been consistently shown to be linked to a greater risk of MND. These are increasing age, being male and a family history of the disease. A number of other risk factors have been identified in various studies but have not been consistently reported in all studies looking at possible causative factors for MND. These include both environmental factors and other non environmental factors. Any possible causative factor for MND must fit with the worldwide distribution, rare onset before 40 years, highest incidence in the 55 to 70 year age group and little evidence for clustering.¹³

Factors evaluated as possible causes of MND include infectious diseases, nutritional factors, extensive exercise, cigarette smoking, trauma, particularly head trauma, and electric shock.

A number of possible environmental risk factors and their links to MND have been investigated. These include metals, solvents and volatile organic chemicals, trace elements, radiation, and agricultural chemicals.

It is possible that MND may result from a number of causes with genetic mutations making an individual vulnerable then an external factor or factors acting to trigger the disease.¹³ Determining any environmental risk factors involved is particularly difficult as there may be a long latent period between exposure to the risk factor and onset of the disease.

The Agency for Toxic Substances and Disease Registry in the USA reviewed literature on environmental risk factors⁸. In this review heavy metal exposure was identified as a risk factor in a number of case control studies but evidence remains inconclusive as this had not been consistently observed in all studies. Lead and mercury have been investigated particularly because they have been associated with neurological symptoms similar to that experienced by people with MND.

The review did not report strong support for diet and trace elements having a role.

Solvents and other volatile chemicals have been studied extensively as possible risk factors and the conclusion was that the epidemiologic literature offered some support for an association between MND and past exposure to organic solvents. However many of these studies had problems with exposure characterisation and chemical specificity. Studies have looked at occupations and the risk of MND with the occupation serving as a surrogate measure of past exposure to chemicals. Occupations where some studies have shown an increased risk include leather workers and painters although other studies have not confirmed

this. Various other occupations with likely exposure to solvents and other chemicals have been evaluated but no strong findings have been reported. There are many limitations in using occupational studies to identify environmental risk factors for MND such as people changing occupations and worksites and variation in work at a particular worksite. Such changes make determining particular exposures to possible risk factors difficult.

Radiation and non-ionising radiation from electric and magnetic fields have been evaluated as risk factors for MND. The review reported that several studies have shown a greater risk for people whose occupations involved greater exposure to electromagnetic fields with cohort and case control studies showing a greater risk of MND in workers whose occupations were related to electrical work. However other studies looking at this occupational risk have not confirmed this. Because of the association with electrical work and EMFs the review looked at the question of electric shock and risk of MND. Once again some case control studies reported this as a risk but others did not.

Agricultural chemicals have been evaluated as a risk factor given the observation in some studies of an association between farming and MND. The review reported that weak significant associations have been found with agricultural work and rural residence and the risk of MND in some studies. However many studies have also found no association between farming or rural living and MND. The results of case control studies investigating possible links between agricultural chemicals and MND have been inconsistent.

Methyl bromide was not mentioned as a possible risk factor for MND in this review.

In summary this review reported that while the aetiology of the disease is unknown and while several environmental risk factors have been investigated for a cause or link the cumulative evidence for specific risk factors is limited and inconsistent. Studies looking at other non-environmental factors were not included.

Another paper looked at spatial clustering of MND based on place of birth and place of death and reported that a wide range of potential environmental risk factors have been studied including welding, agricultural and electrical occupations, smoking, exposure to ionising radiation and to mercury, aluminium and lead. All had been inconclusive.¹³ The same paper reviewed previous evidence for spatial clusters of MND and reported that apart from some familial groupings such cluster studies had been inconclusive with apparent clusters often based on small numbers of cases with the findings likely to have been due to chance. This particular study looked at 1000 cases of MND in Finland using the comprehensive database of residential history available in that country and found clusters based on place of birth and place of death. The authors comment that the results could be consistent with either an environmental or a genetic hypothesis.¹³

Methyl Bromide

Methyl bromide is a gas at room temperature and used as a pesticide to fumigate soil, spaces, structures and commodities. It is odourless (except in high concentration) and colourless and is usually transported as a liquefied compressed gas.

It is the most widely used quarantine fumigant around the world with about 17% of world methyl bromide consumption used for this purpose.¹⁴ The following figures show the amount used in New Zealand and two other countries:

- New Zealand 130 tonnes for all purposes in the year 2000
- USA 26187 tonnes for all purposes in 1996

- Japan 2070 tonnes for quarantine and pre-shipment quarantine use only (Q and QPS) in 1997¹⁴.

In 2003 New Zealand used approximately 20 tonnes for non Q and QPS purposes and 140 tonnes for Q and QPS purposes.¹⁵

Methyl bromide is an ozone depleting substance and as such its use in New Zealand for non quarantine purposes such as soil fumigation was due to be phased out in 2005 but recently extended to the end of 2006 under the Montreal Protocol to which New Zealand is a signatory. Methyl bromide use for Q and QPS is exempt under the Montreal Protocol¹⁶. Efforts to find alternative quarantine fumigants and to establish recovery and recycling systems and hence reduce emissions of methyl bromide are encouraged in the protocol.

It has been used for timber fumigation at the port of Nelson since about 1981 to meet export requirements for certain countries (China, India and Australia) regarding biosecurity control and in particular the killing of *Arhopalus tristis* beetle (Burnt Pine Bark Beetle) which exists in New Zealand forests. It is also used in the fumigation of some imported goods, usually in containers, to meet New Zealand biosecurity controls.

Fumigation of export timber is carried out between the months of November and April as this is the risk period for the *Arhopalus* beetle infestation of timber.

Methyl bromide use varies around New Zealand with it being used in all the significant log and sawn timber exporting ports and in addition it used in agriculture for fumigation of soil particularly in the strawberry horticultural area. Of the one hundred and forty tonnes of methyl bromide used in New Zealand in 2003 for Q and QPS purposes about 10% was used at Nelson. The majority was used at Port Tauranga which used about six times the amount of methyl bromide that Port Nelson used.¹⁵

Health Effects of Methyl Bromide

Acute exposure to methyl bromide can cause significant health effects dependent on the concentration and duration of exposure. There may be delay of several hours between exposure and symptoms. It can affect many of the body systems causing a symptoms such as nausea, vomiting, dizziness, convulsions, skin and eye irritation, shortness of breath, blurred vision, headaches and confusion.^{17,18} Exposure to very high concentrations for several hours can be fatal.

The International Agency for Research on Cancer has evaluated methyl bromide as not classifiable as to its carcinogenicity to humans. This is due to inadequate evidence of carcinogenicity in humans and limited evidence in experimental animals¹⁹. It is not considered to be a reproductive or developmental toxin¹⁸.

Chronic exposure has been associated with peripheral neuropathies, behavioural changes, headaches, visual disturbances, malaise and weakness and possible kidney and liver dysfunction.^{10,18}

People can be exposed to methyl bromide during its manufacture and through its use as a fumigant in ports, in pest control and in horticulture. Natural production of methyl bromide also occurs in the ocean and it can be detected in small amounts in sea water.¹⁹ Inhaled methyl bromide is eliminated from the body in exhaled air or through absorption then metabolism to inorganic bromide. Both methyl bromide and inorganic bromides may be present in food.¹⁰

Cluster investigation Methods

Case definition

The following definition was used in this cluster investigation; 'a case of MND diagnosed after January 1st 1995 occurring in a person who had lived in either Nelson City or Tasman District '.

All cases had been seen by a neurologist and the diagnosis of MND confirmed.

Case finding

Cases were sought through a mail out to local general practitioners, through the local neurologist, the Motor Neurone Disease Association newsletter, and the local media. People with MND or families of people who had died of MND were asked to contact the Medical Officer of Health at the Nelson Public Health Service. Following this contact, consent was sought to access any available NMDHB hospital record and people were advised that they would be contacted again in the near future for interview. Eighteen cases were identified as meeting the case definition. Two of these cases had come to live in Nelson after their diagnosis of MND and had never previously lived in the region. These two cases were then excluded from cluster investigation.

The remaining 16 cases were then further investigated through an interview and a questionnaire with either the case directly, or if the person had died their partner was interviewed.

MND Cluster investigation questionnaire

The questionnaire was adapted from a draft questionnaire being prepared for a case control study on MND in the UK²⁰. Information was sought on demographics, MND history, medical history, family history, occupational history, residential history and a range of possible risk factor exposures. For cases who had died the interview with their partner included information on the length of time they had known the case but obtaining complete information on history and possible exposures was obviously more difficult for these cases.

A Ministry of Health epidemiologist and a Public Health Physician, both experienced in cluster studies reviewed the questionnaire.

The Medical Officer of Health, Nelson, carried out all the interviews.

Other information

Information on the history (time and place) of fumigation operations at Port Nelson was obtained from the Port Nelson Ltd Company. This was then mapped against the occupational history (place of work and years there) of any person with MND who had worked at or around Port Nelson. This mapping analysis was used to help clarify the risk of exposure to methyl bromide.

Routinely collected mortality data for cases of MND was obtained from the Ministry of Health for the Nelson Tasman region and for other regions of New Zealand where timber fumigation activities occur. This then enabled comparison with other regions in New Zealand and with the country as a whole.

Incidence rates for MND in people who had worked at or around Port Nelson could not be calculated as it was not possible to obtain accurate data on the working population in the port

area over the years 1995 to 2005. This meant no figures were available for a denominator population and therefore no incidence rate for this group could be calculated.

Results

Questionnaire results

Case numbers

The number of cases of motor neurone disease identified who had a history of living in Nelson Tasman and had been diagnosed since 1995 was 16. At the time of interview of the cases 12 had died, since then one further case has died.

For cases who had died the length of time the person being interviewed had known the case is recorded in Table One.

Table 1

Years interviewee had known the case	Number of cases who had died
<20	1
20 – 39	3
40 – 49	3
50 – 59	3
>60	2
	12

Gender

The majority of cases were males, (75%), and all the cases who had worked in the port area were male.

Table 2

Gender	Cases
Males	12
Females	4

Ethnicity

All 16 cases were identified as New Zealand European; two had been born outside New Zealand.

Age at diagnosis

Sixty two percent of the cases were aged between 55 and 70 years at diagnosis. Five of the six port area workers were in this age group when diagnosed.

Table 3

Age group (years)	Number of cases	Port area workers
45-49	2	
50-54	3	1
55-59	1	1
60-64	5	2
65-69	4	2
70-74	0	
75-79	1	
Total	16	6

Grouping of MND cases by initial symptoms

There was variation in presenting symptoms across all cases.

Table 4

Initial symptoms	Total cases	Port Area Workers
Muscle weakness and cramp	8	3
Fasciculation	1	
Fasciculation and weakness	2	
Bulbar onset	5	3
	16	6

Classification of MND cases at diagnosis

Classification of MND is difficult and was not specified in all cases. No cases were classified as familial. The port area workers showed a mix of classification types, as did the cases in general.

Table 5

Classification type	Total Cases	Port area workers
Bulbar	5	3
Pseudo neuritic	2	
Primary lateral sclerosis	1	1
MND (unspecified)	7	2
Non bulbar (atypical)	1	
	16	6

Past History of the cases

In relation to past medical history a wide range of illnesses were reported. Apart from one case who had a history of a stroke no neurological diseases were reported. Three cases had hypertension, two diabetes and two asthma. Various other illnesses were reported. Six cases reported significant infections in the past including tetanus, adult mumps, tuberculosis and severe influenza.

Immunisation history was unknown for the majority of cases.

Table 6

Illness	Yes	No	Comments
Past history of illness requiring admission to hospital.	12	4	A range of illnesses and operations was reported
Past history of illness requiring medication for 6 months or more.	9	7	

Three of the sixteen cases reported non food allergies. Bee stings, (one case), and pollens, (two cases). Three cases reported food allergies.

Other past history

All sixteen cases consumed alcohol at some time with two reporting periods of time when the consumption of alcohol had been greater than the suggested safe upper limit of 14 standard drinks a week for women and 21 standard drinks a week for men.

Smoking history is reported in Table 7 along with other factors that have been suggested in research as possible risk factors for MND.

Occupational history

The sixteen cases represented a range of occupations. Many cases had changed occupation and workplace a number of times. Six cases gave a history of having worked in the Port Nelson area. The length of time at workplaces in that area ranged from 5 to 40 years.

For a number of occupations there was potential for exposure to chemicals that have been considered as possible MND risk factors. In particular these were heavy metals, solvents and other volatile chemicals.

Recreational interests

A wide range of recreational interests was reported with some having the potential for exposure to possible MND risk factors. Primarily this was lead exposure through shooting but also solvent exposure through activities such as boat building.

Possible MND risk factors

These are shown for the sixteen cases in Table Seven. Table Eight shows possible risk factors for the subset of people who worked in the port area.

Possible MND risk factors	Yes		No		Comments								
	Number	%	Number	%									
Past history of trauma requiring admission to hospital	7	44%	9	56%									
History of being knocked unconscious	5	31%	11	69%									
Family history of MND	3	19%	13	81%	MND reported in a cousin, parental uncle, and a parental aunt.								
History of electric shock	5	31%	11	69%									
History of possible exposure to ionising radiation	1	6%	15	94%	Work involvement at radioactive sites.								
History of likely occupational exposure to electro magnetic fields	1	6%	15	94%									
History of smoking cigarettes	10	62%	6	38%	Of the 10 cases where smoking history was reported <table border="1" data-bbox="837 853 1283 981"> <thead> <tr> <th>Years of Smoking</th> <th>Number</th> </tr> </thead> <tbody> <tr> <td><10</td> <td>2</td> </tr> <tr> <td>10-19</td> <td>3</td> </tr> <tr> <td>>20</td> <td>5</td> </tr> </tbody> </table>	Years of Smoking	Number	<10	2	10-19	3	>20	5
Years of Smoking	Number												
<10	2												
10-19	3												
>20	5												
History of intensive physical training	2	12%	14	88%									
History of living greater than 12 months in a rural area	12	75%	4	25%									
History of farm work for greater than 12 months	5	31%	11	69%									
History of possible occupational or hobby exposure to lead	5	31%	11	69%	Possible lead exposure through involvement with gun clubs and rifle shooting ranges. (5 cases) One case also worked with lead and mercury.								
History of possible solvent exposure	7	44%	9	56%	Cases worked in the petroleum, spray painting, boat building, and chemical industries.								
History of pesticide or herbicide use / and possible exposure (excluding methyl bromide)	6	38%	10	62%	4 cases had very limited use of garden herbicides. 1 case reported exposure to herbicide. 1 case used 245T. 1 case also reported working for a pest fumigation company in the 1970s for one year.								
History of work directly with methyl bromide	0		16										
History of work at or near a known methyl bromide fumigation site	6		10		6 cases reported an occupational history that involved work sites in the Port Nelson area. (NB. One further case did voluntary weekend work adjacent to the port.)								

Possible motor neurone disease risk factors in the six cases with a work history in the Port Nelson area.

Table 8

Possible MND risk factors	Yes Number	No Number	Comments
Past history of trauma requiring admission to hospital	3	3	
History of being knocked unconscious	2	4	
Family history of MND	0	6	
History of electric shock	0	6	
History of likely occupational exposure to electro magnetic fields	0	6	
History of possible exposure to ionising radiation	0	6	
History of smoking cigarettes	3	3	
History of intensive physical training	1	5	
History of living greater than 12 months in a rural area	3	3	
History of farm work for greater than 12 months	2	4	
History of possible occupational or hobby exposure to lead.	2	4	
History of possible solvent exposure	3	3	
History of pesticide or herbicide use / and possible exposure. (excluding methyl bromide)	4	2	Two cases report very occasional use of garden herbicide. 1 case used 245T. 1 case worked for a pest fumigation company for one year.
History of work directly with methyl bromide	0	6	No case worked directly with methyl bromide as a fumigator.
History of work at or near a fumigation site	6	0	Six cases worked in the port Nelson area. Risk of possible exposure to methyl bromide is examined further in the report.

For both the 16 cases as a whole and the six port area workers there were cases who had a history of hospital admission for trauma and cases where head trauma had caused unconsciousness.

There was a family history of MND in three cases but none of these were port area workers. The family history was not in first degree relatives.

Five cases had a history of electric shock, one case possible exposure to radiation (radioactive site work), and one case with work that is likely to have lead to EMF exposure. These exposures were not reported in the port area workers.

A history of cigarette smoking was reported in ten of the 16 cases and for five of these it was for greater than 20 years. Half of the six port area workers reported smoking.

Extensive physical exercise has been raised as a possible risk factor for MND and out of the 16 cases two reported periods of extensive physical training.

The majority of cases and half the port area group lived rurally at some stage with five cases reporting a history of farm work. All cases had moved residence with the number of moves ranging from 1 to 13. The average number of moves was four. Eight cases had been born in the Nelson Tasman region and six had lived in the region all of their lives.

Possible exposure to lead was reported in five cases who had with significant involvement in pistol and rifle shooting. Two of these cases were in the port area group. One case reported an exposure risk to mercury through work with the metal.

Three of the port worker group and seven cases overall reported possible work related solvent and other volatile chemical exposure risk. This was associated with work in the petroleum, boat building, painting and chemical industries.

Of the six cases where herbicide use was reported, four had very occasional use of garden herbicides, one used herbicides, probably 245T, more intensively on a lifestyle block and one had an incident of accidental exposure to probable 245-T in the late 1970s. This was the only definite exposure of herbicide reported. In relation to pesticides other than methyl bromide one case was previously involved in pest fumigation work. The fumigant was not known. None of the sixteen cases had worked directly with methyl bromide. All cases were asked if they had worked at or near a methyl bromide fumigation site (timber fumigation, soil sterilisation in horticulture and residential fumigation). Six cases reported work in the Port Nelson area. No other cases reported working near a fumigation site although one case reported work in horticulture and did not know if methyl bromide had ever been used on the property.

Other Chemical Exposures

A range of chemical exposures were identified in addition to the exposures mentioned in Table 7. Three of the cases of MND had histories of working in the timber or building industry with exposure to treated timber. One case worked in the chemical industry and another with photographic chemicals. Two cases reported developing "sensitivity" to chemicals used in their work. Two cases had hospital admissions for chemical exposure in the past. The chemicals involved in the hospital admissions were chlorine, carbon tetrachloride, hydrochloric acid and sulphuric acid. Two cases had exposure to explosive chemicals (nitrates).

Summary of case information

Sixteen cases of MND were identified as having been diagnosed in Nelson Tasman since 1995. Twelve were male and four female. Sixty two percent of the cases were in the age group 55 – 70 years at the time of diagnosis.

There was a mixed picture of presenting symptoms and of classification types of MND. No case had been classified as familial there being no history of MND in parents, siblings and children.

Half of the cases had been born in Nelson Tasman and approximately one third had lived in the region all their lives. Two cases had immigrated to New Zealand, one over 40 years ago and one eight years ago.

The range of risk factors that have been reported in studies as possibly being linked with MND were reported among all cases. These included head injury, electric shock, cigarette smoking, rural residence and possible heavy metal (prominently lead) and solvent exposure.

In relation to other chemicals the definite exposures reported included one case of accidental herbicide exposure, two cases developed specific chemical sensitivity related with chemicals used in their work and two cases had been admitted to hospital for chemical exposure incidents. One of these cases had two separate admissions at different times with different chemicals.

Possible MND risk factors reported in the port area worker subgroup included head injury, cigarette smoking, rural residence and possible lead and solvent exposure. There was one case in this group who had a definite chemical exposure incident.

Fumigation history

Timber fumigation (logs and sawn timber) at Port Nelson began after 1981 and has continued since during the November to April period each year when the *Arhopalus* beetle is active and a potential biosecurity risk for export timber. Not all timber is fumigated with methyl bromide as only certain countries require timber imported from New Zealand to be fumigated. The Australian requirement changed in 2004 with a decrease in the concentration of methyl bromide required to be used in the fumigation of timber being exported to Australia.

Container fumigations of some imported goods also occur but these involve significantly smaller amounts of methyl bromide per fumigation than exported timber. These fumigations may occur all year round.

The sawn timber fumigation sites at Port Nelson have changed over the years. Initially fumigation was done outside under covers in the vicinity of the Main wharf. Since 1995 fumigations have been done in buildings under covers, either at Port Nelson Ltds Shed 2, (1995 – 2005) or Stevedoring Services Ltd Graham Street building, (circa 2001 – 2004). Since March 2005 all sawn timber has been fumigated in Port Nelson Ltd's Shed 3, which is further away from the port boundary than the previously used Shed 2.

Logs have been fumigated outside under covers at a range of sites in the port area over the years since 1981. There have been no log fumigations at Port Nelson since the latter part of 2004.

Exposure risk assessment

For methyl bromide to be a risk factor in MND the case must have been exposed to the fumigant prior to the development of any signs and symptoms of MND.

In assessing any exposure risk to workers from methyl bromide a number of factors ideally need to be considered. These include but are not limited to:

- Proximity of the worker to the fumigation site
- The fumigation process, (quantity and concentration of methyl bromide used, venting time, use of venting stacks)
- The frequency of fumigations
- The way methyl bromide dissipates in the vented air plume
- The weather conditions at the time of fumigations and venting
- Whether the worker was always at the work site
- Length of time of possible exposure to any methyl bromide
- Whether the worker was inside or outside a building.
- Concentration of methyl bromide in the air the worker was exposed to.

For this cluster investigation the occupational history of the cases was mapped against proximity to the fumigation site. This was used as the key measure to estimate exposure risk.

Of the six cases that worked in the Port Nelson area, two of these cases had the highest risk of exposure to methyl bromide through proximity to fumigation sites. They worked for many years for Port Nelson Ltd (or the previous Harbour Board), or stevedoring companies in the port area. It is likely that they had episodes of exposure.

The third case was employed at several workplaces adjacent to the Port Nelson boundary for many years. For about eleven years one workplace was immediately adjacent to a fumigation site. The case also did some casual stevedoring work inside the port boundary. It is likely that this case had episodes of exposure to methyl bromide.

The fourth case worked at various places around the port area since the mid 1970s. For two years one of these places was approximately 60-70metres from a log fumigation site. All other workplaces were further away from any fumigation sites. Risk of exposure to methyl bromide is likely to have been very low.

The fifth case for a period of about 10 years had an office base in a building approximately 50m from a small quarantine facility. Very small amounts of methyl bromide were used at this facility approximately once or twice a week. The nature of the case's work meant that a lot of time was spent in the field away from the office base. Risk of exposure to methyl bromide is likely to have been very low.

The sixth case worked in the port area part time in the early 1980s. The work place was greater than 300 metres from the nearest timber fumigation operations at the time. Risk of exposure to methyl bromide is unlikely.

In addition there was a case whose voluntary weekend work was based 150 metres or so from the nearest fumigation site. A risk of exposure to methyl bromide is unlikely.

In summary considering the six people who worked in the port area and the risk of exposure to methyl bromide, three cases could have had episodes of exposure over the years preceding the onset of symptoms of MND. For the three other cases there is unlikely there has been exposure to methyl bromide. Therefore for the 16 cases of MND diagnosed in Nelson Tasman

since 1995 three cases are likely to have had episodes of exposure to methyl bromide. The number, dose and duration of these possible exposures is unknown.

NZ Mortality Data on MND

Mortality data for MND was available up to 2001 and data was obtained from the Ministry of Health for the period of 1996 to 2001²¹. The mortality data reports deaths from MND where this is recorded on the death certificate as the principal cause of death and deaths with MND where the person had MND but the principal cause of death was another illness. This mortality is reported as age adjusted rates and standardised mortality ratios along with 95% confidence intervals.

These were obtained for several areas of the country where log exporting ports are located and for New Zealand as whole.

This data is shown in the table 9 and table 10. The two cases excluded from the cluster investigation occurred after 2001 and hence the data in these tables include all recorded MND cases in Nelson Tasman for the period 1996 – 2001.

Motor Neurone Disease Deaths 1996 – 2001

Table 9 Deaths from MND

Region	Deaths	Age adjusted rate (per 100,000)	SMR	95% CI Lower	95% CI Upper
Whangarei District	18	2.9	171	101	271
Tauranga District	18	1.9	114	68	180
Napier City	6	1.5	67	24	145
Tasman District	5	1.8	83	27	193
Nelson City	5	1.1	76	24	176
Marlborough District	8	2.0	120	52	236
Nelson City / Tasman District *	10	1.5	79	38	145
Christchurch City / Banks Peninsula District	55	2.0	111	83	144
Other	402	1.7	97	88	107
New Zealand	517	1.8	100		

Table 10 Deaths with MND

Region	Deaths	Age adjusted rate (per 100,000)	SMR	95% CI Lower	95% CI Upper
Whangarei District	22	3.5	119	74	180
Tauranga District	29	2.8	101	68	146
Napier City	12	2.5	74	38	130
Tasman District	6	2.1	57	21	124
Nelson City	9	2.1	75	34	143
Marlborough District	14	3.3	119	65	200
Nelson City / Tasman District *	15	2.2	67	37	110
Christchurch City / Banks Peninsula District	107	3.5	120	98	145
Other	715	3.0	98	91	106
New Zealand	914	3.0	100		

* Subtotals for the two TLAs provided above.

The SMR (standardised mortality ratio) enables comparison of regional and national mortality data. That is, what is observed in the region compared with would be expected on the basis of the national population. If the SMR of the region is greater than 100 what is observed in that region is higher than expected. If it is less than 100 the regional mortality is below what is expected nationally. However the small number of cases of MND limit precision and this is reflected in the wide confidence intervals (95% CI), which show the possible range in which the true SMR for that region could fall.

The age-adjusted rates are mortality rates per 100,000 population per year and have been manipulated to enable valid comparison between regions. This allows for the different age structures that exist in different regional populations.

Literature review Regarding MND and Methyl Bromide

The Institute of Environmental Science and Research Ltd reviewed motor neurone disease epidemiology and methyl bromide toxicology as part the cluster investigation.¹¹ The conclusion was that the ‘ pattern of MND and its variants reflect different aetiologies and individual susceptibilities reflecting genetic makeup and physiology. The evidence suggests that MeBr has a variety of neurological effects in lab animals and humans, including acute and chronic effects on the peripheral and central nervous systems. However, the neuropathology of these changes is not consistent with that of MND and there is little epidemiological evidence to support a causal link between MND and MeBr exposure. There is no research finding that demonstrates a continuing degeneration of neural tissue in animals or humans once exposures to MeBr cease’.¹¹

(MeBr stands for methyl bromide).

Discussion

Sixteen cases of MND were identified as having lived in the region and been diagnosed since 1995.

The geographic clustering of some of these cases based on the area they worked (Port Nelson) was the reason for the concern over a disease cluster of MND being raised. Six cases were identified as having a work history that involved the Port Nelson area. The length of time individual cases worked in this area ranged from 5 to 40 years. A specific incidence rate for MND for this group of cases can not be calculated. Rates can only be calculated for the Nelson and or Tasman population as these are the smallest unit that includes the group of cases and for which statistical data is available to use as a denominator population in calculating rates. Port area worker population numbers and the time worked there were not available. Therefore it is possible that any excess aggregation of cases, (over and above that of chance) maybe diluted out by using the larger denominator population.

Three of the sixteen cases of MND could have had episodes of exposure to methyl bromide associated with proximity to timber fumigation operations. Timber fumigation started in the port area in 1981. No definite exposure can be confirmed and the frequency, amount and duration of any possible exposures are unable to be estimated.

The potential for exposure occurred prior to the cases developing symptoms of MND. The possibility of methyl bromide influencing the development of MND in these three cases can not be ruled out. However the fumigant has not been reported in the medical literature as being a possible risk factor for MND and methyl bromide has been used extensively around the world for many years. Other countries use significantly more methyl bromide than New Zealand. If methyl bromide were to cause MND it is highly likely that clusters of MND would have been reported and investigated. This has not been the case. In addition other ports in New Zealand use greater amounts of methyl bromide than Port Nelson and the mortality rates for MND in those areas are similar to the rate for Nelson Tasman.

The majority of the cases had histories that included possible risk factors for MND although for some this was just a history of having lived in a rural environment. The specific agents that are possible risk factors that were reported most commonly were cigarette smoking, lead exposure and solvent exposure. These factors were also the most commonly reported in the port area workers.

Conclusion and Recommendations

Analysis of mortality data has not shown any increase in number of cases of MND in Nelson Tasman compared to what was expected for a population of Nelson Tasman's size and age structure.

The number of cases of MND identified as having occurred in the region between 1995 – 2005 is consistent with what would be expected for a population of this size.

MND has few confirmed risk factors apart from increasing age and a family history of the disease. Various other risk factors have been proposed as contributing to MND and this possibly applies particularly to genetically susceptible individuals.

A number of these risk factors have been shown to be present in the cases investigated in Nelson Tasman both for the 16 cases as a whole and the six cases who had a work history involving the Port Nelson area. The time worked in this area ranged from five to forty years. Three cases had the possibility of episodes of exposure to the fumigant methyl bromide. No exposure can be confirmed and neither can the dose and duration and frequency of any actual exposures.

Methyl bromide is used in greater amounts at other New Zealand ports and in much greater amounts elsewhere in the world. It has not been reported in the medical literature as being associated with MND and no causal relationship between methyl bromide and MND has been established by this investigation.

Random occurrence or chance is the most likely explanation for the grouping of MND cases with a work history involving the Port Nelson area.

However raising the concern about a possible link between methyl bromide fumigation and MND has brought into focus the fumigation process and possible health effects. This along with consideration of environmental effects has highlighted the need to ensure best possible practice around any use of methyl bromide.

Recommendations

- 1 Current work involving OSH, Port Nelson, the stevedoring company and the fumigators in ensuring best possible processes are in place for fumigation should continue. This includes the monitoring of fumigant levels, using best venting processes, monitoring compliance with codes of practice and exploring options for any biological monitoring of methyl bromide in workers.
- 2 Methods to minimise the amount of methyl bromide used and then released to air should be further explored for example recovery and recycling technology.
- 3 Further work and research into methyl bromide release during and after fumigation should be undertaken. This should include the measurement and monitoring of any methyl bromide released to air and also modelling of any air discharge. This will allow further, more comprehensive assessment of methyl bromide levels in air around timber fumigation operations and hence better assessment of any possible risks to the health of both workers at the work site and to the public in general.
- 4 The relevant government agencies such as OSH, the Environmental Risk Management Authority, the Ministry of Health and the Maritime Safety Authority, along with Port Nelson and the fumigating companies should jointly develop a work plan for the work outlined in recommendation three.

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