Impact of Phenol-based Cleaners at Royal Perth Hospital

Epidemiology Branch
Department of Health WA

May 2011

Delivering a **Healthy WA**

Disclaimer:
This report details the results of an epidemiological analysis of the risk of cancer among past and present Royal Perth Hospital Patient Support Service employees. Whilst every effort has been made to accurately estimate these risks, there are known variability in the accuracy of the data provided to us and this variability must be taken into account in the interpretation of the results in this report.

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Abbreviations

AIHW: Australian Institute of Health and Welfare

CI: Confidence Interval

CNS: Central Nervous System

HR: Hazard Ratio

NDI: National Death Index

OR: Odds Ratio

OSH: Occupational Safety and Health

PSS: Patient Support Services

RPH: Royal Perth Hospital

SIR: Standardised Incidence Ratio

SMR: Standardised Mortality Ratio

SRR: Standardised Rate Ratio

WA: Western Australia

WACR: Western Australian Cancer Registry

WADLS: Western Australian Data Linkage System

WADR: Western Australian Death Registrations

Glossary

Mean:
Mean is commonly called the "average". The mean is the sum of all scores divided by the number of scores.

P-value:
The p-value is the probability of rejecting the null hypothesis of a study question when the hypothesis is true. The null hypothesis is usually a hypothesis of "no difference". For example there is no difference in a particular characteristic between two populations. A p-value of 0.05 indicates that there is only a 5% chance of rejecting the null hypothesis when it is actually true; that is, of deciding, on the basis of an observed difference, that there really is a difference when many repetitions of the study would show that there wasn't.

95% confidence interval:
A confidence interval shows the range in which the true value of a measure we have estimated is likely to lie. The 95 per cent confidence interval is the range of estimates within which the true value would lie 95% of the time.

Standardised Incidence Ratio:
An SIR is the ratio of the observed number of events (cases of cancer in this study) in a specific population or geographic region relative to what it would be if the population had the same rate of these events and characteristics as a larger comparison population. In this study the Perth Metropolitan population was chosen as the comparison population.

Standardised Mortality Ratio:
An SMR is the ratio of the observed number of deaths (either all deaths or deaths from a specific cause) in a specific population or geographic region to what it would be if the population has the same rate of these events and characteristics as a larger comparison population. In this study the Perth Metropolitan Area was chosen as the comparison population.

Chi-square test of independence:
Chi-square is a statistical test used to estimate a p-value for the difference between two or more sets of frequencies.

T-test (Independent Sample):
The independent sample t-test is used to estimate a p-value for the difference in the means of two independent samples.

Chi-square test of trend
A chi-square test that also takes into account the natural order of three or more sets of frequencies being compared and estimates a p-value for the null hypothesis that the differences in the sets of frequencies do not increase or decrease in a linear fashion.

Executive Summary

Staff at both the Wellington Street and Shenton Park campuses of Royal Perth Hospital (RPH) have reported that phenol-based cleaners caused a range of symptoms. Of greater concern, is the belief that there is an increase in cancer incidence among these staff.

A toxicology report on three phenol-based cleaning agents, including constituents, found the common property of these substances was irritation at high concentration. The acute effects were dermal or through inhalation. None of the substances reviewed were classified as carcinogenic to humans, apart from ethanol through oral exposure alone. Some of the polychlorophenols have been classified as "possibly carcinogenic', but the evidence is limited or lacking in humans.

An occupational cohort analysis was conducted to determine if an excess of cancer cases or deaths occurred among Patient Support Services (PSS) staff at RPH compared to the Perth Metropolitan population from 1983 to 2008. The cohort of workers chosen for the study included those most likely to be exposed to high levels of phenol-based cleaners, as any association between phenol-based cleaner use and ill-health would be easiest to detect in this group. A survey of past and current employees was undertaken to provide supplementary information on the health of PSS employees and details of exposure to phenol-based cleaners.

There were 232 cancers diagnosed over the study period. The number and types of cancers diagnosed were similar to those in the Perth Metropolitan population. There was no single or rare cancer type occurring in high numbers. When adjusted for age, sex and calendar year, the risk of cancer was statistically similar to that of the Metropolitan population. While there was an excess of cancers of unknown primary site, the nature of these cancers is unclear and, in the absence of any overall increase in cancer risk, the interpretation of this excess is difficult. Additionally, no consistent association was found between an increase in cancer risk and duration of PSS employment or time since first PSS employment.

There were 184 deaths of PSS employees during the study period. When adjusted for age, sex and calendar year, the risk of cancer deaths was statistically similar to that of the Metropolitan population. However, the risk of cancer death was found to be higher with longer duration of PSS employment. The risk of all-cause deaths, and more specifically non-cancer related deaths, was elevated compared to the Metropolitan population, particularly among male PSS employees.

Only 20% of those invited took part in the survey. A higher prevalence of health conditions was reported in survey respondents compared to the Metropolitan population. Subsequent analysis revealed the demographic and employment characteristics of respondents were different to those of the non-respondents, so the results need to be interpreted with caution due to the possibility of selection bias. No association was found between cancer incidence and total exposure time to phenol-based cleaners. An association was found between other respiratory diseases and total exposure time to phenol-based cleaners

In conclusion, the investigation did not find elevated rates of cancer among PSS employees exposed to phenol-based cleaners from 1983 to 2008. There is no clear or consistent evidence of a cancer cluster and little to suggest that working with phenol-based cleaners, in particular, increased the risk of being diagnosed with cancer. Working with phenol-based cleaners, however, has probably caused doctor diagnosed respiratory conditions other than asthma.

Chapter 1   Introduction

Phenol-based cleaners are used in hospitals for their wide spectrum bacteria killing properties and were used at Royal Perth Hospital (RPH) in Western Australia (WA) from the 1970's until August 2009 when they were removed from use.

Over a number of years, staff at both the Wellington Street and Shenton Park campuses of RPH have reported that the use of phenol-based cleaners caused a range of symptoms that included headaches, skin conditions and respiratory difficulties. For some staff, sensitivities to the cleaning agents have been clinically confirmed and they have been offered alternative duties within the hospital. While on the whole, these symptoms appear to have been short term, some individuals report ongoing conditions that they attribute to phenol exposure. Of more serious concern, is the belief that there has been an increase in cancer incidence in these staff.

In 2009, concern was raised by hospital staff and the Liquor Hospitality and Miscellaneous Union about a possible cancer cluster following exposure to phenol-based cleaners at RPH.

In response, the use of the agents was ceased by RPH and the RPH Executive established a steering committee to investigate concerns. The steering committee included representatives from the Occupational Safety and Health Unit (OSH) at RPH, the RPH and South Metropolitan Area Health Service (SMAHS) Executive, the Department of Health Epidemiology Branch and Professor Bruce Armstrong, Professor of Public Health at The University of Sydney. The role of OSH was to liaise with employees and the Union, and to provide employment details and administrative support. The role of the RPH and SMAHS Executive was project management and media communications. The Epidemiology Branch provided cancer cluster analysis advice, analytical and survey support, conducted the analysis and prepared the report. Professor Armstrong was appointed as an independent expert to provide advice on the nature of the investigation required and to act as an external reviewer of this report.

Based on current cancer cluster guidelines (Queensland Health, 2009) the steering committee decided to undertake an investigation involving a toxicology review and an epidemiological assessment. The principal aim of this study was to determine whether there was any evidence of a cancer cluster among past and present staff at Royal Perth Hospital due to the use of phenol-based cleaning products. A recommendation will be made on the need to conduct further detailed analysis based on the findings of this investigation.

Chapter 2   Phenol-based Cleaners

Use of Phenol-based cleaners at RPH

Phenol-based cleaners are used in hospitals for their wide spectrum bacteria killing properties (Orion, 2006; Whiteley Medical, 2007). Their use was introduced as they were considered to be less corrosive than chlorine-based cleaners but still effective against bacteria such as *Mycobacterium tuberculosis* and *Staphylococcus aureus*. While phenol-based cleaners may be less corrosive, they are still classified as hazardous substances and should not make contact with skin or eyes and should not be swallowed or inhaled (IPCS, 1994). Protective apparel should be worn, such as protective clothing, gloves and face goggles or masks when phenol-based cleaning products are in use (IPCS, 1994).

Phenol-based cleaners were in use at RPH from at least the 1970s. Medol was the first phenol-based cleaner (used prior to 1982), followed by Prephen (1982-2001) and Phensol (2001-2009). The use of Prephen was discontinued in 2001 due to the number of cases of dermatitis, breathing problems, asthma and allergic skin rashes reported by staff since its use commenced in 1982. Phensol was used from 2001 onwards at RPH campuses, following consultation with WorkSafe and the Liquor Hospitality and Miscellaneous Union, and restricted to use in infectious areas. After its introduction there was a significant reduction of health conditions reported by staff. However, in August 2009, when concern was raised over a possible link between cancer and phenol-based cleaning products, the use of Phensol and phenol-based cleaning products was discontinued at both RPH sites.

Toxicology Review of chemicals in Phenol-based cleaners

A toxicity review on three chemical cleaning agents was conducted by the Toxicology section of the Environmental Health Directorate, DoH WA. This information was used to determine if phenols or other constituents in the cleaning agents used at RPH had the potential to be carcinogenic (cancer causing). Information on exposure limits, acute and chronic health effects and their potential for carcinogenicity was provided on the chemicals listed as ingredients in the cleaning agents. This toxicity information informed the early stages of the epidemiological investigation (presented in this report) undertaken by the Epidemiology Branch into a potential cancer cluster at RPH.

The Toxicology section of the Environmental Health Directorate conducted a desktop review of the chemical ingredients found in the three phenol-based cleaning agents used at RPH. The toxicology information in Appendix 1 provides a tabular summary of the toxicity and health effects associated with phenols and other chemicals present in the cleaning agents used at RPH. The exposure information identifies current standards or guidelines of exposure used to protect human health. They vary according to how the chemical is used in the workplace and with the final intended use of the product.

The ingredients investigated are listed below along with their common uses:

- *o*-phenyl phenol - used in fungicides and antibacterials
- *o*-benzyl-p-chlorophenol - commonly used as preservatives in cosmetics
- substituted phenol compounds – various commercial products
- *p*-chloro-*m*-cresol – many commercial uses
- xylenols – many commercial products

- 2,4,6-trichlorophenol – preservative in cosmetics and prescription medication and used in wood and leather finishing products
- sodium hydroxide – many commercial uses
- ethanol – many commercial products
- Sodium alkyl sulphate (anionic surfactants) – many cleaning products

A characteristic shared by the substances listed above is their capacity to be irritants at high concentrations. This means the effect of exposure to the chemical may be seen very soon after the exposure occurs. These acute effects predominately fall into two categories, dermal (on or through the skin) and inhalation (from breathing in the vapours).

Dermal effects have been documented in all the chemicals investigated. The most common effect is an immediate sensation of burning of the skin, but eczema or dermatitis and other dermal symptoms are also possible following extended exposure.

Inhalation effects are associated with breathing in vapours and exposure of the mucous membranes of the nose and eyes to the vapours. Symptoms include irritation and stinging of the nose, mouth and eyes, headaches, nausea, gastrointestinal effects, excessive respiratory secretions, muscle twitching and weakness and coughing. The long term effects of exposure include muscle twitches, tremors and neurological impairment.

While the chemicals which make up each cleaning agent have a range of associated acute and chronic health conditions, their link with cancer is less substantiated. Of the chemicals/ chemical families investigated, none have been classified as carcinogenic to humans through dermal or inhalation exposure while ethanol has been classified as carcinogenic through oral exposure alone.

Some polychlorophenols have been classified as "possibly carcinogenic" to humans. The reason for this classification is that while there is some evidence of carcinogenicity in animals, the evidence is limited or lacking in humans and further research is required to support a cancer classification. For example 2,4,6-trichlorophenol in Medol, one of the cleaning agents, has been reported in occupational studies as possibly carcinogenic. Studies of workers in tanneries exposed to 2,4,6-trichlorophenol have provided evidence of a link between 2,4,6-trichlorophenol and non-Hodgkin lymphoma and soft tissue sarcomas. The evidence is confounded by the presence of other potentially carcinogenic chemicals in the workplace. Worker exposure to this phenol is also common in hospitals however the overall weight of evidence from either hospital exposure or tannery exposure is not sufficiently strong to sustain a classification above "possibly carcinogenic" by the International Agency for Research on Cancer (IARC).

The non-phenolic chemical, sodium hydroxide has been linked with cancer of the oesophagus, through inhalation. However, the evidence strongly suggests that the cancer is not directly caused by the chemical but as a consequence of the tissue damage from repeated and long term exposure to vapours. Neither the IARC nor the US EPA has classified sodium hydroxide as carcinogenic based on the current evidence.

Chapter 3   Methodology

The epidemiological investigation into concerns about the use of phenol-based cleaners at RPH commenced in December 2009 and followed recognised guidelines for assessing a reported cancer cluster (Queensland Health, 2009; NHMRC, 2008; Ministry of Health NZ, 1997).

A cancer cluster is the occurrence of a greater than expected number of cases of a particular cancer within a group of people, a geographical area, or a period of time (Queensland Health, 2009; Centre for Disease Control, 1990). A cluster assessment is the scientific process to determine if there are an increased number of cancer cases and to determine if there is a biologically plausible causal agent/s for the increase in cases (Queensland Health, 2009; Centre for Disease Control, 1990).

Typically, a suspected cancer cluster is more likely to be a true cluster if there are an increased number of cases of a single or of similar cancer types in an age group that is not usually affected by that type of cancer (National Cancer Institute, 2006).

The epidemiological assessment at RPH involved two distinct stages. Each stage of the epidemiological assessment was primarily designed to determine if there was evidence of a cancer cluster at RPH, while also assessing if there was an increased risk of other ill-health or death. The first stage involved conducting an occupational cohort analysis to determine if there was an increased risk of cancer and death among employees exposed to phenol-based cleaners at RPH. The second stage involved conducting a survey to assess the level of exposure and whether this was related to the incidence of cancer, and to determine the frequency of other health conditions among RPH employees.

3.1 Methodology for Cohort Analysis

An occupational cohort analysis was conducted to determine if there was an excess risk of cancer and death among RPH employees exposed to phenol-based cleaners. A standard occupational cohort methodology was used (Breslow & Day, 1987) which was the methodology used in the ABC Women's Health Study (Sitas & O'Connell, 2009) and is similar to previous Department of Health WA investigations (Epidemiology Branch, 2003; Public Health Intelligence Directorate, 2008).

An occupational cohort analysis involves following a cohort of employees over a defined period of time, observing the number of cases identified with the disease of interest (in this case cancer) and determining if the number of observed cases is comparable to the number expected, estimated from rates of cancer in a similar population that is generally not exposed to agents, chemical or otherwise, to which the occupational group is exposed (Sitas & O'Connell, 2009). This methodology allows the assessment of the likelihood of there being a cluster in the defined population group.

In this cohort analysis RPH employees in Patient Support Services (PSS) positions were followed over the study period of January 1, 1983 to December 31, 2008 to determine if they had an excess risk of cancer and death in comparison with expected numbers based on the rates of cancer and death in the general Perth Metropolitan population. In estimating the expected numbers, rates specific to sex and age categories of the population for each calendar year were used so as to obtain expected numbers that were

based on a population with the same sex and age composition as the RPH employees covered by the investigation, and to correctly reflect the period during which the observed cases of cancer and deaths occurred in the RPH employees.

The analysis was limited to a discrete group of employees, PSS employees, as they were the RPH employees likely to have the highest level of exposure to the phenol-based cleaners. If evidence of an association between cancer risk among PSS employees and the use of phenol-based cleaners were to be found then consideration would be given to including other staff groups.

The Perth Metropolitan population was used to calculate the expected number of cancers and deaths as the RPH is located within this population and it was confirmed with Human Resource records that over 98% of employees lived in the Perth Metropolitan area.

The study period commenced in 1983 as this reflected the earliest time point at which phenol–based cleaners were known to be consistently in use at both RPH campuses and when complete cancer and mortality data for Western Australia were available. The study period concluded in 2008 as this was the most recent year that complete data from the WA Cancer Registry and WA Death Registrations were available.

Data collection and extraction

Ethical approval was provided for this study by the Department of Health WA Human Research Ethics Committee (DOHWA HREC).

RPH Human Resources records

Human Resource records were used to identify all PSS employees who worked at RPH at any time during the study period (1983-2008). Employees were selected for participation in the study based on their employment at some time between the identified dates and the position/s they held while employed by RPH at both Wellington Street and Shenton Park Campuses. Full-time, part-time, permanent and casual employees of RPH who were employed in PSS positions were included. All employment types were included in the study as a casual worker could potentially work a full-time equivalent week by filling in for different sections of the hospital on different days of the week. The PSS positions included job titles such as cleaner, hotel services, housekeeper, laboratory assistant, orderly, patient care assistant, theatre assistant and ward attendant.

Human Resource records for employment were paper-based until 1995 when the electronic Human Resource Information System (HRIS) was introduced. Paper-based records were searched manually for all employees with relevant positions and employment within the period 1982 to 1996. HRIS electronic records were searched from 1995 to the date of extraction (March, 2010). Paper records were entered into a study database and merged with those from the electronic records. Periods of employment on either side of the study period were included to ensure that no positions or employees were omitted due to data entry issues and also to allow employees who started work after 2008 to be invited to complete the survey in stage two of the epidemiological assessment.

Linkage to health records

Human Resource records were matched to cancer and death records through the WA Data Linkage System (WADLS) to identify any employees who had been diagnosed with cancer or who had died during the study period. The WADLS links core population health

data sets in WA using rigorous, internationally accepted privacy preserving protocols, probabilistic matching and extensive clerical review (Holman et al. 1999).

Data from the WA Cancer Registry (WACR) and WA Death Registrations (WADR) were extracted for employees who had a matching record in one or other of them to provide information on cancer diagnoses and deaths. Data from the WA Electoral Roll was extracted to provide information on employees who had moved out of the state and to provide the most recent address to RPH for mailing out surveys. Additional information was requested from the WA Electoral Roll and WA Hospital Morbidity Data System to provide date of birth details and sex for those missing from the Human Resource records.

National Death Index data was also requested from the Australian Institute of Health and Welfare (AIHW) to identify deaths in other states in Australia. National cancer data from the National Statistics Clearing House was not requested due to time constraints and the unavailability of recent, complete data.

In addition to the data obtained for RPH employees, data was also provided by the WACR, the Australian Bureau of Statistics and WADR for the Perth Metropolitan population to determine the expected rates of cancer and deaths over the study period.

Cancer
Cancer is defined as a varied group of diseases where cells in the body mutate and multiply out of control. They form local tumours, can invade and damage the tissue around them, and can spread to other parts of the body to cause further damage (Australian Institute of Health and Welfare, 2010).

In this study, eligible cancers were confirmed cases of primary neoplasms of types subject to a statutory notification requirement, diagnosed during the study period (1983-2008), and registered with the WACR by April 2010. This incorporated malignant, invasive neoplasms ("cancers") included in standard cancer incidence reporting as well as in-situ carcinomas and benign and uncertain behaviour central nervous system (CNS) tumours. Other benign, uncertain behaviour and unconfirmed tumours were excluded as they are not routinely reported to the WACR and do not fit the generally accepted definition of cancer. All primary neoplasms were included; therefore an individual could have second and subsequent primary occurrences of the same or different types of neoplasm.

Cancer incidence and mortality data was provided by the WACR for RPH PSS employees and the Perth Metropolitan population. Details on the type of cancer/s, diagnosis date, age at diagnosis were included as well as death details if the cancer was the cause of death.

Deaths
Deaths that occurred between 1983 and 2008, and were registered with the WADR by April 2010 were included in this study. Death details were provided by the WADLS for RPH PSS employees and the Perth Metropolitan population.

In addition, deaths of RPH PSS employees identified by linkage to the National Death Index and not previously identified within the WA dataset were included.

Figure 1 provides an overview of the data collection and extraction process for study participants.

Figure 1: Flow chart of data collection and extraction of study participants.

RPH employment records
Patient Support Services
employees from 1982-March 2010
N=3,377 (19,114 positions)

Linkage to WADLS
Linked N=3,180
Not linked N=197

WA Cancer Registry[†]
Cancer incidence and
mortality from 1983-2008
N=224 (246 cancers)

WA Death Registrations[†]
Deaths from 1983-2008
N=186

WA Electoral Roll
Electoral roll records for
1988-April 2010
N=2,859

National Death Index
Additional deaths from
1983-2008
N=10

Patient Support Services employees with
commencement and completion date prior
1983 or after 2008 excluded
N=129
        Cancer n=11 (14 cancers)
        Deaths n=12

Exclusions

Eligible study population
RPH Patient Support Services employees 1983-2008
N=3,248
        Cancer notifications 1983-2008 n=213 (232 cancers)
        Death notifications   1983-2008 n=184

N = Total cases in the group (number of people unless otherwise specified)
n = subset of total cases (N) (number of people unless otherwise specified)
[†] WA Cancer Registry and WA Death Registrations not complete after 2008

In summary of the data collection and extraction process, there were 3,377 people identified in the Human Resource records with Patient Support Services roles who appeared to be employed there at any time from 1983 to 2008. A match to any record in the WADLS was found for 3,180 (94.2%). Of the 3,377, 129 were excluded as they were found not to have worked in PSS within the study period 1983-2008 after a closer examination of their records. Therefore, 3,248 (3,377 minus 129) people were included in the cohort analysis. The high level of linkage to WADLS indicates a high probability of identifying all cancers and deaths in this group.

Statistical analysis

The statistical analysis of this occupational cohort study involved a descriptive analysis of the study population and calculation of standardised rate ratios. That is, rate ratios that take into account the age and sex distribution of the PSS employees and the years in which cancer cases and deaths occurred among them.

The descriptive analysis provided an overview of the study population including information about the workforce (e.g. years of employment, age at first employment and

duration of employment), cancer diagnoses (e.g. age at diagnosis, type of cancer diagnosed) and deaths.

Standardised rate ratios (SRR), in the form of standardised incidence ratios (SIR) and standardised mortality ratios (SMR), were calculated as the ratio of the total number of observed cases or deaths to the expected number of cases or deaths to determine if there was an increased risk of cancer or death among PSS employees. Employees were followed from 1983 or the start of employment (whichever was later) until the end of follow-up (31/12/2008) or event (death or out of state; whichever was earliest) and any cancers or deaths that occurred during this time where included. This methodology is the preferred approach for cluster assessments as it allows for a latency period from exposure to diagnosis or death.

Observed cancers were defined as eligible primary neoplasms identified from the WACR data and diagnosed after commencement of employment in a PSS position at RPH. The observed cancers could be diagnosed during or after employment in a PSS position ceased at RPH, and each individual could be diagnosed with more than one primary cancer.

Observed deaths were those identified in the WADR or NDI, and, for cancer deaths, were cross referenced with WACR data. Deaths were included if they occurred during or after employment in a PSS position.

Expected cancers were calculated by multiplying the sex, 5-year age group, and calendar year specific incidence rates of cancer in the Perth Metropolitan population by the corresponding number of person-years of follow up of the RPH cohort and summing across all stratifying variables. Cancer incidence rates were calculated using the same eligibility criteria as for RPH employees by age, sex, year of diagnosis and cancer type from 1983-2008.

Expected deaths were calculated using the same methodology using WADR data for all cause deaths and WACR mortality data for cancer caused deaths. The WACR mortality data was used for calculating the rate of cancer deaths in the Perth Metropolitan region as cause of death coding for 2008 deaths was unavailable in the WADR and the WACR provides more consistent and detailed information on the type of cancer implicated across the entire study period.

The person-years of follow-up used in the calculation of expected cancers and deaths included time during and after employment from 1983-2008. The person-years of follow-up was from the commencement of employment in PSS role or 1/1/1983 (which ever came last) until the earliest of either leaving WA (from electoral roll or Human Resource record) death or end of study date (31/12/2008). Follow-up did not cease at the date of cancer diagnosis as each person was still at risk of being diagnosed with another cancer as multiple primaries were included in the analysis (Driscoll et al 2008; MonCOEH 2009). The Lexis macro was used in SAS to accurately calculate the person-years of follow-up by age, sex, year and cancer or death type (Carstensen, 2004).

The SIRs and SMRs were calculated for cancer and death with variation by age, sex, year of employment, cancer type or cause of death, and the type of phenol-based cleaner examined. The type of phenol-based cleaner used by each employee was determined by the employment start and finish times, and the information from the Occupation Safety and

Health Unit at RPH indicating which phenol-based cleaners were in use during each year. Therefore, individuals employed between 1983 and 2001 were categorised as exposed to Prephen and individuals employed after 2001 were classified as exposed to Phensol. The groups were not mutually exclusive.

The calculation of 95% confidence intervals (CI) for the SIRs and SMRs were based on a Poisson distribution using the methods recommended for small numbers in cluster assessment guidelines (Centre for Disease Control USA, 1990; Queensland Health, 2009). Sensitivity analyses were also conducted to determine the impact of assumptions and exclusions on the results.

In addition to the calculation of SIRs and SMRs, a Cox regression analysis was conducted to consider the possible impact of duration of employment and time since first employment on the risk of cancer and death. Age at start of the study was used as the time-scale (Korn et al 1997). Time since employment continued to be counted if a cancer diagnosis occurred, as the person would still be at risk of an additional cancer.

All analyses were completed in SAS Enterprise Guide Version 4.2.

3.2 Methodology for Survey

A survey was undertaken as part of the investigation. The purpose of the survey was to (i) extend the scope of the investigation beyond cancer incidence and death to include more acute self-reported health conditions that were commonly reported by staff exposed to phenol-based cleaners, and (ii) to provide an opportunity to identify whether there was any relationship between the level of phenol-based cleaner exposure and reported disease outcomes.

Survey instrument

A survey questionnaire was designed to assess an individual's exposure to phenol-based cleaners during their time at Royal Perth Hospital and to collect some health-related information not available through existing administrative datasets.

Potential participants were sent an approach letter with the questionnaire explaining the purpose of the survey, why they had been selected to take part, and confirmation that any reports or results arising from the study would be de-identified and confidential. A contact number was provided for people who required more information. The questionnaire and a reply paid envelope were also included in the mail-out. A copy of the questionnaire is located in Appendix 2.

People surveyed

A breakdown of the response rate is provided in Table 1 for those who returned their questionnaires by the 3rd September 2010. A total of 3,377 people were identified as having been employed at RPH since 1983 in a PSS position; they formed the survey population. Human Resource records were matched to the WA Data Linkage System (WADLS) and the latest address for each person was extracted from the WA Electoral Roll. For individuals who could not be matched by the WADLS, Human Resource records were used to obtain an address. On the 26th May 2010, questionnaires were sent to 2,460 people for whom addresses were available and who were still alive as at 30th June 2010. A total of 33 letters were returned as the wrong address. A further two people were later identified as deceased after the initial mail out. This left an accessible sample of 2,425. A reminder letter, and second questionnaire if requested, was sent out on the 1st July 2010. Union officials were notified on the 20th August 2010 that questionnaires would only be collected for two more weeks and none were accepted after the 3rd September 2010. A total of 510 questionnaires were returned, however 16 of these were ineligible for inclusion. Final analysis was therefore undertaken on 494 respondents, which represents a response rate of 20.4%. While this response rate is low, it is not unusual for mailed requests for participation in health research in Australia at this time (Australian Institute of Health and Welfare, 2008).

Table 1: Response rate for RPH survey

		No. of	%
A.	**INITIAL SAMPLE**	**3,377**	**100.0**
	A1. Did not have address	711	21.1
	A2. Identified as deceased	206	6.1
B.	**SENT QUESTIONNAIRE**	**2,460**	**72.8**
	B1. Return to sender	33	
	B2. Identified as deceased after initial mail out	2	
C.	**ACCESSIBLE SAMPLE**	**2,425**	**71.8**
D.	**NON-RESPONSE AFTER 3 ATTEMPTS**	**1,915**	**77.8**
E.	**RETURNED QUESTIONNAIRE**	**510**	**21.0**
	E1. Ineligible - finished work at RPH prior to 1/1/1983	9	
	E2. Filled out incorrect questionnaire	1	
	E3. Duplicates	6	
	E4. Completed questionnaire	494	
F.	**RESPONSE RATE: E4/(E+D)**		**20.4**

Demographics and employment history

The final survey database included a total of 494 people, of whom 204 (41.3%) were male and 290 (58.7%) were female. The age of respondents at the time of the survey ranged from 18 to 86, with an average age of nearly 55.

The most frequent positions held by employees during their time at RPH included cleaners (43.1%), patient care assistants (39.9%) and orderlies (18.0%). Approximately 65.0% of respondents were still employed at RPH, and length of employment with the hospital ranged from 1 week to 52 years[1], with an average of almost 11 years (Table 2).

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[1] Includes current employees and employees no longer working at Royal Perth Hospital.

Table 2: Demographic characteristics and employment history of survey respondents

	Sample (N)	Estimated prevalence (%)
Sex		
Male	204	41.3
Female	290	58.7
Age		
18 to 44 years	102	20.6
45 to 54 years	127	25.7
55 to 64 years	151	30.6
65+ years	114	23.1
Campus worked at		
Wellington Street	421	85.2
Shenton Park	193	39.1
Positions held at RPH		
Cleaner	217	43.9
Patient care assistant (PCA)	201	40.7
Orderly	89	18.0
Catering	81	16.4
Nurse/Nursing assistant	35	7.1
CSSD	19	3.8
Sterilisation	12	2.4
Theatre assistant	11	2.2
Ward assistant	10	2.0
Other/Miscellaneous	71	14.4
Still working at RPH		
Yes	169	34.2
No	323	65.4
Length of employment with RPH*		
Less than 1 year	65	13.2
Between 1 and 5 years	107	21.7
More than 5 years and up to 10 years	111	22.5
More than 10 years and up to 15 years	76	15.4
More than 15 years and up to 20 years	53	10.7
More than 20 years	82	16.6

*Includes current employees and employees no longer working at Royal Perth Hospital.

Analysis of exposure

A variable called 'total exposure' was calculated based on an individual's responses to the time spent using phenol-based cleaners in various job locations within RPH.

For each location (e.g. MRSA room) the total number of hours spent using phenol-based cleaners was calculated. For full details on the calculation of this variable see Appendix 3.

Once exposure in hours was calculated for all the areas in which an individual had used phenol-based cleaners, they were summed together to get an overall total exposure to phenol-based cleaners.

The distribution of the total exposure is shown in Figure 2. The mean total exposure was 8,265 hours with a standard deviation of 14,263.

Figure 2: Percent distribution of survey respondents by total exposure (in hours) to phenol-based cleaners
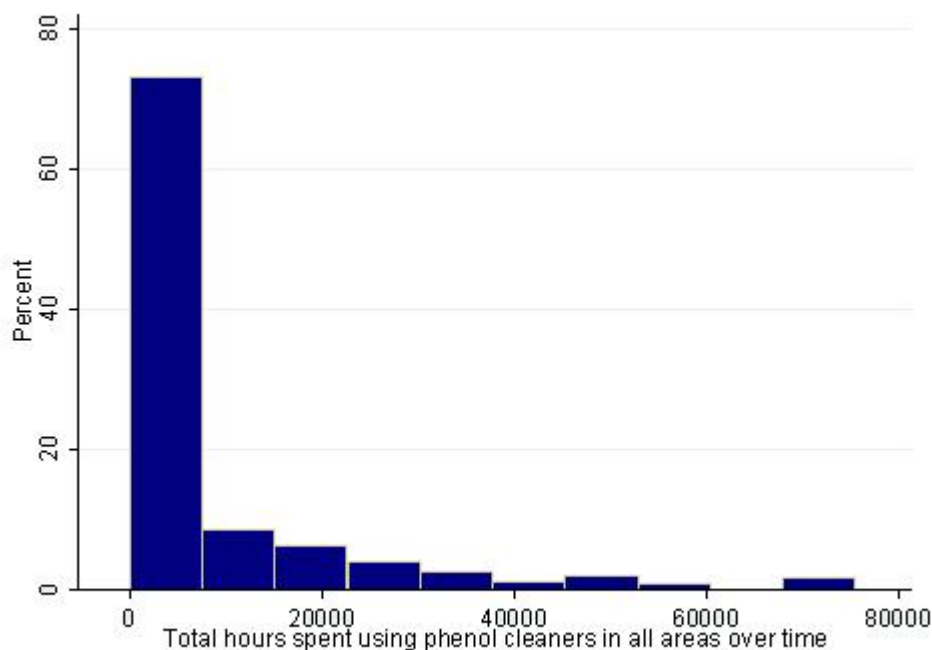
Calculation of total exposure required respondents to fill in <u>all</u> four questions for a particular area (e.g. MRSA room). Any missing values meant that an exposure could not be generated. Approximately 50% of respondents who indicated that they used phenol-based cleaners provided enough information to calculate their total exposure in each area. Total exposure was calculated for a total of 245 respondents.

Statistical analysis

The statistical analysis of the survey respondents involved a descriptive examination of the demographics, employment history, exposure profile, and health status of participants.

Tables of results present the estimate of the prevalence of selected health conditions along with the 95% confidence interval around that estimate for survey respondents and the Perth Metropolitan population. As defined statistically, the 95 per cent confidence interval is the range of estimates of the prevalence within which its true value would lie in 95% of repetitions of the survey. In practical terms, it provides an indication to the reader of how certain they can be about the actual prevalence given its estimated value and the variability in estimates due to the comparatively small number of people surveyed. Comparison data for the Perth Metropolitan population was provided by the WA Department of Health's Health and Wellbeing Surveillance System (HWSS) which is a continuous data collection system that monitors the health and wellbeing of Western Australians (Joyce & Daly, 2010).

For individuals who provided permission to link their exposure data with other health records held by the WA Department of Health logistic regression was used to assess whether increased exposure was associated with an increased risk of cancer.

Supplementary analysis was also undertaken to validate survey responses and to compare survey respondents with the total study cohort. Qualitative analysis of survey comments was also included. Further detail is provided in the results section.

Survey data was analysed using both SPSS (V15.0) and Stata (V10).

Chapter 4   Results: Employee Characteristics

Demographics and employment history

Out of the initial 3,377 people identified for the study cohort, 129 people were later excluded as their employment was confirmed to not fall within the appropriate time period. A total of 3,248 eligible people were employed by RPH in Patient Support Services roles between January 1, 1983 and December 31, 2008.

Of the 3,248, 439 were employed at the start of the study period (13.5%), and an average of 108 new employees joined the study each year (3.3%). There were slightly more females (n=1,739, 53.5%) than males (n=1,509, 46.5%), and the average age at start of follow-up (employment start date or 1/1/1983) was 36 years, with the youngest being 15 years and the oldest 70 years. The year of birth of employees ranged from 1918-1992, and the average was 1958.

Figure 3: Number of new and all PSS RPH employees, by year, 1983 - 2008
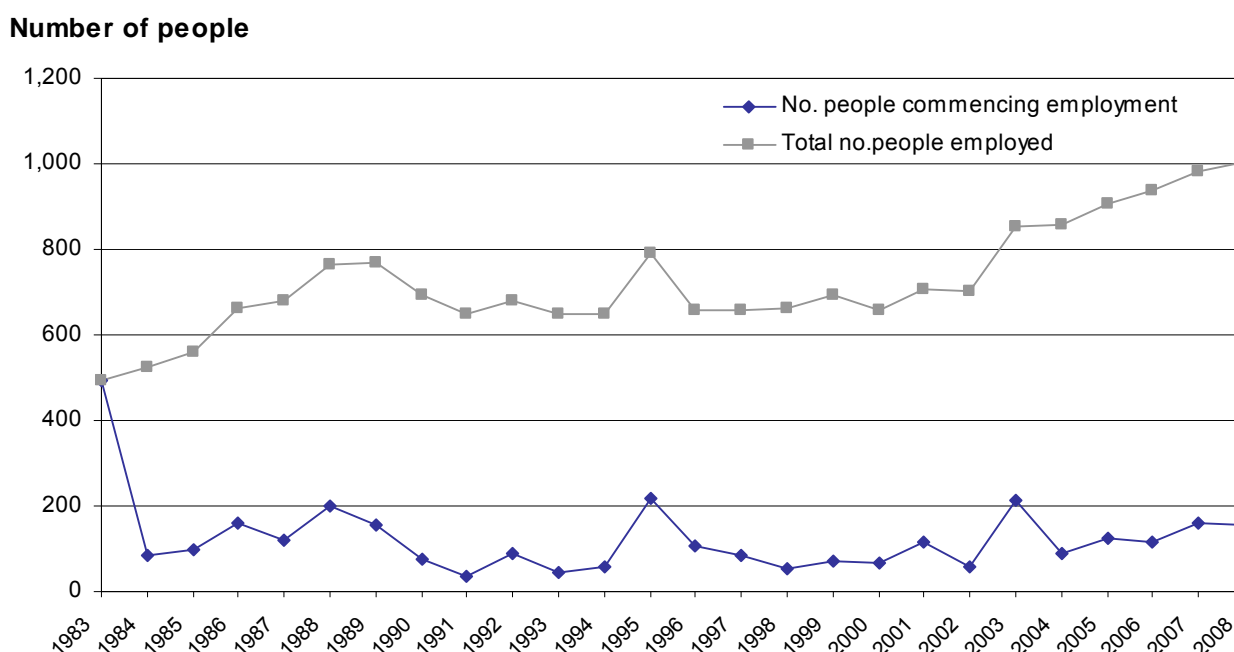
The average number of people employed for every year of the study period was 725, with a steady increase from 493 in 1983 to 1,005 in 2008 (Figure 3). The average age of employees each year ranged from 37 years to 46 years (Figure 4).

Figure 4: Mean age at commencement of employment and for all RPH PSS employees, by year, 1983 - 2008

Mean age in years
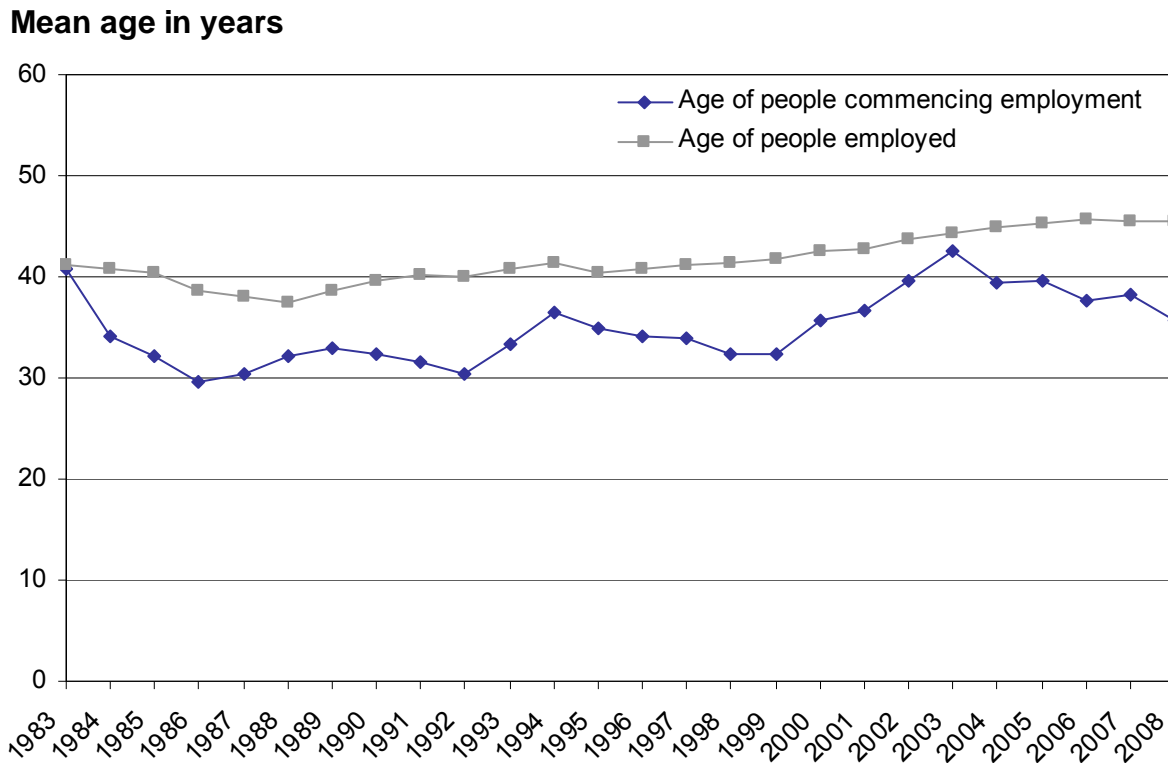
The average duration of employment during the study period was 5.0 years, with 1,133 (34.9%) people employed in PSS positions at RPH for less than one year, and 43 (1.3%) people employed during the entire study period. The average duration of employment during the study period was slightly higher in males (5.3 years) than females (4.7 years), see Table 3.

There were 474 people who had at least one gap in their RPH PSS employment history, with the maximum number of gaps equal to 26. The average total gap time during employment history was 1.9 years. After excluding gap periods, the average duration of employment decreased to 4.7 years.

The number of people employed at RPH while Prephen and Phensol was used were 2,214 (68.2%) and 1,624 (50.0%) respectively. The groups are not mutually exclusive as 590 people were employed during the period of time when the phenol-based cleaners changed. The average age at the start of follow-up and average duration of employment during the study period were similar for both groups (data not shown).

The 3,248 people included in the study had Human Resource records for over 19,000 positions. The majority of paper based records included details for one position per person prior to 1995, where the majority of electronic records included details for multiple positions from 1995 onwards. Of the PSS positions, patient care positions accounted for 45.6%, cleaner positions for 19.9% and orderly positions for 19.1%. The remaining positions accounted for less than 5.0% each.

Table 3: Summary employment details for RPH PSS employees during the study period 1983–2008

Employment Details	Male		Female		Combined	
	N	%	N	%	N	%
Number of employees	1,509	46.5	1,739	53.5	3,248	100.0
Number of employees with gap in employment	281	59.3	193	40.7	474	100.0
	Mean	**Range***	**Mean**	**Range***	**Mean**	**Range***
Year of birth	1959	1918-1992	1957	1919-1991	1958	1918-1992
Age at start of follow-up	35.6	16.0-70.0	36.2	15.0-65.0	35.9	15.0-70.0
Duration of employment (in years)	5.3	0.0-26.0	4.8	0.0-26.0	5.0	0.0-26.0
Duration of employment excluding gaps (in years)	5.0	0.0-26.0	4.5	0.0-26.0	4.7	0.0-26.0
Number of gaps in employment	1.8	1.0-13.0	1.5	1.0-26.0	1.7	1.0-26.0
Duration of gaps in employment (in years)[†]	1.9	0.0-18.8	2.0	0.0-18.9	1.9	0.0-18.9

*Minimum range of 0.0 refer to less than <0.01 years
†For those with at least one gap in employment

Full-time positions accounted for 57.6% of all positions, 35.9% were part-time and the remaining unknown. Of all PSS positions 63.5% were permanent, 15.4% fixed term, 19.8% casual and the remaining other or unknown. Full-time positions were more likely to be permanent, where part-time positions were more likely to be casual. The average number of hours worked per fortnight was 68; however the average number of hours worked per fortnight was missing for almost 4,000 positions. Full-time positions and those with unknown employment status averaged 74 hours per fortnight, where part-time positions averaged 50 hours per fortnight. There was little difference between the average number of hours worked and permanent status.

No information was available from Human Resource records on other demographic factors, such as Indigenous status and country of birth. Information on health risk factors such as smoking, alcohol consumption and diet were also not available.

Number and type of cancers
Figure 5 shows the number of cases diagnosed during each year of the study. There were 232 cancers diagnosed in 213 people during the study period and after their commencement at RPH in a PSS position. There were 19 people diagnosed with multiple cancers and all were diagnosed with two cancers during the study period.

Of the 232 cancers, 66 were diagnosed during employment and the remaining 166 were diagnosed after ceasing employment at RPH in a PSS position. Diagnoses in females account for 59.1% compared to 41.4% in males. The average age at diagnosis was 56 years overall, 54 years for females and 59 years for males.

The year of diagnosis for the 232 cancers ranged from 1983 and 2008 and the number of diagnoses per year increased over the period of the study.

Figure 5: Number of total cancers diagnosed in RPH PSS employees, by sex, 1983–2008

Number of cancer diagnoses
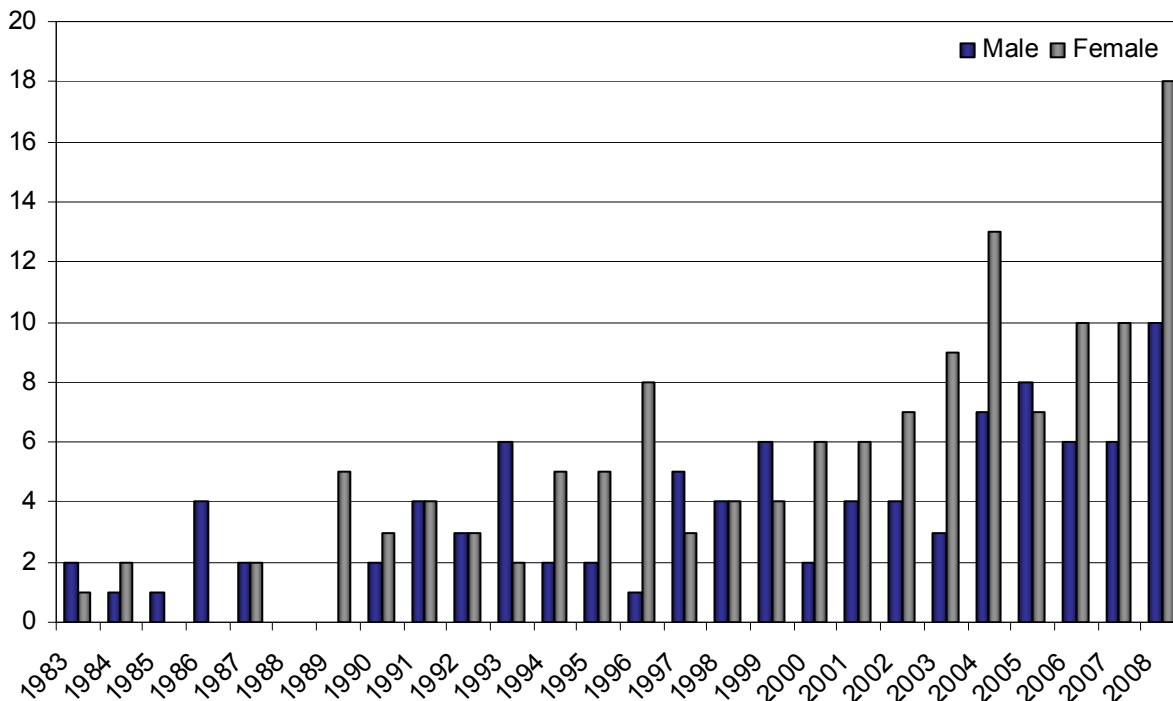
The average duration of employment prior to diagnosis was 5.2 years, with 59 (27.7%) people being employed for less than 1 year. The average age at start of follow-up was 43.7 years, and the average duration of time from start of follow-up to diagnosis was 11.7 years.

The types of cancers diagnosed in the RPH PSS employees are shown in Table 4. The most common types of cancers in males were lung cancer (n=15), colorectal cancer (n=13), prostate cancer (n=10), cancer of unknown primary site (n=7), skin melanoma (n=6) and in situ skin melanoma (n=6). The most common cancer types in females were breast cancer (n=33), followed by in situ cervical carcinoma (n=12), colorectal cancer (n=12), in situ breast carcinoma (n=11) and lung cancer (n=10), The types of cancers most common among both genders of RPH PSS employees were similar to those among males and females of the Perth Metropolitan population (WA Cancer Registry, 2010).

Table 4: Number of cancers diagnosed in RPH PSS employees, by type and sex, 1983–2008

Cancer type	N Male	N Female	N Combined
Breast *(females only)*	-	33	33
Lung, bronchus & trachea	15	10	25
Colorectal cancer	13	11	24
Unknown primary site	7	5	12
In-situ cervical carcinoma *(females only)*	-	12	12
In situ breast carcinoma *(females only)*	-	11	11
In situ skin melanoma	6	5	11
Prostate *(males only)*	10	-	10
Melanoma (skin)	6	4	10
Leukaemias	5	4	9
Lymphomas	3	4	7
Ovary *(females only)*	-	6	6
Tongue	3	1	4
Stomach	3	1	4
Cervix *(females only)*	-	4	4
Uterus (corpus) *(females only)*	-	4	4
Oesophagus	2	1	3
Liver & intrahepatic bile ducts	1	2	3
Bladder & urinary tract	3	-	3
Thyroid gland	-	3	3
Mesothelioma	1	2	3
Myeloma & plasma cell tumours	2	1	3
in situ carcinoma	1	2	3
Myelodysplastic diseases	3	0	3
Pancreas	1	1	2
Vagina *(females only)*	-	2	2
Testis *(males only)*	2	-	2
Kidney	1	1	2
Brain	1	1	2
In situ bladder carcinoma	2	-	2
Lip, gum & mouth	1	-	1
Anus	1	-	1
Gallbladder & bile ducts	1	-	1
Bones, joints & articular cartilages	-	1	1
Nervous system, periph./autonomic	-	1	1
Eye & lacrimal gland	-	1	1
Non-melanoma skin cancer (exc. SCC/BCC)	1	-	1
Benign CNS neoplasm	-	1	1
In situ colorectal carcinoma	-	1	1
Chronic myeloproliferative diseases	-	1	1
Total	**95**	**137**	**232**

Number and type of deaths

During the study period, there were 184 deaths of RPH PSS employees. Of these, 174 were identified within the WADR by the WADLS. An additional 10 (5.7%) were identified by linkage with the NDI.

Of the 184 deaths, 22 died while still employed at RPH and the remaining 162 died after ceasing employment at RPH in a PSS position. Male deaths accounted for 58.7% of all deaths compared to 41.3% in females. The average age at death was 61 years for males and females.

The year of death ranged from 1983 to 2008 and the number of deaths per year fluctuated over the period of the study. Figure 6 shows the number of deaths during each of the study.

Figure 6: Number of deaths in RPH PSS employees, by sex and year of death, 1983–2008

Number of deaths
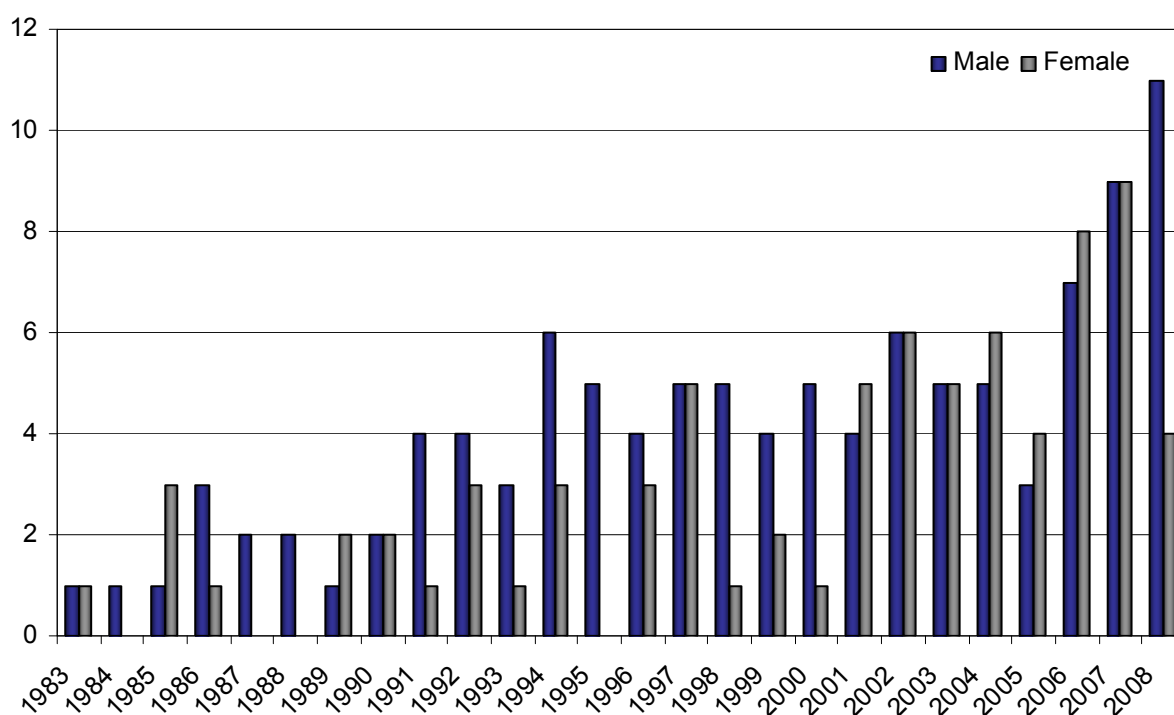
The average duration of employment prior to death was 5.2 years, with 40 (21.7%) people being employed for less than one year. The average age at start of follow-up was 47 years, and the average duration of time from start of follow-up to death was 13.6 years.

Person-years of follow-up

In the analysis of cancer and death in the RPH PSS employee cohort, the total person-years of follow-up, which includes time during and after employment, was 44,543. The average person-years of follow-up for each person was 13.7 in total, 12.8 for males and 14.5 for females. The total person-years of follow-up by age, sex and year for cancer and death are shown in appendix 5.

Chapter 5   Results: Cancer Incidence and Mortality

Risk of cancer

SIRs were calculated for the RPH PSS cohort by age, sex and year for follow-up time during and after employment. The results are summarised in Table 5.

Table 5: Risk of cancer among RPH PSS employees, during and after employment, by age, sex and year, 1983-2008*

Year	Sex	Age	N cases observed	N cases expected	SIR	95% CI
1983-2008	Combined	Combined	232	262.0	0.89	(0.78-1.01)
1983-2008	Male	Combined	95	106.4	0.89	(0.72-1.09)
	Female	Combined	137	155.7	0.88	(0.74-1.04)
1983-2008	Combined	20-29 yrs	8	7.4	1.08	(0.47-2.14)
		30-39 yrs	19	22.7	0.84	(0.50-1.31)
		40-49 yrs	35	46.2	0.76	(0.53-1.05)
		50-59 yrs	72	75.7	0.95	(0.74-1.20)
		60-69 yrs	60	71.7	0.84	(0.64-1.08)
		70+ yrs	38	38.2	1.00	(0.70-1.37)
1983-1989	Combined	Combined	20	18.5	1.08	(0.66-1.67)
1990-1999	Combined	Combined	76	76.6	0.99	(0.78-1.24)
2000-2008	Combined	Combined	136	166.9	0.81	(0.68-0.96)

*Results presented are standardised by age, sex and year unless otherwise indicated as age, sex or year specific.

The SIR for cancer from 1983-2008 was 0.89 with a 95% confidence interval (CI) of 0.78 to 1.01. This indicates that the observed number of cancer diagnosis (n=232) is very similar to that expected (n=262.0) based on the rates in the Perth Metropolitan population. Similar results were found by sex, age group and year of employment (Table 5). In each case, the 95% confidence intervals show the degree of statistical uncertainty around the actual value of the SIR. Put simply, for men and women together, the lower bound to the confidence interval of 0.78 suggests that, given statistical uncertainty in the number of people who were diagnosed with cancer in the PSS employees, the rate of cancer could be as much as 22% less in employees than in the Perth Metropolitan Area population; the upper bound of 1.01 suggests it could be as much as 1% more. The confidence intervals around the SIRs are wider for males and females separately, and for individual age groups, than they are for all PSS employees together. These wider intervals reflect greater statistical uncertainty because of the smaller numbers of cases of cancer in these sub-groups of PSS employees. Considered together, the SIRs in Table 5 provide no evidence to suggest that the incidence of cancer in PSS employees was higher than that in the Perth Metropolitan Area. Statistical uncertainty, however, means that the possibility of a small increase or a small decrease cannot be completely ruled out.

To consider the possible impact of duration of employment and time since first employment on the risk of cancer, a Cox regression analysis was conducted with age at start of the study used as the time-scale (Korn et al 1997). Time since first employment continued to be counted if a cancer diagnosis occurred as the person would still be at risk of an additional cancer. In this analysis the risk of cancer was lower in males compared to females. After adjusting for sex, and time since first employment the relative risk of cancer for those employed for 1-4 years was 0.94 (95% CI: 0.66-1.33), and for those employed for

5 or more years the relative risk was 1.23 (95% CI: 0.88-1.73), when compared to those employed for less than one year. There was however no consistent upward trend in the hazard ratios (HRs) and the p-value was high (p-value for trend = 0.17). After adjusting for sex and duration of employment the relative risk of cancer based on time since first employment for those followed for 9-18 years was 2.20 (95% CI: 1.62-3.00) and for those followed for 19 or more years the relative risk was 0.81 (95% CI: 0.55-1.19). No trend was apparent in the HRs for time since first employment (Table 6).

Table 6: Adjusted hazard ratios of cancer among RPH PSS employees, with age at start of study/ employment as the time scale

	N‡	Hazard Ratio	95% CI	p-value
Sex				
Female	125	1.00		
Male	88	0.65	(0.49-0.86)	0.003
Duration of employment				
<1 years	59	1.00		
1-4 years	70	0.94	(0.66-1.33)	
5 + years	84	1.23	(0.88-1.73)	0.17†
Time since first employment				
0-8 years	86	1.00		
9-18 years	86	2.20	(1.62-3.00)	
19+ years	41	0.81	(0.55-1.19)	0.96†

‡ Number of PSS employees with a cancer diagnosis, contributing to this analysis (Total N = 213).
† p-value for trend analysis across duration of employment categories and time since first employment categories.

The risk of the most common cancer types during the study period, 1983-2008, are shown in Table 7. The SIRs for most cancer types shown, and the degree of uncertainty around them as reflected in the CIs, provide little or no evidence that they are more frequent in PSS employees than in people living in the Perth Metropolitan Area.

Table 7: Risk of cancer among RPH PSS employees, during and after employment, for most common cancer types, 1983-2008

Cancer type*†	N cases observed	N cases expected	SIR	95% CI
Breast *(females only)*	33	42.5	0.78	(0.53-1.09)
Lung, bronchus & trachea	25	16.2	1.54	(1.00-2.27)
Colorectal	24	22.9	1.05	(0.67-1.56)
In situ cervical carcinoma *(females only)*	12	15.5	0.77	(0.40-1.35)
Unknown primary site	12	4.0	2.98	(1.54-5.20)
In situ breast carcinoma *(females only)*	11	7.0	1.58	(0.79-2.83)
In situ skin melanoma	11	18.8	0.58	(0.29-1.05)
Melanoma (skin)	10	27.1	0.37	(0.18-0.68)
Prostate *(males only)*	10	21.7	0.46	(0.22-0.85)
Leukaemias	9	4.4	2.04	(0.93-3.87)
Lymphomas	7	8.4	0.83	(0.33-1.71)
Ovary *(females only)*	6	3.5	1.72	(0.63-3.74)

*Only those cancer types with 5 or more cancers were included for statistical reasons.
†Sex specific results are presented for those cancers indicated as male or female only.

The observed numbers of cases of lung cancer, in situ breast carcinoma (in females), leukaemia, and cancer of the ovary (in females) in PSS employees were higher than expected, but the 95% confidence intervals show the statistical uncertainty of the SIRs.

For lung cancer in particular, the 95% CI indicates that the rate of lung cancer among PSS employees statistically could have ranged from equal to or higher than the Perth Metropolitan population. The wide confidence intervals, because of the small number of cases of specific cancer types, neither establishes nor rules out an increase in the rates of these types of cancer among PSS employees compared to the Perth Metropolitan population.

The SIR for cancers of unknown primary site was 2.98, with a lower bound of the 95% confidence interval suggesting that the rate among PSS employees is at least 54% higher compared to the Perth Metropolitan population. Cancers of unknown primary site are those for which a pathology test was unable to be completed, or unable to confirm, the location of the primary (first) cancer. While there is some debate about the nature of these cancers, it is probable that most are a cross-section of the commoner cancers for which a primary site could not be determined.

For all *malignant* cancers, which are those typically reported by the WACR, the SIR was 0.92 (95% CI: 0.79-1.06). For all other cancer types included in this analysis (in situ carcinomas and benign and uncertain behaviour CNS tumours) the SIR was 0.75 (95% CI: 0.54-1.02).

When looking at the exposure to the different phenol-based cleaners, based on the period of employment, the SIR for exposure to Prephen, which occurred in those employed from 1983-2000, was 0.89 (95% CI: 0.77-1.02); for exposure to Phensol, which occurred in those employed from 2001-2008, it was 0.75 (95% CI: 0.54-1.02). These SIRs are little different and do not suggest any material difference in risk of cancer between exposures to these two phenol-based cleaners.

To consider the impact of the duration of employment and time since first employment on the risk of cancer of unknown primary site, a Cox regression analysis was conducted. All cancers of unknown primary site were included in the analysis (n = 12), rather than just those which were individuals' first primary cancers of the study period (n = 9). To allow the impact of both duration of employment and time since first employment to be investigated in the model age at the start of the study was used as the time-scale. After adjusting for sex and time since first employment, the risk of cancer for those employed for 1-4 years was 2.59 (95% CI: 0.27-25.18), and for those employed for 5 or more years was 7.21 (95% CI: 0.82-63.19) when compared to those employed for less than one year. In both instances, the risk was substantially higher than for those with less than one year duration of employment a trend was apparent in the hazard ratios (p-value for trend = 0.04) (Table 8). After adjusting for sex and duration of employment the relative risk of cancer of unknown primary site based on time since first employment for those followed for 9-18 years was 10.41 (95% CI: 1.20-90.41) and for those followed for 19 or more years the risk was 12.31 (95% CI: 1.43-105.70). In both instances, the risk was substantially higher than for those with 0-8 years of time since first employment and a trend was apparent in the hazard ratios (p-value for trend = 0.01) (Table 8).

Table 8: Adjusted hazard ratios of cancer of unknown primary site among RPH PSS employees, with age at start of study or employment as the time-scale

	N‡	Hazard Ratio	95% CI	p-value
Sex				
Female	5	1.00		
Male	7	1.62	(0.49-5.37)	0.43
Duration of employment				
<1 years	1	1.00		
1-4 years	3	2.59	(0.27-25.18)	
5 + years	8	7.21	(0.82-63.19)	0.04†
Time since first employment				
0-8 years	1	1.00		
9-18 years	5	10.41	(1.20-90.41)	
19+ years	6	12.31	(1.43-105.70)	0.01†

‡ Number of PSS employees with a cancer of unknown primary site, contributing to this analysis (Total N = 12).
† p-value for trend analysis across duration of employment categories and time since first employment categories.

Risk of death

SMRs were also calculated for the RPH PSS cohort by age, sex and year for follow-up time during and after employment. The results are summarised in Table 9.

Table 9: Risk of death among RPH PSS employees, during and after employment, by age, sex and year, 1983-2008*

Year	Sex	Age	N cases observed	N cases expected	SMR	95% CI
1983-2008	Combined	Combined	184	148.8	1.24	(1.06-1.43)
1983-2008	Male	Combined	108	77.7	1.39	(1.14-1.68)
	Female	Combined	76	71.1	1.07	(0.84-1.34)
1983-2008	Combined	20-29 yrs	5	4.4	1.15	(0.37-2.67)
		30-39 yrs	13	9.3	1.39	(0.74-2.38)
		40-49 yrs	16	17.6	0.91	(0.52-1.48)
		50-59 yrs	38	32.8	1.16	(0.82-1.59)
		60-69 yrs	62	41.5	1.49	(1.15-1.91)
		70+ yrs	50	43.0	1.16	(0.86-1.53)
1983-1989	Combined	Combined	18	15.2	1.18	(0.70-1.87)
1990-1999	Combined	Combined	63	47.9	1.32	(1.01-1.68)
2000-2008	Combined	Combined	103	85.8	1.20	(0.98-1.46)

*Results presented are standardised by age, sex and year unless otherwise indicated as age, sex or year specific.

The observed number of deaths (n=184) is higher than that expected (n=148.8) based on the rates in the Perth Metropolitan population. The SMR for death from 1983-2008 was 1.24 with a 95% confidence interval (CI) of 1.06 to 1.43. The lower bound of the 95% confidence interval suggests that the rate of deaths among PSS employees is at least 6% higher than among the Perth Metropolitan population (Table 9).

The SMR for male deaths was 1.39 with a confidence interval of 1.14 to 1.68. The lower bound of the 95% confidence interval suggests that the rate of death among male PSS employees is at least 14% higher in male PSS employees than among the Perth

Metropolitan male population. The SMR for female deaths was 1.07 with a 95% confidence interval (CI) of 0.84 to 1.34. The 95% CI indicates that the rate of deaths among female PSS employees statistically could have ranged from 16% lower up to 34% higher than the Perth Metropolitan female population.

Considered together, the SMRs in Table 9 provide some evidence to suggest that deaths in PSS employees, in particular males, occurred at a higher rate than in the Perth Metropolitan Area.

The type of chemical exposure, based on period of employment, was examined for Prephen and Phensol. The SMR for exposure to Prephen was 1.23 (95% CI: 1.05-1.43) indicating the rate of deaths among PSS emplpyees is at least 5% higher than among the Perth Metropolitan population and was similar to the SMR for all-cause deaths. The SMR for Phensol was 1.02 (95% CI: 0.64-1.54) indicating that the rate of death could have ranged from 36% lower and 54% higher than the Perth Metropolitan population.

To consider the possible impact of duration of employment and time since first employment on the risk of death, a Cox regression analysis was conducted with age at start of the study as the time-scale. After adjusting for sex and time since first employment the relative risk of death based on duration of employment for those employed for 1-4 years was 1.39 (95% CI: 0.94-2.05) and for those employed for 5 or more years the relative risk was 1.55 (95% CI: 1.05-2.30). There was a consistent upward trend in the HRs (p-value for trend = 0.03). After adjusting for sex and duration of employment the relative risk of death based on time since first employment for those followed for 9-18 years was 2.84 (95% CI: 2.00-4.03) and for those followed for 19 or more years the relative risk was 1.86 (95% CI: 1.27-2.72). In both instances, the risk was substantially higher than for those with 0-8 years of follow-up and a trend was apparent in the hazard ratios (p-value for trend = 0.0003) (Table 10).

Table 10: Adjusted hazard ratios of death among RPH PSS employees, with age at start of study/ employment as the time-scale

	N‡	Hazard Ratio	95% CI	p-value
Sex				
Female	76	1.00		
Male	108	1.43	(1.05-1.93)	0.02
Duration of employment				
<1 years	40	1.00		
1-4 years	72	1.39	(0.94-2.05)	
5 + years	72	1.55	(1.05-2.30)	0.03†
Time since first employment				
0-8 years	58	1.00		
9-18 years	71	2.84	(2.00-4.03)	
19+ years	55	1.86	(1.27-2.72)	0.0003†

‡ Number of PSS employees who died during the study period, contributing to this analysis (Total N = 184).
† p-value for trend analysis across duration of employment categories and time since first employment categories.

Since the SMR results demonstrated an increased risk of death in PSS employees, in particular males, the causes of deaths (cancer or non-cancer) were investigated separately. SMRs for cancer deaths in the RPH PSS cohort by age, sex and year for follow-up time during and after employment are presented in Table 11.

Table 11: Risk of cancer death among RPH PSS employees, during and after employment, by age, sex and year, 1983-2008*

Year	Sex	Age	N cases observed	N cases expected	SMR	95% CI
1983-2008	Combined	Combined	72	62.3	1.15	(0.90-1.45)
1983-2008	Male	Combined	37	28.5	1.30	(0.91-1.79)
	Female	Combined	35	33.8	1.03	(0.72-1.44)
1983-2008	Combined	20-29 yrs[‡]	-	-	-	-
		30-39 yrs[‡]	-	-	-	-
		40-49 yrs	10	7.3	1.37	(0.66-2.52)
		50-59 yrs	16	17.2	0.93	(0.53-1.51)
		60-69 yrs	28	20.4	1.37	(0.91-1.99)
		70+ yrs	16	15.0	1.07	(0.61-1.73)
1983-1989	Combined	Combined	7	6.3	1.12	(0.45-2.31)
1990-1999	Combined	Combined	28	20.1	1.39	(0.92-2.01)
2000-2008	Combined	Combined	37	36.0	1.03	(0.72-1.42)

*Results presented are standardised by age, sex and year unless otherwise indicated as age, sex or year specific.
‡ Number of observed cases too small to calculate an SMR for this age category.

The observed number of cancer deaths (n=72) is higher than that expected (n=62.3) based on the rates in the Perth Metropolitan population. The SMR for cancer deaths from 1983-2008 was 1.15 with a 95% confidence interval (CI) of 0.90 to 1.45. The 95% CI indicates that the rate of deaths among PSS employees could have ranged from 10% lower up to 45% higher. Similar results were found by age group and year of employment (Table 11).

The SMR for male cancer deaths was 1.30 with a confidence interval of 0.91 to 1.79. The 95% confidence intervals show the degree of statistical uncertainty around the actual value of the SMR. For males, the lower bound to the confidence interval of 0.91 suggests that, given statistical uncertainty in the number of males who died of cancer among PSS employees, the rate of death due to cancer could be as much as 9% less in male employees than in the male Perth Metropolitan Area population; the upper bound of 1.79 suggests it could be as much as 79% more. Statistical uncertainty means that the possibility of a small increase or a small decrease cannot be completely ruled out for males. The SMR for female cancer deaths was 1.03 with a 95% confidence interval (CI) of 0.72 to 1.44 (Table 11).

To consider the possible impact of duration of employment and time since first employment on the risk of cancer death a Cox regression, with age at start of the study as the time-scale was completed. When considering the risk of death due to cancer after adjusting for sex and time since first employment the relative risk of cancer death based on duration of employment for those employed for 1-4 years was 1.44 (95% CI: 0.74-2.82) and for those employed for 5 or more years was 2.19 (95% CI: 1.15-4.20). In both instances, the risk was higher than for those with less than one year duration of employment and a trend was apparent in the hazard ratios (p-value for trend = 0.01). After adjusting for sex and duration of employment the relative risk of death based on time since first employment for those followed for 9-18 years was 3.38 (95% CI: 1.95-5.85) and for those followed for 19 or more years the relative risk was 1.43 (95% CI: 1.75-2.70). There

was however no consistent upward trend in the hazard ratios (HRs) and the p-value was high (p-value for trend = 0.12) (Table 12).

Table 12: Adjusted hazard ratios of cancer death among RPH PSS employees, with age at start of study/ employment as the time-scale

	N‡	Hazard Ratio	95% CI	p-value
Sex				
Female	35	1.00		
Male	37	1.00	(0.62-1.61)	0.99
Duration of employment				
<1 years	13	1.00		
1-4 years	25	1.44	(0.74-2.82)	
5 + years	34	2.19	(1.15-4.20)	0.01†
Time since first employment				
0-8 years	22	1.00		
9-18 years	32	3.38	(1.95-5.85)	
19+ years	18	1.43	(0.75-2.70)	0.12†

‡ Number of PSS employees who died during the study period from cancer, contributing to this analysis (Total N = 72).
† p-value for trend analysis across duration of employment categories and time since first employment categories.

SMRs were also calculated for non-cancer deaths in the RPH PSS cohort by age, sex and year for follow-up time during and after employment, results are presented in Table 13.

Table 13: Risk of non-cancer death among RPH PSS employees, during and after employment, by age, sex and year, 1983-2008

Year	Sex	Age	N cases observed	N cases expected	SMR	95% CI
1983-2008	Combined	Combined	110	86.4	1.27	(1.05-1.54)
1983-2008	Male	Combined	69	49.2	1.40	(1.09-1.78)
	Female	Combined	41	37.2	1.10	(0.79-1.49)
1983-2008	Combined	20-29 yrs	5	3.8	1.32	(0.43-3.08)
		30-39 yrs	11	7.3	1.50	(0.75-2.69)
		40-49 yrs	6	10.3	0.58	(0.21-1.27)
		50-59 yrs	20	15.7	1.28	(0.78-1.97)
		60-69 yrs	34	21.1	1.61	(1.11-2.25)
		70+ yrs	34	28.0	1.21	(0.84-1.70)
1983-1989	Combined	Combined	11	8.9	1.24	(0.62-2.21)
1990-1999	Combined	Combined	35	27.8	1.26	(0.88-1.75)
2000-2008	Combined	Combined	64	49.7	1.29	(0.99-1.64)

*Results presented are standardised by age, sex and year unless otherwise indicated as age, sex or year specific.

The observed number of non-cancer deaths (n=110) is higher than that expected (n=86.4) based on the rates in the Perth Metropolitan population. The SMR for non-cancer deaths from 1983-2008 was 1.27 with a 95% confidence interval (CI) of 1.05 to 1.54. The lower bound of the 95% confidence interval suggests that the rate of non-cancer deaths among PSS employees is at least 5% higher than among the Perth Metropolitan population (Table 13).

The SMR for male non-cancer deaths was 1.40 with a confidence interval of 1.09 to 1.78. The lower bound of the 95% confidence interval suggests that the rate of non-cancer

deaths among male PSS employees is at least 9% higher than among the Perth metropolitan male population. The SMR for female cancer deaths was 1.10 with a 95% confidence interval (CI) of 0.79 to 1.49 (Table 13). The 95% confidence intervals show the degree of statistical uncertainty around the actual value of the SMR. The 95% CI indicates that the rate of deaths among PSS employees could have ranged from 21% lower up to 49% higher. Statistical uncertainty means that the possibility of a small increase or a small decrease cannot be completely ruled out for females.

Using a Cox regression to consider the possible impact of duration of employment and time since first employment on the risk of death from conditions other than cancer, the risk of death due to conditions other than cancer was higher in males 1.78 (95% CI: 1.19-2.66) compared to females. After adjusting for sex and time since first employment the relative risk of non-cancer deaths based on duration of employment for those employed for 1-4 years was 1.46 (95% CI: 0.90-2.38) and for those employed for 5 or more years the relative risk was 1.32 (95% CI: 0.79-2.22). No trend was apparent in the hazard ratios and the p-value was high (p-value for trend =0.31). After adjusting for sex and duration of employment the relative risk of death based on time since first employment for those followed for 9-18 years was 2.50 (95% CI: 1.57-3.97) and for those followed for 19 or more years the relative risk was 2.22 (95% CI: 1.37-3.58). In both instances, the risk was substantially higher than for those with 0-8 years of follow-up and a trend was apparent in the hazard ratios (p-value for trend = 0.0006) (Table 14).

Table 14: Adjusted hazard ratios of non-cancer death among RPH PSS employees, with age at start of study/ employment as the time dependant variable

	N‡	Hazard Ratio	95% CI	p-value
Sex				
Female	41	1.00		
Male	69	1.78	(1.19-2.66)	0.005
Duration of employment				
<1 years	25	1.00		
1-4 years	47	1.46	(0.90-2.38)	
5 + years	38	1.32	(0.79-2.22)	0.31†
Time since first employment				
0-8 years	35	1.00		
9-18 years	38	2.50	(1.57-3.97)	
19+ years	37	2.22	(1.37-3.58)	0.0006†

‡ Number of PSS employees who died during the study period from a condition other than cancer, contributing to this analysis (Total N = 110).

† p-value for trend analysis across duration of employment categories and time since first employment categories.

Sensitivity analysis

A sensitivity analysis was conducted to determine the impact of some aspects of the study design on risk estimates.

The analysis presented above included all primary cancers diagnosed in an individual during the study period, including multiple primaries of the same type and non-malignant tumours that are not typically reported in standard incidence reporting but are recorded by the WACR. Therefore the analysis was repeated including only cancers reported by the WACR International Agency for Cancer Research (IARC) guidelines for reporting multiple primaries in the compilation of incidence statistics (Threlfall and Thompson, 2010; Jensen et al, 1991). Under this method, the number of observed cancers decreased from 232 to 186 and the expected number of cancers decreased from 262.0 to 190.2. The overall risk of cancer, from 1983-2008, was 0.98 (95% CI: 0.84-1.13). This result compares with, and is not materially different from, 0.89 (0.78-1.01) in the main analysis (Table 5).

It is important to consider the impact of cancers diagnosed interstate that would not have been notified to the WACR and therefore not included in the analysis. National cancer data was not requested for the project due to time constraints and the unavailability of recent, complete data. Therefore, assuming the same percentage of interstate deaths found by the NDI is expected for cancers (5.7%), we would have identified an additional 13 cancer diagnoses. The SIR for all cancers would then have been 0.94 (95% CI: 0.82-1.06), which would not suggest a different conclusion to that based on the results in Table 5.

Most cancers have a latency period of at least 5-10 years, which is the time between exposure to a risk factor and diagnosis (Queensland Health, 2009). Therefore if a cancer diagnosis occurs within a short period of time after an exposure it is unlikely to have been caused by the exposure. When the analysis is restricted to person-years of follow-up accumulated and cancers diagnosed at least 5 years after commencing employment at RPH, the SIR for cancer is 0.89 (95% CI: 0.77-1.03). When it is restricted to at least 10 years, the SIR for cancer is 0.80 (95% CI: 0.67-0.95). These estimates are similar to the estimate reported in Table 5.

A latency period of at least 5 and 10 years was also considered for the death analysis. The risk of deaths, when restricted to person-years of follow-up and deaths occurring at least 5 years after commencing employment was 1.25 (95% CI: 1.06-1.46) and for at least 10 years was 1.27 (95% CI: 1.05-1.52). These estimates are also similar to the analysis that did not include these latency periods (Table 9).

In occupational cohort studies an upper age cut-off is sometimes used to avoid problems due to incomplete ascertainment of deaths occurring in the occupational cohort (Sorahan et al., 2005). Restricting the analysis presented in this report to people aged less than 85 years had little impact on the results. The SIR for cancer was 0.88 (95% CI: 0.77-1.00) and the SMR for all-cause deaths was 1.25 (95% CI: 1.07-1.45). This suggests that any under-ascertainment of deaths there might have been has not had a material effect on the results.

To consider the impact of the accuracy of the RPH Human Resource records, the analysis was repeated assuming that the employment start date was inaccurate by a margin of two years. This figure was chosen based on the comparison of the Human Resource records with the questionnaire responses (see Chapter 8 for more details). For cancer, when the start year was made 2 years later the SIR for all cancers was 0.96 (95% CI: 0.84-1.09), and when it was made 2 years earlier the SIR was 0.84 (95% CI: 0.73-1.09). For deaths, the SMRs were 1.33 (95% CI: 1.15-1.54) and 1.18 (95% CI: 1.02-1.36) when the start year was made 2 years later or earlier respectively. These estimates indicate that if the Human Resource records were systematically incorrect by a margin of 2 years, this would have only a small impact on the findings.

Chapter 6   Results: Survey Reported Health Conditions

The primary purpose of the survey was to extend the scope of the investigation beyond cancer incidence and death to include more acute self-reported health conditions that were commonly reported by staff exposed to phenol-based cleaners.

Number and type of health conditions

Table 15 presents the prevalence (expressed as a percentage) of several self-reported, doctor diagnosed health conditions among survey respondents. Conditions were selected if (a) there was evidence in the scientific literature that they may be associated with exposure to phenol-based cleaners and/or (b) data was available on the prevalence of this condition in a suitable comparison population.

The prevalence for each condition was standardised to the age and sex distribution of the most recent estimated WA resident population, 2008 (Australian Bureau of Statistics, 2008). The most frequently self-reported health condition amongst respondents was ever being diagnosed with asthma (23.7%), followed by a skin condition other than skin cancer (19.2%).

To provide context, the adjusted prevalence for each health condition was also compared with the published prevalence of these same conditions in the general population.

Comparison data was obtained from the 2009 WA Health and Wellbeing Surveillance system, a continuous data collection system that monitors the health and wellbeing of Western Australians (Joyce & Daly, 2010). To ensure consistency, prevalence of the same health conditions were calculated for all adults aged 18 years and over in the Perth Metropolitan area during 2009. Again, estimates were adjusted for the age and sex distribution of the 2008 WA population.

Table 15: Comparison of self-reported, doctor diagnosed health conditions between survey respondents and a comparison population

Health condition	Survey respondents			Perth metroplitan area†			p-value*
	Number	Percent	95% CI	Number	Percent	95% CI	
Cancer	85	12.6	(9.8 - 16.1)	247	5.1	(4.4 - 5.9)	0.00
Asthma ever diagnosed	97	23.7	(20.0 - 28.0)	459	14.8	(13.7 - 16.0)	0.00
Current asthma	84	14.7	(11.7 - 18.4)	276	8.4	(7.5 - 9.4)	0.00
Respiratory condition other than asthma	56	9.3	(6.9 - 12.4)	152	3.6	(3.0 - 4.3)	0.00
Skin condition other than skin cancer	104	19.2	(15.7 - 23.1)	N/A	N/A	N/A	N/A
TOTAL	**494**			**3,671**			

† Data obtained from the WA Health and Wellbeing Surveillance System 2009.
* p-value obtained from chi-square test of independence.

Substantially higher percentages of survey respondents reported having been diagnosed with cancer, asthma and other respiratory conditions than did the general Perth population.

Table 16 presents the prevalence (expressed as a percentage) of self-reported health symptom frequency in the past four weeks for survey respondents still working at Royal Perth Hospital. The estimates were standardised to the age and sex distribution of the 2008 WA population. The most frequently reported health symptom in the past four weeks amongst respondents was skin irritations, rashes or eczema (15.2%), followed by sore or irritated eyes (7.8%).

The Health and Wellbeing Surveillance system was again used to identify the frequency of self-reported health symptoms in the general population as a comparison, although only data from 2003 were available. The differences are less than those for self-reported, doctor diagnosed conditions (Table 15), however survey respondents reported a higher prevalence of each symptom and those for skin irritation, rashes or eczema and cough or sore throat were relatively high.

Table 16: Comparison of health symptom frequency in the last four weeks between survey respondents and a comparison population

Health symptom‡	Survey respondents			Perth metroplitan area†			p-value*
	Number	Percent	95% CI	Number	Percent	95% CI	
Headache	14	6.4	(3.4 - 11.5)	125	4.8	(4.0 - 5.8)	0.11
Skin irritations, rashes or eczema	25	15.2	(10.2 - 21.8)	228	9.7	(8.6 - 11.0)	0.03
Sore or irritated eyes	14	7.8	(4.4 - 13.2)	153	5.9	(5.0 - 6.9)	0.39
Cough or sore throat that was not due to a cold or the flu	16	7.5	(4.0 - 12.7)	126	4.6	(3.8 - 5.5)	0.03
Difficulty breathing	8	5.3	(2.7 - 10.4)	65	2.3	(1.8 - 3.0)	0.19
Nausea	6	3.7	(1.5 - 8.1)	N/A	N/A	N/A	N/A
Nose bleeds	1	0.3	(0.0 - 3.8)	4	0.1	(0.0 - 0.4)	0.75
TOTAL	**169**			**2,430**			

† 2003 data obtained from WA Health and Wellbeing Surveillance System.
‡ Per cent of people who experienced the condition every day or almost every day.
* p-value obtained from chi-squire test of independence.

Chapter 7   Results: Exposure and Health

A secondary purpose of the survey was to capture more detailed information on patterns of use and duration of exposure to phenol-based cleaners that could provide a better understanding of the extent of exposure and be used to see if risk of health outcomes increased with increasing exposure.

Exposure to phenol-based cleaners

Table 17 shows that most people (82.2%) who worked in the Methicillin-resistant Staphylococcus Aureus (MRSA) rooms used phenol-based cleaners in their work. Nearly all respondents to the survey had used phenol-based cleaners at some time (96.6%), with only 1.0% indicating that they had little or no contact with phenol-based cleaners. Just over 6.0% of respondents recalled having registered with RPH as Prephen sensitive and 3.2% of respondents had been placed on alternative duties.

Table 17: Exposure characteristics of survey respondents

	Sample (N)	Estimated Prevalence (%)
Proportion who used phenol-based cleaners when working in each area		
MRSA rooms	267	82.2
Medical Engineering and Phyics Department (MEPD)	24	75.0
Laboratories	20	62.5
Burns unit	16	50.0
TB wards (Emergency Department, Intensive Care unit, 9C)	143	65.0
VRE rooms	159	79.9
Other	91	40.1
Level of contact with phenol-based cleaners		
Used phenol-based cleaners	477	96.6
Worked in areas cleaned with phenol-based cleaners only	12	2.4
Had little or no contact with phenol-based cleaners	5	1.0
Occupational health status		
Registered with Royal Perth Hospital as Prephen sensitive	30	6.1
Assessed by occupational health for sensitivity to Prephen	27	5.5
Placed on alternative duties as a result of assessment	16	3.2

Table 18 shows a breakdown of how long respondents were exposed to phenol-based cleaners for each area of the hospital. People who worked in the MRSA rooms or 'other' areas used phenol-based cleaners the most number of days, on average 1,184 and 1,320 days respectively during their employment at RPH. However, phenol-based cleaners were only used, on average, 2.4 hours per typical day spent in the MRSA rooms compared to an average of 3.9 hours per typical day in the Burns Unit. Respondents who worked in 'other' areas accumulated, on average, a total of 5,535 hours of exposure to phenol-based cleaners when working in these 'other' areas. The next highest amount of exposure was accumulated through work in TB wards (average 3,136 hours of exposure), followed by work in MRSA rooms (average 3,021 hours of exposure). The least amount of exposure was accumulated through work in the Burns Unit, with average accumulated hours of exposure of 1,686.

Table 18: Profile of exposure to phenol-based cleaners for each area within the hospital

	N	Mean	Minimum	Maximum
MRSA rooms				
Total days working in MRSA rooms	221	1,368	1.0	8,640
Total time using cleaners (days)	180	1,184	0.0	5,760
Hours per day spent using cleaners	233	2.4	0.0	8
Total hours of exposure to cleaners	167	3,021	0.1	34,560
MEPD rooms				
Total days working in MEPD rooms	24	910	1.0	4,560
Total time using cleaners (days)	21	870	0.1	4,596
Hours per day spent using cleaners	32	2.64	0.1	8
Total hours of exposure to cleaners	18	2,841	0.1	13,680
Laboratories				
Total days working in Laboratories	49	892	1.0	4,560
Total time using cleaners (days)	36	912	0.2	4,560
Hours per day spent using cleaners	48	2.78	0.0	8
Total hours of exposure to cleaners	34	2,444	0.2	9,800
Burns unit				
Total days working in Burns unit	94	662	1.0	8,640
Total time using cleaners (days)	63	408	0.0	5,760
Hours per day spent using cleaners	86	3.9	0.0	12
Total hours of exposure to cleaners	59	1,686	0.1	19,200
TB wards				
Total days working in TB wards	115	806	0.3	5,760
Total time using cleaners (days)	84	793	0.0	5,760
Hours per day spent using cleaners	113	3.31	0.1	30
Total hours of exposure to cleaners	80	3,136	0.1	50,400
VRE rooms				
Total days working in VRE rooms	131	900	1.0	5,760
Total time using cleaners (days)	94	854	0.2	5,760
Hours per day spent using cleaners	135	3.06	0.1	12
Total hours of exposure to cleaners	94	2,424	0.3	23,040
Other area				
Total days working in Other areas	193	1,356	1.0	8,640
Total time using cleaners (days)	152	1,320	0.1	8,640
Hours per day spent using cleaners	193	3.46	0.0	8
Total hours of exposure to cleaners	146	5,535	0.1	69,120

N is the number of respondents contributing to the mean, minimum and maximum values

Female PSS employees accumulated, on average, 9,593 hours of exposure to phenol-based cleaners. This was substantially higher than male PSS employees who were exposed for an average of 6,609 hours during their employment (data not shown).

Exposure and health

Survey respondents were asked for permission to link the exposure information they provided in the survey with other health records, such as the Cancer Registry, stored at the Department of Health. A total of 443 respondents (89.7%) gave permission to link their data and a total of 245 respondents provided sufficiently complete exposure information to enable calculation of their total exposure to phenol-based cleaners. Of these, 227 gave permission to link their data and also provided enough information to calculate exposure.

Because an estimate of total exposure to phenol-based solvents could only be calculated for just over half of the respondents, two analyses were done to assess whether analysing only these respondents with complete exposure information would be likely to have an important effect on results that relate estimated total exposure to health.

First, an analysis was done to determine whether there were important differences between the characteristics of respondents who provided exposure information and those who did not. These results are presented in Table 19

Second, a further analysis was undertaken to determine whether respondents who provided incomplete exposure information were likely to have a different exposure profile from those who provided complete information. Means of three key exposure variables – total days spent working, proportion of time using cleaners and hours per day using cleaners – were calculated using all available exposure data for each particular area (e.g. MRSA room) given by the respondents with incomplete information. These means were then compared to the corresponding means for respondents who had provided complete exposure information. The results of this analysis are provided in Appendix 6. There were no great differences in the means of any of the exposure variables between the two groups (except for MEPD rooms; however only one respondent had provided incomplete information), suggesting that respondents with missing information were unlikely to have a greatly different exposure to those with complete information.

Table 19: Comparison of demographics, employment history and health status among survey respondents with and without exposure information

	Survey respondents with exposure information			Survey respondents without exposure information		
	Number	Percent	95% CI	Number	Percent	95% CI
Sex						
Male	109	44.5	(38.2 - 50.8)	95	38.2	(32.1 - 44.2)
Female	136	55.5	(49.2 - 61.8)	154	61.8	(55.8 - 67.9)
Health conditions						
Current asthma	46	20.2	(15.0 - 25.5)	38	16.7	(11.8 - 21.5)
Ever diagnosed with asthma	53	22.5	(17.1 - 27.8)	44	19.0	(13.9 - 24.1)
Respiratory condition other than asthma	27	12.0	(7.7 - 16.3)	29	12.8	(8.4 - 17.2)
Skin condition other than skin cancer	60	26.1	(20.4 - 31.8)	44	19.2	(14.1 - 24.4)
Cancer	44	18.9	(13.8 - 23.9)	41	17.5	(12.6 - 22.4)
Health symptoms in previous four weeks†						
Headache	29	12.3	(8.1 - 16.5)	27	11.4	(7.3 - 15.5)
Skin irritations, rashes or eczema	44	18.6	(13.6 - 23.6)	30	12.7	(8.4 - 17.0)
Sore or irritated eyes	34	14.2	(9.8 - 18.7)	29	12.3	(8.1 - 16.6)
Cough or sore throat that was not due to a cold or the flu	47	19.6	(14.5 - 24.6)	31	13.2	(8.9 - 17.6)
Difficulty breathing	21	8.7	(5.1 - 12.3)	16	6.8	(3.6 - 10.1)
Nausea	13	5.4	(2.5 - 8.3)	7	3.0	(7.9 - 5.2)
Nose bleeds	1	0.4	(0.0 - 1.2)	0	0.0	(0.0 - 0.0)
Employment						
Still working at RPH	94	38.8	(32.5 - 44.9)	75	30.0	(24.4 - 35.9)
	Number	Mean	95% CI	Number	Mean	95% CI
Age						
At time of survey (years)	245	53.9	(52.3 - 55.5)	249	55.8	(54.3 - 57.3)
Employment						
Duration in years	245	11.5	(10.3 - 12.5)	249	9.8	(8.5 - 10.8)

† Per cent of people who experienced the condition every day or almost every day.

People who had been employed longer at RPH and respondents who were still working at RPH were more likely to provide complete exposure information. While the frequency of none of the health conditions or symptoms could be considered certainly different between the two groups, the prevalence of 11 of the 12 asked about was greater in those who provided complete exposure information than in those who did not. This suggests that the former group were more likely to report health conditions or symptoms than the latter.

Analyses were undertaken to investigate whether there was an association between exposure to phenol-based cleaners and the occurrence of cancer, as recorded in the Cancer Registry. The continuous variable 'total exposure' was divided into three equal tertiles as shown in Table 20.

Table 20: Number and percent of respondents in total exposure tertiles

	Exposure range (hrs)	Number	Percent	Cumulative percent
1st tertile - low exposure	0 - 400	82	33.5	33.5
2nd tertile - moderate exposure	401 - 5736	81	33.0	66.5
3rd tertile - high exposure	5737 - 75600	82	33.5	100.0
Total		**245**	**100**	

Table 21 resents a summary of cancer diagnoses from the Cancer Registry in all 443 respondents who agreed to linkage of their responses to their health records. There were 44 of the 443 respondents who had an eligible cancer diagnosis, as verified by the WA Cancer Registry. A total of 18 of these cancers were diagnosed in the 227 who provided complete exposure data.

Table 21: Demographic and exposure characteristics[1] of survey respondents with and without a cancer diagnosis

	Survey respondents with eligible cancer diagnosis from Cancer Registry			Survey respondents without eligible cancer diagnosis from Cancer Registry			p-value
	Number	Percent	95% CI	Number	Percent	95% CI	p-value
Sex							
Male	16	36.4	(21.6 - 51.2)	162	40.6	(35.8 - 45.4)	0.59*
Female	28	63.6	(48.8 - 78.4)	237	59.4	(54.6 - 64.2)	
Exposure							
Low exposure (0-400 hours)	4	22.2	(0.9 - 43.5)	70	33.5	(27.0 - 39.9)	
Moderate exposure (401-5736 hours)	7	38.9	(13.9 - 63.8)	68	32.5	(26.1 - 38.9)	0.42†
High exposure (5737-75600 hours)	7	38.9	(13.9 - 63.8)	71	34.0	(27.4 - 40.4)	
	Number	Mean	95% CI	Number	Mean	95% CI	p-value
Age							
At time of survey (years)	44	60.0	(56.3 - 63.7)	399	54.6	(53.4 - 55.7)	0.00‡
Exposure							
Total exposure (hours)	18	9030.0	(2393.5 - 15665.7)	209	8077.0	(6178.7 - 9976.2)	0.78‡

[1] Demographic characteristics are shown for all 443 respondents who permitted linkage to health records and exposure characteristics are shown only for the 227 respondents who also provided complete exposure data.
* p-value obtained from chi-square test of independence.
† p-value obtained from chi-square test of trend.
‡ p-value obtained from independent sample t-test.

On average, survey respondents who had been diagnosed with cancer were older than respondents who had not been diagnosed with cancer (p=0.00). There were no great differences between the two groups with regard to sex or total exposure time to phenol-based cleaners.

These variables were then entered into a logistic regression analysis in the Stata statistical analysis package. Logistic regression analyses the relationship between one or more explanatory variables (in this case sex, age and exposure) and an outcome variable (in this case presence or absence of a cancer diagnosis) and calculates an odds ratio to measure the strength of the associations of explanatory variables with the outcome variable, taking into account any correlations between the explanatory variables. The odds ratio is an estimate of the relative risk, which is the ratio of the risk of the outcome (a cancer diagnosis) in the second and subsequent categories of each of the explanatory

variables relative to the risk of the outcome in the first, or baseline, category of each (OR and relative risk of 1). For each exposure variable, the baseline category is the lowest exposure category. The results are presented in Table 22

Table 22: Adjusted odds ratios for cancer in survey respondents[1] as recorded by the WA Cancer Registry

	Odds Ratio	95% CI	p-value
Age*	1.07	(1.02-1.12)	0.01
Sex			
Female	1.00		
Male	1.54	(0.57-4.19)	0.39
Exposure tertile			
Low (0-400 hours)	1.00		
Moderate (401-5736 hours)	1.58	(0.43-5.83)	
High (5737+ hours)	1.39	(0.37-5.18)	0.66†
Total exposure (hours)‡	1.000	(0.996-1.003)	0.97

[1] Analysis limited to respondents who also provided complete exposure data.
* The OR for age reflects the relative increase in risk per year of age.
† p-value for trend analysis.
‡ The OR for total exposure reflects the relative increase in risk per 100 hours of exposure.

As would be expected, cancer risk increased with age (p=0.01). Risk of cancer appeared higher in those with moderate or high exposure relative to risk in those with low exposure. There was, however, no consistent upward trend in the ORs and the p-value for trend was high (p=0.66). Thus, these apparent increases could easily be due to chance. The uncertainty about these increases is underlined by the fact that moving one person from either the moderate or the high exposure category to the low exposure category would move the odds ratios much closer to one. The analysis was re-run using cancer diagnoses self-reported by survey respondents instead of those recorded by the WA Cancer Registry (results shown in Table 23), but there was little overall difference to the results.

Table 23: Adjusted odds ratios for cancer in survey respondents[1] as self-reported

	Odds Ratio	95% CI	p-value
Age*	1.06	(1.02-1.09)	0.00
Sex			
Female	1.00		
Male	0.91	(0.45-1.85)	0.60
Exposure tertile			
Low (0-400 hours)	1.00		
Moderate (401-5736 hours)	1.79	(0.74-4.34)	
High (5737+ hours)	1.57	(0.65-3.84)	0.35†
Exposure (hours)‡	1.000	(0.997-1.002)	0.83

[1] Analysis limited to respondents who also provided complete exposure data.
* The OR for age reflects the relative increase in risk per year of age.
† p-value for trend analysis.
‡ The OR for total exposure reflects the relative increase in risk per 100 hours of exposure.

This process was repeated for the other self-reported health conditions reported in the survey: current asthma, other respiratory conditions and skin conditions other than skin cancer.

Table 24 resents a summary of the characteristics of respondents with a self-reported doctor diagnosis of current asthma and respondents without a self-reported doctor diagnosis of current asthma. There were no great differences between the two groups with regard to any of the variables explored.

Table 24: Demographic and exposure characteristics of survey respondents[1] with and without current asthma

	Survey respondents with self-reported doctor diagnosed asthma			Survey respondents without self-reported doctor diagnosed asthma			
	Number	Percent	95% CI	Number	Percent	95% CI	p-value
Sex							
Male	30	35.7	(25.2 - 46.2)	159	42.9	(37.8 - 47.9)	0.23*
Female	54	64.4	(53.8 - 74.7)	212	57.1	(52.1 - 62.2)	
Exposure							
Low exposure (0-400 hours)	11	23.9	(11.1 - 36.7)	68	37.6	(30.4 - 44.7)	
Moderate exposure (401-5736 hours)	18	39.1	(24.5 - 53.8)	54	29.8	(23.1 - 36.6)	0.19†
High exposure (5737-75600 hours)	17	37.0	(37.0 - 51.4)	59	32.6	(25.7 - 39.4)	
	Number	Mean	95% CI	Number	Mean	95% CI	p-value
Age							
At time of survey (years)	84	55.8	(53.1 - 58.5)	371	54.4	(53.2 - 55.7)	0.35‡
Exposure							
Total exposure (hours)	46	10662.6	(6151.3 - 15174.0)	181	7983.5	(5847.5 - 10119.5)	0.27‡

[1] Analysis limited to respondents who also provided complete exposure data.
* p-value obtained from chi-square test of independence.
† p-value obtained from chi-square test of trend.
‡ p-value obtained from independent sample t-test.

Table 25 presents the adjusted odds ratios for current asthma among survey respondents. Risk of current asthma appeared higher in those with moderate and high exposure than in those with low exposure; but lack of a consistent trend for the OR to increase with increasing exposure and the high p-value (p=0.22) suggest that these apparent increases could be due to chance.

Table 25: Adjusted odds ratios for current asthma in survey respondents[1] as self-reported

	Odds Ratio	95% CI	p-value
Age*	1.00	(0.97-1.03)	0.90
Sex			
Female	1.00		
Male	0.77	(0.39-1.52)	0.45
Exposure tertile			
Low (0-400 hours)	1.00		
Moderate (401-5736 hours)	2.08	(0.90-4.82)	
High (5737+ hours)	1.74	(0.74-4.10)	0.22†
Exposure (hours)‡	1.001	(1.000-1.003)	0.33

[1] Analysis limited to respondents who also provided complete exposure data.
* The OR for age reflects the relative increase in risk per year of age.
† p-value for trend analysis.
‡ The OR for total exposure reflects the relative increase in risk per 100 hours of exposure.

Table 26 presents a summary of the characteristics of respondents who reported that they had been diagnosed with a respiratory condition other than asthma and respondents who did not report such a history. On average, survey respondents who had been diagnosed with a respiratory condition other than asthma were older than respondents who had never been diagnosed with a respiratory condition other than asthma (p=0.00). Respondents with a respiratory condition other than asthma had a much higher mean exposure time to phenol-based cleaners than respondents without a respiratory condition (p=0.00). Respondents with a respiratory condition were also more likely to be classified as having high exposure compared to respondents without a respiratory condition (p=0.00).

Table 26: Demographic and exposure characteristics of survey respondents[1] with and without other respiratory conditions

	Survey respondents with self-reported doctor diagnosed respiratory condition			Survey respondents without self-reported doctor diagnosed respiratory condition			
	Number	Percent	95% CI	Number	Percent	95% CI	p-value
Sex							
Male	24	42.9	(29.8 - 56.2)	166	41.9	(37.0 - 46.8)	0.89*
Female	32	57.1	(43.8 - 70.5)	230	58.1	(53.2 - 63.0)	
Exposure							
Low exposure (0-400 hours)	5	18.5	(2.9 - 34.2)	73	36.9	(30.1 - 43.6)	
Moderate exposure (401-5736 hours)	8	29.6	(11.2 - 48.0)	62	31.3	(24.8 - 37.8)	0.02†
High exposure (5737-75600 hours)	14	51.9	(31.7 - 72.0)	63	31.8	(25.3 - 38.4)	
	Number	Mean	95% CI	Number	Mean	95% CI	p-value
Age							
At time of survey (years)	56	60.2	(57.1 - 63.4)	396	53.6	(52.4 - 54.8)	0.00‡
Exposure							
Total exposure (hours)	27	16525.9	(8739.5 - 24312.2)	198	7295.4	(5439.1 - 9151.7)	0.00‡

1 Analysis limited to respondents who also provided complete exposure data.
* p-value obtained from chi-square test of independence.
† p-value obtained from chi-square test of trend.
‡ p-value obtained from independent sample t-test.

Table 27 presents the adjusted odds ratios for other respiratory conditions among survey respondents. Risk of other respiratory conditions appeared higher in the moderate and high exposure groups than in the low exposure group, and increased consistently across the three exposure categories. This pattern, together with the increased OR for total exposure indicates that exposure to phenol-based cleaners has probably increased the risk of these other respiratory conditions.

Table 27: Adjusted odds ratios for other respiratory conditions in survey respondents[1] as self-reported

	Odds Ratio	95% CI	p-value
Age*	1.03	(1.00-1.07)	0.09
Sex			
Female	1.00		
Male	1.01	(0.43-2.34)	0.99
Exposure tertile			
Low (0-400 hours)	1.00		
Moderate (401-5736 hours)	1.73	(0.53-5.60)	
High (5737+ hours)	2.75	(0.92-8.23)	0.06†
Exposure (hours)‡	1.003	(1.001-1.005)	0.01

[1] Analysis limited to respondents who also provided complete exposure data.
* The OR for age reflects the relative increase in risk per year of age.
† p-value for trend analysis.
‡ The OR for total exposure reflects the relative increase in risk per 100 hours of exposure.

Table 28 presents a summary of the characteristics of respondents who reported they had been diagnosed with a skin condition other than skin cancer and respondents who did not report such a diagnosis. There were no great differences between the two groups in any of the characteristics examined, although those with a history of skin conditions other than skin cancer did report a higher average total exposure than those without.

Table 28: Demographic and exposure characteristics of survey respondents[1] with and without skin condition

	Survey respondents with self-reported doctor diagnosed skin condition			Survey respondents without self-reported doctor diagnosed skin condition			
	Number	Percent	95% CI	Number	Percent	95% CI	p-value
Sex							
Male	45	43.3	(33.6 - 52.9)	144	40.6	(35.4 - 45.7)	0.62*
Female	59	56.7	(47.0 - 66.4)	211	59.4	(54.3 - 64.6)	
Exposure							
Low exposure (0-400 hours)	13	21.7	(10.9 - 32.4)	66	38.8	(31.4 - 46.2)	
Moderate exposure (401-5736 hours)	25	41.7	(28.8 - 54.5)	49	28.8	(21.9 - 35.7)	0.08†
High exposure (5737-75600 hours)	22	36.7	(24.1 - 49.2)	55	32.4	(25.2 - 39.5)	
	Number	Mean	95% CI	Number	Mean	95% CI	p-value
Age							
At time of survey (years)	104	55.3	(53.0 - 57.6)	355	54.4	(53.1 - 55.6)	0.49‡
Exposure							
Total exposure (hours)	60	11295.5	(7144.6 - 15446.4)	170	7387.5	(5279.6 - 9495.5)	0.07‡

[1] Analysis limited to respondents who also provided complete exposure data.
* p-value obtained from chi-square test of independence.
† p-value obtained from chi-square test of trend.
‡ p-value obtained from independent sample t-test.

Table 29 presents the adjusted odds ratios for a skin condition among survey respondents. After adjusting for age and sex, respondents who indicated they were moderately exposed to phenol-based cleaners were more than twice as likely to self-report a doctor-diagnosed skin condition compared to respondents who reported a low exposure. However, the odds ratio for those with high exposure was somewhat less than that in those with moderate exposure and the p-value was reasonably high (p for trend = 0.12). Thus while exposure to phenol-based cleaners may be associated with a higher risk of skin conditions other than skin cancer, this analysis does not establish this with certainty.

Table 29: Adjusted odds ratios for skin condition in survey respondents[1] as self-reported

	Odds Ratio	95% CI	p-value
Age*	1.01	(0.99-1.04)	0.41
Sex			
Female	1.00		
Male	1.13	(0.61-2.07)	0.71
Exposure tertile			
Low (0-400 hours)	1.00		
Moderate (401-5736 hours)	2.48	(1.15-5.38)	
High (5737+ hours)	1.92	(0.87-4.25)	0.12†
Exposure (hours)‡	1.002	(1.000-1.003)	0.11

[1] Analysis limited to respondents who also provided complete exposure data.
* The OR for age reflects the relative increase in risk per year of age.
† p-value for trend analysis.
‡ The OR for total exposure reflects the relative increase in risk per 100 hours of exposure.

Chapter 8   Results: Survey Responses and Validation

Validation of survey responses

Some of the information collected in the survey was also available through other administrative datasets including RPH Human Resource records and the WA Cancer Registry. Where possible, analysis was undertaken to determine the level of similarity between survey responses and other records in order to validate the accuracy of the survey responses. Table 30 presents the proportion of survey responses that matched with other records.

Table 30: Proportion of survey responses with matching information to other records

	% with same information
Date of birth	98.2
Sex	98.8
Cancer	88.9
Duration of employment	80.6*

*within 2 years

One in ten survey respondents reported cancer information that did not match with records held by the WACR. Of these, 87% reported having been diagnosed with a cancer but this could not be verified by the WACR. Potential reasons for this include the respondent being diagnosed in another State or country, being diagnosed prior to 1982 when cancer reporting became mandatory in WA, being diagnosed with a cancer or other condition not included in the scope of "cancer" used (such as the very common SCC or BCC of the skin), an unintentional error when answering the survey, or an error in linkage. A further 13% did not report having been diagnosed with cancer on the survey but were present on the WACR. This may be due to being diagnosed with a very specific type of cancer that the individual did not realise was cancer (in particular, people diagnosed with an in situ cancer may not be told that they have cancer), an error in linkage, or an unintentional error when answering the survey.

Comparison of survey respondents with total study cohort

Demographic and health characteristics were compared between survey respondents and the total study cohort who were still alive as at 30th June 2010 to see if there were any major differences in the profiles of the two groups. Comparative analysis was undertaken on only those people from the total study cohort who were still alive as only these people had the opportunity to complete the survey. Table 31 provides a comparison of the two groups.

Table 31: Comparison of survey respondents with total study cohort

	Survey respondents N = 494		Total study cohort N = 3248	
	%	95% CI	%	95% CI
Sex				
Male	41.3	(36.9 - 45.6)	45.7	(44.0 - 47.5)
Female	58.7	(54.3 - 63.1)	54.3	(52.5 - 56.0)
Cancer				
Identified by Cancer Registry	9.1	(6.6 - 11.7)	4.5	(3.8 - 5.2)
Age				
Mean (years)	54.9	(53.8 - 55.9)	51.0	(50.5 - 51.5)
Duration of employment				
Mean (years)	10.5	(9.7 - 11.3)	5.7	(5.5 - 6.0)
Current employment status				
Still work at RPH	34.3	(30.1 - 38.6)	24.3	(23.0 - 26.0)

On average, survey respondents were older than the total study cohort as at 30th June 2010. They had also worked at Royal Perth Hospital nearly twice as long and were more likely to still be working at RPH.

Survey respondents were twice as likely as the total study cohort to have been diagnosed with a cancer recorded by the Cancer Registry.

Survey comments

At the end of the survey respondents had the opportunity to provide further comments. Of the 494 survey respondents 51.2% (n=253) provided a comment.

In this report only general themes reported in the comments have been discussed to ensure individual confidentiality. However, all comments (de-identified) have been made available to RPH to ensure they are aware of any issues raised in the comments section of the survey.

Of the comments provided four main topics were identified. These were:
- Descriptions of current and past health conditions.
- Uncertainty over chemicals the staff member used during their employment.
- The level of information on the phenol-based cleaners that was provided to staff.
- Descriptions of exposure and issues with recollection of exposure duration.

The most common comments were around health conditions or effects. The most commonly mentioned health conditions or effects were skin ailments and respiratory problems. Some of these health issues were reported to have been short-term and only present whilst using the chemicals; others were reported to be long-term and still present when the chemicals were no longer used. Other health issues raised related to reproductive issues and cancer.

Comments on the information provided to staff on the safety and use of phenol-based cleaners could be categorised into two distinct groups. The first group included respondents who stated that they were aware of possible health effects from exposure to the cleaners and knew what protective equipment needed to be worn. The second group contained comments and statements that no information was provided to staff and when concerns were initially raised, management did not act on the concerns of staff.

Comments on exposure also fell into two groups: how people were exposed and the difficulties in calculating exposure. For how people were exposed, a common issue raised was that cleaners were not the only staff members who used the phenol-based cleaning products, with catering and nursing staff also using the cleaners. In addition, the areas where the cleaners were used was vast, with infectious wards being the most commonly mentioned, but also kitchens, patient rehabilitation areas and other hospital wards and annexes.

The comments regarding exposure also demonstrated that some respondents had difficulty determining their exact exposure as they may not have worked with the phenol-based cleaners for some time. Some respondents indicated that they felt uncertain in accurately estimating their exposure in days.

Chapter 9   Discussion

Cancer is relatively common with 10,408 new cases registered in WA during 2008 and the estimated lifetime risk of cancer to age 75 is 1 in 3 for males and 1 in 4 for females (Threlfall and Thompson, 2010). There are many different types of cancer, each with known or suspected risk factors associated with its development that may be common with other types or unique to the specific cancer. The development of cancers associated with exposure to risk factors may take many years, even decades, before diagnosis, which makes it difficult to identify the cause of that cancer.

In this cancer cluster investigation, the pattern of cancer incidence and death among PSS employees was compared to that in the Perth Metropolitan population.

Cancer incidence and mortality

A total of 232 primary cancers were diagnosed in the study cohort during the study period. The types of cancer diagnosed among the cohort were similar to those found in the general population and there was no single or rare cancer type occurring among the cohort in high numbers, with the possible exception of cancers of unknown primary site (depending on whether they are viewed as being a special type of cancer or simply a mixture of otherwise reasonably common types of cancer that are hard to diagnose when they present at an advanced stage).

The definition of cancer used in this study was broader than usual, including *in situ* and benign and uncertain behaviour CNS neoplasms identified in both the PSS cohort and the Perth Metropolitan population. Calculation of standardised incidence ratios indicated that the actual number of cancers observed was not appreciably different from the number of cancers expected, when compared to the Perth Metropolitan population. When the analysis was repeated including only those cancers typically reported in public reports on cancer incidence, the findings remained similar.

When considering individual cancer types, there was little or no evidence of an excess number in the PSS cohort compared to the Perth Metropolitan population. The only exception was cancers of unknown primary site. Cancers of unknown primary site typically occur in older people, late diagnoses, and in persons with a history of smoking (Tracey et al 2008). Further analysis of this cancer type indicated that an increased duration of employment and the longer the time since first employment were both associated with an increased risk of cancers of unknown primary site, although the small numbers in the analysis generated considerable uncertainty around these estimates.

When considering the health outcome of death, there were 184 individuals in total who passed away during the study period. The standardised mortality ratios for all causes indicated that there was an excess of observed deaths to the number of deaths expected, when compared to the Perth Metropolitan population. In particular, the analysis of deaths in males indicated that there probably was an increase in risk. The analysis of causes of death indicated that male deaths were elevated for both cancer and non-cancer causes, in particular the latter. However, there was no particular cause of death that occurred in unexpected numbers and no corresponding increase in women, who were also exposed to phenol-based cleaners, with analysis suggesting that females had on average a longer exposure duration than males. Thus it seems unlikely that the excess male deaths could be explained by exposure to a specific agent such as phenol-based cleaners. Further

analysis suggests that longer duration of employment was associated with an increased risk of cancer deaths and, in addition, a longer time since first employment was associated with non-cancer deaths in this cohort. As the study covers a long period of time it is possible that important health characteristics of this group of workers have changed over time and could contribute to these observed associations. Over the study period the workplace policies of RPH have also changed, for example the introduction of a smoke free policy. The smoke free policy would probably influence smoking behaviour of existing and new employees at the site and might influence comparisons in risk of cancer and death by duration of employment and by time since first employment.

There are several important considerations to be taken into account when considering whether the results for overall cancer incidence or mortality, as presented, reflect the true position with respect to the health outcomes of PSS employees exposed to phenol-based cleaners when compared with those of other people in Perth.

There were 18.5% and 44.0% of cancer cases among PSS employees diagnosed within five years and ten years, respectively, of commencing employment. Given that the latency period between most exposures and cancer is usually at least 5-10 years, it is unlikely that exposure to phenol-based cleaners would increase the risk of cancer within this time period, although scientific uncertainty regarding the toxicology of phenol-based cleaners cannot exclude this possibility entirely. When the risk of cancer was assessed excluding these cases, the estimates were similar to the analysis without taking latency into account. Similar findings were also found for deaths.

The study sought to include all staff with a known direct use of phenol-based cleaners. The decision to only include employees in PSS positions was made in order to target those workers *most* at risk of any ill-effects that could be associated with exposure to phenol-based cleaners. Full-time, part-time and casual positions were all included in the analysis to provide a full spectrum of exposure profiles. The appropriate identification of RPH staff as PSS with high exposure to phenol-based cleaners depends upon the accurate recording of staff details and the use of correct occupation categories to define the group.

It is also possible that the Human Resource records for employees are inaccurate and have led to employees incorrectly being included or excluded, or their employment history is incorrect. While demographic data was cross-checked with other administrative datasets where possible, we were unable to verify the accuracy and reliability of employment data provided by RPH Human Resources and there is the potential for measurement error for variables including employment duration, and start and finish dates of employment.

After considering the consistency between Human Resource records and self-reported employment history in the questionnaire, a sensitivity analysis was conducted to determine the effect of varying the start date for each employee. A margin of two years was considered appropriate for the sensitivity analysis as over 50% had an exact match on start date and over 70% matched within the two year time-frame. The resulting SIRs indicated that this would not alter the findings for cancer incidence or mortality between the PSS cohort and the Perth Metropolitan population.

The Perth Metropolitan population was selected as a suitable comparison due to the location of RPH and its employees within Metropolitan boundaries. Human Resource records confirmed that greater than 98% of staff resided within Metropolitan postcodes.

The definition and population structure and size of the Perth Metropolitan area was the same as that used for the WA Cancer Registry reporting.

Information on other potential risk factors for cancers and death, such as sun exposure, cigarette smoking, alcohol consumption and diet was not available for either the PSS cohort or the comparison population data. Therefore, it was assumed that the PSS cohort had a similar health risk profile as the Perth Metropolitan profile. However, if the pattern of risk factors among PSS employees is significantly different from those in the wider community, this may mask or contribute to an increase in risk.

In Western Australia, notification of cancer and death are required by law and both the WACR and the WADR collect information from a variety of sources to assist in maintaining the completeness and accuracy of the databases. As a result, they represented the best-possible source of data for this study. Cancer diagnoses were only included if they occurred *after* the individual started work at RPH to ensure that an exposure period existed and could be measured. The study period was defined as 1983 until 2008 to correspond with known use of cleaners and the availability of reliable health records.

The WA Data Linkage System was able to match around 95% of employees identified through RPH records. The high level of linkage provides a considerable degree of confidence that the vast majority of eligible cancer diagnoses and deaths were captured in the study analyses.

While every effort was made to ensure that all relevant cancer diagnoses and deaths within the study period were captured and reported, it is possible that a diagnosis or death overseas or in another State was not ascertained. Linkage to the National Death Index accounted for deaths occurring in other States by identifying cases lost to follow-up and including these in the analysis of deaths. A sensitivity analysis was conducted assuming the same percentage of cancers were lost to follow-up (5.7%) also showed no evidence of an excess of cancer incidence among the PSS cohort.

A significant strength of the linked data analysis of the entire cohort was the large size of the cohort, and the availability of data going back 25 years, allowing for an extensive follow-up period. The sample size was sufficiently large to provide reliable and accurate estimates, and had the statistical power to detect effects in the situation being investigated.

Other medical conditions

Toxicology evidence suggested that chemical ingredients found in the three phenol-based cleaning agents under investigation could have dermal and inhalation effects. Analysis of the survey data demonstrated that the most frequently self-reported health condition amongst respondents was ever being diagnosed with asthma and skin irritations. Survey respondents were more likely to report they had been diagnosed with asthma or a respiratory condition than other people in the general Metropolitan population in WA (no comparison data was available for skin irritations).

In addition, analysis of survey respondents still working at RPH indicated that they were more likely to report having skin irritations or a cough/sore throat most or every day in the past four weeks when compared to the frequency of these symptoms in the general population.

The ability to use established survey questions that had been previously tested for validity and reliability constituted a major strength of the survey, and allowed for a genuine comparison to be made with the general Perth Metropolitan population.

However, it is important to note that survey respondents may not be representative of the total study cohort, with only 20% of study participants choosing to take part in the survey. It is possible that individuals who have suffered health problems were more likely to participate in the survey, a selection bias that would affect the results of comparisons with the general Perth population. Analysis comparing survey respondents and the total study cohort indicated that there were substantial differences in demographic and employment characteristics between the two groups and survey respondents were also more likely to have been diagnosed with cancer when compared to the total study cohort.

In addition, the study was particularly limited in its ability to evaluate recent health symptom frequency. Only current employees could be assessed as the questionnaire asked for health symptoms experienced in the four weeks prior to the survey. Furthermore, comparative estimates for the frequency of these symptoms in the general Perth Metropolitan population could only be calculated for 2003. While significant variation in symptom frequency is not assumed to occur over time, more recent data would ideally have been used for comparative purposes.

Exposure

Given that a potential source of exposure had been identified, a comprehensive toxicological assessment was also undertaken. The toxicological assessment demonstrated the limited evidence in the scientific literature on the potential for phenol and polychlorinated phenolic chemicals to cause cancer in humans. The lack of robust scientific toxicology evidence was one of the justifications for this investigation into the possible carcinogenicity of phenol-based cleaning agents used at RPH.

There are many factors that affect a person's reaction to the chemicals in the cleaning agents apart from the concentration and form of chemical. These include existing health conditions, pattern of use and duration of exposure to the chemicals and the use of personal protection equipment.

As a result, an important intention of the survey was to capture more detailed information on patterns of use and duration of exposure for individuals for further investigation. Analysis on a sub-sample of survey respondents who provided detailed exposure information and gave permission to have their data linked found little evidence to suggest there was an association between total exposure (in hours) to phenol-based cleaners and incidence of cancer.

No relationship was found between exposure and current asthma as reported in the survey. However, respondents who reported a moderate or high exposure to phenol-based cleaners were more likely to report a diagnosis of other respiratory conditions, and this relationship increased consistently with exposure. Furthermore, respondents who reported moderate exposure to phenol-based cleaners were more than twice as likely to report having been diagnosed with a skin condition, although there was no association for respondents who reported high exposure. This pattern of association between exposure

level and risk of skin conditions suggests that there may be other factors contributing to the association that were not considered when modelling the relationship.

Interpretation of the results of the analysis of level of exposure to phenol-based cleaners and risk of cancer or other health conditions must take into account limitations in the data. Assessment of exposure was based on self-reporting, which is highly vulnerable to recall bias. Respondents who provided exposure information had worked at RPH for longer and were also more likely to still be working at RPH. As a result, their recall of exposure is likely to be more comprehensive than respondents who had stopped working at RPH some years ago, or who only worked at RPH for a short time period, a supposition that is supported by the comments of survey respondents.

The investigation into health conditions and exposure was restricted by the relatively high level (~50%) of incomplete answers to exposure questions and the subsequent small sample available to analyse. The small sample size limited the power of the calculations to detect small but significant increases in risk.

Therefore, while the intent of the survey was to provide more detail on exposure and health in order to more thoroughly investigate a potential association; this was hampered by several methodological factors, including the potential recall bias in self-reporting of exposure and the low response rate. Most importantly, selection bias is likely to have affected results, with analysis showing that survey respondents were considerably different to the total study cohort with regard to demographic and employment characteristics, as well as being more likely to have been diagnosed with cancer. For this reason, the conclusions of the study became more reliant on the linked data analysis of the entire cohort.

Overall, the rate of cancers and cancer deaths observed among PSS employees at Royal Perth Hospital from 1983 to 2008 were similar to those among the general population, although an excess of cancers of unknown primary site and increased cancer deaths with longer duration of employment were identified among PSS employees. However, there was no evidence to indicate that working with phenol-based cleaners, in particular, increased a person's chances of being diagnosed with cancer or cancer death.

Chapter 10   Conclusions

This report presents the results of a cancer cluster investigation into the use of phenol-based cleaners at RPH to determine if there is any statistical evidence of a cancer cluster among past and present staff. The investigation included a toxicological assessment, occupational cohort analysis and a survey of exposure and self-reported health outcomes.

The investigation found no clear or consistent evidence to suggest a cancer cluster exists. The only cancer type that occurred in higher numbers than would be expected was cancers of unknown primary site. The study did find a slightly elevated risk of cancer death among PSS employees with a longer duration of employment. However, given a similar increased risk for deaths from causes other than cancer it seems unlikely that exposure to phenol-based cleaners contributed to these increased risks.

The investigation also found evidence of a relationship between respiratory conditions and the amount of time staff had been exposed to cleaners.

Therefore, in relation to the primary purpose of this investigation, there was little evidence to suggest that working with phenol-based cleaners increased the risk of cancer.

Chapter 11   References

Australian Institute of Health and Welfare (2008). Nursing and midwifery labour force 2005. National health labour force series no. 39. Cat. No. HWL 40. Canberra: AIHW.

Australian Institute of Health and Welfare (2010). Australia's health 2010. Australia's health series no. 12. Cat. no. AUS 122. Canberra: AIHW.

Breslow NE, & Day NE (1987). Statistical Methods in Cancer Research, Volume II – The design and analysis of cohort studies, Lyon: International Agency for Research on Cancer

Cartensen B (2004). Lexis macro for splitting person-time in sas. Updated by Paul Dickman. Available from: http://staff.pubhealth.ku.dk/~bxc/Lexis/. Access Date: 28 September 2010.

Driscoll T, Foster G & Driscoll F (2008). Investigation of a reported cluster of cancer cases at the National Gallery of Australia. Final Report to the National Gallery. ELMATOM Pty Ltd.

Epidemiology Branch (2003). Analysis of Health Status of former Kimberley APB Workers: Report to the Expert Medical Panel, Perth: Western Australian Department of Health.

Holman CD, Bass AJ, Rouse IL, Hobbs MS (1999). Population-based linkage of health records in Western Australia: development of a health services research linked database. Australian and New Zealand Journal of Public Health. Vol. 23 pp. 453-9.

Jensen OM, Parkin DM, MacLennan R, Muir CS, Skeet RG (1991). Cancer Registration: Principles and methods. IARC Scientific Publication No. 95, Lyon: International Agnecy for Research on Cancer.

Joyce S, & Daly A, 2010. Health and Wellbeing of Adults in Western Australia 2009, Overview of Results. Department of Health, Western Australia.

Korn EL, Graubard BI, Midthune D (1997). Time-to-event analysis of longitudinal follow-up of a survey: choice of the time scale. American Journal of Epidemiology. Vol. 145 No. 1 pp. 72-80.

IARC (1999a). Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Vol. 71, Lyon: International Agency for Research on Cancer.

IARC (1999b), Some Chemicals that cause Tumours of the Kidney or Urinary Bladder in Rodents and Some other Substances, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Vol. 73, Lyon: International Agency for Research on Cancer.

IPCS (1994). o-Phenylphenol, CAS No. 90-43-7, Geneva: International Programme on Chemical Safety.

Centre for Disease Control (1990). Guidelines for investigating clusters of health events. MMWR Recommendations and Reports 39;1-16 Atlanta: CDC

Ministry of Health NZ (1997). Investigating Clusters of Non-Communicable Disease. Guidelines for Public Health Service. Wellington: Ministry of Health

Monash Centre for Occupational and Environmental Health (2009). Final Report on Queensland Fire Fighters' Cancer Incidence Study. Monash University.

National Cancer Institute (2006). Cancer Clusters, National Cancer Institute Fact Sheet. Bethesda: US National Cancer Institutes of Health. Available from: http://www.cancer.gov/cancertopics/factsheet/Risk/clusters. Access Date: 13 May 2010.

National Health and Medical Research Council (2008). NHMRC Cancer Cluster Workshop information paper: 'The investigation of reported cancer clusters: briefing paper'. Canberra: National Health and Medical Research Council.

Orion Laboratories (2006). Material Safety Data Sheet: Prephen Disinfectant (Concentrate), Balcatta: Orion Laboratories Pty Ltd.

Public Health Intelligence Directorate (2008). Busselton Hospital workforce cancer analysis. Perth: Western Australian Department of Health.

Queensland Heath (2009). Queensland Health Guidelines: Assessment of clusters of non-communicable disease 2009. Brisbane: Queensland Health

Sitas F & O'Connell D (2009). ABC Women's Health Study. Sydney: The Cancer Council NSW

Sorahan T, Kinlen LJ, Doll R (2005). Cancer risks in a historical UK cohort of benzene exposed workers. Occupational and Environmental Medicine. Vol 62:231-236.

Threlfall TJ, Thompson JR (2010). Cancer incidence and mortality in Western Australia, 2008. Statistical Series Number 87. Perth: Western Australian Department of Health.

Tracey EA, Glass P, Rodeer D, Currow D, Jelfs P, Bishop J (2008). Unknown Primary Cancer in New South Wales. Sydney: Cancer Institute NSW

WA Cancer Registry (2010). Cancer Incidence 2004-2008 by statistical local area (SLA), Perth: Western Australian Department of Health.
Available at: http://www.heakth.wa.gov.au/wacr/dcos/SLA0408.xls. Access Date: 2 February 2010.

Whiteley Medical (2007). Material Safety Data Sheet – Phensol Issue No. 11, North Sydney: Whiteley Corporation Pty Ltd.

Chapter 12   Appendices

Appendix 1: Full Toxicology Report

Toxicology Comments on Ingredients of Cleaning Agents

Ref: M.Goetzmann 93884919
January 2010

Purpose: The Epidemiology Branch is conducting an investigation into a potential cancer cluster in Royal Perth Hospital (RPH). Cleaning products containing phenol have been identified as possible causal agents for both cancer and other health conditions.

RPH staff has asked *if ingredients other than phenol are potentially carcinogenic.*

Toxicology has been asked to review the MSDS' of cleaning products routinely used in the 1980's and identify & provide information on 'other' toxic ingredients.

Toxicology information on each ingredient listed in each of the supplied MSDS' follows for completeness.

The following should be considered when using the information provided.

1) **It is not known if the formulations (ingredients and %) of the products used twenty to thirty years ago, when the exposure is alleged to have taken place, is the same as the current formulations.**
2) **The pattern of exposure (frequency, duration) the concentration of the products and how they were used is unknown. Type of adverse health effects will relate to exposure patterns and pathway (inhalation, dermal or ingestion) of exposure. Ingredients listed are found in many personal & commercial products hence pattern of use information in relation to these products is important.**
3) **Individuals with underlying health conditions may be sensitive at lower concentrations. Individuals sensitive to phenols may have an acute reaction at low concentrations.**
4) **Exposure information provided relates to exposure to individual ingredients. If used in combination health effects could be additive.**
5) **Where occupational exposure levels are given – the levels are intended to protect individuals wearing the required personal protection equipment (PPE).**
6) **PPE is indicated for all the products – PPE includes eye shield, chemical resistant gloves, protective clothing and respiratory when using the products in a space that is enclosed or poorly ventilated.**
7) **Not all ingredients are identified / specified on the MSDs. Where the chemical 'family' has been identified, toxicology information is provided for the 'family' group.**
8) **Acute health effects are similar for the majority of phenolic compounds. The nature of the reaction to the odour (unpleasant smell, irritation, cough) often limits exposure.**

Ingredients classified as phenolics
o-phenyl phenol
o-benzyl-p-chlorophenol
substituted phenol compounds
p-chloro-m-cresol
xylenols
2,4,6-trichlorophenol

Other ingredients
sodium hydroxide
ethanol

Unidentified / Unspecified Ingredients
Phensol contains unidentified *ingredients deemed not to be hazardous*
Prephen 1-100 contains an unidentified *surfactant* & unspecified *substituted phenols*
Medol contains unspecified xylenols – group of 6 isomers
Sodium alkyl sulphate (anionic surfactants) – group of 6 in this family (octyl, nonyl, decyl, undecyl, dodecyl, tetradecyl) cas no. supplied is for group.

Table A1.1: Health effects of chemicals in phenol-based cleaners

Chemical (Cas No.)	Exposure limits	Health Effects - Symptoms		
		Acute	Chronic - non-cancer	Chronic - cancer
o-phenyl phenol (90-43-7)	•Limits N/A •OPP and its sodium salt (SOPP) are broad spectrum fungicides and antibacterials in many products and many opportunities for exposure.	• Burning/stinging eyes, nose throat • Dermal – burning pain, • Inhalation - headache, giddiness, nervousness, blurred vision, weakness, nausea, cramps, diarrhoea, and discomfort in the chest. Signs include sweating, miosis, tearing, salivation and other excessive respiratory tract secretions, vomiting, cyanosis, papilledema, uncontrollable muscle twitches followed by muscular weakness, • Severe case - convulsions, coma, loss of reflexes, and loss of sphincter control (reversible is treated quickly).	• eczema/dermatitis dermal symptoms • kidney lesions following long term high level exposure • twitching, muscle tremors, neurological impairment;	Human data lacking
o-benzyl-p-chlorophenol (chlorophene) (120-32-1)	• Chlorophene and dichlorophene commonly used preservative in cosmetics. • Chlorophene max allowable conc in cosmetics 0.2% in EU* • dichlorophene – max allowable conc in cosmetics 0.5%	• Ingestion – burning pain, mouth, oesophagus, stomach • Burning/stinging eyes, nose throat • Inhalation - headache, giddiness, nervousness, blurred vision, weakness, nausea, cramps, diarrhoea, and discomfort in the chest. Signs include sweating, miosis, tearing, salivation and other excessive respiratory tract secretions, vomiting, cyanosis, papilledema, uncontrollable muscle twitches followed by muscular weakness, • Severe case - convulsions, coma, loss of reflexes, and loss of sphincter control (reversible is treated quickly). • Dermal – 10% solution – primary skin irritant	• PCT, TV (see adjacent acute entry) • Mild eczema/dermatitis dermal symptoms, with prolonged contact with solutions of 0.03%. • Implicated in 2 epidemics of neonatal hyperbilirubinemia in 2 hospitals when exposed to disinfectant containing 3.5% chlorophene combined with OPP (this combination is found in phensol). •Twitching, muscle tremors, neurological impairment;	Human data lacking

	in EU*	causing burning pain, numbness, brown staining, known to cause Porhyria cutanea tarda (PCT) and toxic vitiligo (TV), eczema/dermatitis like symptoms.		
p-chloro-m-cresol (59-50-7)	•Reported lethal dose in humans 50-500mg/kg • Dilutions <1% not shown to cause skin or eye irritation. •vascular dermatitis at 1.5% •OHSA – occupational exposure 22mg/m^3 8-h	•Skin irritant – >1% eczema, vesicular dermatitis, urticaria •Eye irritant >1% , oedema of eye lids, erythema •Inhalation – burning pain of moth nose & throat, Muscle weakness and transient peripheral neurtoxitcity reported in sensitive individuals. • Inhalation – cough, pallor, sweating, weakness, headache, dizziness, shallow breathing, hypotension, shock, death.	•Persistent skin irritation after prolonged or repetitive contact with skin •Isomers of creosol (p & m) are known to be highly corrosive. •600 µg/m^3 m-cresol associated with Neurotoxicity.	Not likely to cause cancer
2,4,6-trichlorophenol (88-06-2)	Common preservative in cosmetics, prescription medications and commercial products – wood & leather finishing products	•Eyes- corneal injury from chemical burns •Skin – chemical burns likely on contact •Muscle weakness, porphyria in sensitive individuals •Muscle weakness and transient peripheral, neurtoxitcity reported in sensitive individuals. • Inhalation – burning pain of mouth nose & throat, transient reduced lung function, cough, pallor, sweating, weakness, headache, dizziness, shallow breathing, hypotension, shock, death. .	•Pulmonary fibrosis cannot be ruled out •Chloracne •Chronic cough, bronchitis •Twitching, muscle tremors, neurological impairment;	In occupational settings – occupational exposure hospitals/tanneries associated with -•Non-Hodgkin Lymphoma •Soft tissue sarcomas
Xylenols (dimethylphenols) 6 isomers with	Occur naturally, present in some foods.	•Skin irritants •Symptoms common to phenol compounds - •Progressive symptoms of headache, dizziness,	•dermatitis. •twitching, muscle tremors, neurological impairment;	N/A

different cas nos. As a group identified by 1300-71-6.	Manufactured xylenols are present in many commercial products.	ringing in the ears, nausea, vomiting, muscular twitching, mental confusion, loss of consciousness and possible death from lethal paralysis of the central nervous system.	•Isomers of xylenol are known to be highly corrosive	
substituted phenol compounds (unidentified)	See note (4) below table 2	In general - typical phenol-exposure-type symptoms in sensitive an overexposed individuals. Specific symptoms depends on phenol compound	•twitching, muscle tremors, neurological impairment;	Human data lacking
sodium hydroxide (1310-73-2)	•Max upper limit 2mg/m^3 occupational exposure level (8-h /day / 40-h working week) •8µg/m^3 reference exposure level (OEHHA) for protection public against mild symptoms •Mild to moderate respiratory irritation is experienced at a concentration	•Irritates all tissue types. •skin – burning pain, ulceration •mucous membranes (nose, mouth, eyes) burning pain, ulceration •inhaling dust or mist may cause cough, dyspnea (difficulty breathing - breathlessness)	•Dermatitis, chemical-induced asthma (ATSDR) •dyspnea, ulceration of nasal passages (OEHHA)	See note (3) below table 2.

	of 0.5 mg/m3 for 1-h Severe effects at 5mg/m^3 for 1-h (AIHA, 2002;OEHHA, 1999). •The FDA allows it as a food additive in levels not to exceed 1%.			
ethanol (64-17-5)	1000ppm (1885 mg/m^3) 8-h ACGIH, OSHA	Inhalation: At these levels sensitive individuals report headache after 33 mins exposure. Higher concentrations (≥5000ppm)cause, dizziness, fatigue, cough, tearing of eyes, ataxia		•GI system cancers associated with alcoholism. •No cancers associated with inhalation.
sodium alkyl sulphate – 6 members of family (72906-11-7 as a group)	•Sodium dodecyl (lauryl) sulphate (151-21-3) is common in cleaning products. •Concentrations should not exceed 1% for products	Skin & eye irritation has been documented at concentrations ranging 0.20 – 26% .	Unlikely to be a skin sensitiser based on human data and product use and safety complaints register.	No data to indicate it is carcinogenic

	designed to be in prolonged contact with the skin.			

Table A1.2: Cancer classification related to chemicals in phenol-based cleaners

Chemical (Cas No.)	Exposure	Cancer Classification [+]			comments
		IARC group	US EPA group	other	
o-phenyl phenol (OPP) (90-43-7)	OPP and its sodium salt (SOPP) are broad spectrum fungicides and antibacterials in many products and many opportunities for exposure.	3*	• likely to be carcinogenic to humans at high doses of (200mg/kg/day), • unlikely at low doses**	calOEHHA – classify OPP as carcinogenic	*Bladder tumours in mice & rats with OPP in diet. No human carcinogenicity data available In humans rapid excretion indicated, unlikely to accumulate. **previously classified B2 – possible carcinogen in humans.
o-benzyl-p-chlorophenol (chlorophene) (120-32-1)	• Chlorophene and dichlorophene commonly used preservative in cosmetics. • Chlorophene max allowable conc in cosmetics 0.2% in EU* • dichlorophene – max allowable conc in cosmetics 0.5% in EU*	Not classified **			• Carcinomas in renal system in mice (ref NTP) ** Chlorophene is not classified – there is evidence suggesting lack of carcinogenicity for dichlorophenol but overall exposure to combinations of polychlorophenols or their sodium salts is possibly carcinogenic to humans (2B) • evidence of tumour promotion in rodents. *risk of chronic health effects uncertain.
p-chloro-m-cresol (59-50-7)	•Widely used as preservative in many common products including some prescription medications. •Dilutions <1% not shown to cause skin or eye irritation. 1.5% shown to cause	Not listed as carcinogenic			

	vesicular dermatitis. OHSA – occupational exposure 22mg/m^3 8-h				
2,4,6-trichlorophenol (88-06-2)	Common preservative in cosmetics, prescription medications and commercial products – wood & leather finishing products	2B	2B	NTP reasonable suspicion of being a human carcinogen	In occupational settings – hospitals/tanneries associated with •Non-Hodgkin lymphoma •Soft tissue sarcomas
Xylenols (dimethylphenols) 6 isomers with different cas nos. As a group identified by 1300-71-6.	•Occur naturally, present in some foods. Manufactured xylenols are present in many commercial products.	Not classified			
substituted phenol compounds (unidentified)	See note (4) below table 2	3*			Classified as phenols. Substituted phenols have Ni, Br, OH, Cl located in O, P or M locations on the ring – O>P>M in pH. Individual mono-chlorophenols have not been classified.
sodium hydroxide	•Max upper limit 2mg/m^3 occupational exposure level (8-h /day / 40-h working week) (OSHA) •8µg/m^3 reference exposure level	See note (3) below table.			

	(OEHHA) for protection public against mild symptoms •Mild to moderate respiratory irritation is experienced at a concentration of 0.5 mg/m3 (AIHA, 2002;OEHHA, 1999). •The FDA allows it as a food additive in levels not to exceed 1%.				
ethanol	1000ppm (1885 mg/m^3) 8-h ACGIH, OSHA	1 (oral only)		Inhalation unlikely to cause cancer	
sodium alkyl sulphate – 6 members of family (72906-11-7 as a group)	Extensive opportunity for exposure – many personal care products, cosmetics, soaps, detergents, disinfectants.				No data to indicate it is carcinogenic

+ Classification of Carcinogenicity

    IARC –   **Group 1** – carcinogenic to humans.
         Group 2A – probably carcinogenic to humans
          Group 2B – possibly carcinogenic to humans
          Group 3 – not classifiable as carcinogenic to humans (due to lack of data)
         Group 4 – probably not carcinogenic to humans.
    US EPA - **Group A -** carcinogenic to humans
         Group B (1 & 2) - probably carcinogenic to humans

Group C - possibly carcinogenic to humans
Group D - not classifiable as carcinogenic to humans (due to lack of data)
Group E - probably not carcinogenic to humans

Notes

1. Chlorophenols can be converted to their sodium salt in the presence of sodium carbonate – sodium salts are generally of equal or greater toxicity relative to the parent compound. Chlorophenol disinfectants should not be mixed with cleaning products containing sodium carbonate.

2. polychlorophenols toxicity is enhanced in the presence of other polychlorophenols – products should not be mixed.

3. Sodium hydroxide - Reports of cancer of the oesophagus 15 to 40 years after the formation of narrow points caused by corrosion induced by sodium hydroxide by chronic exposure to vapours. However, these cancers were most likely the result of tissue destruction and scar formation rather than a direct carcinogenic action of sodium hydroxide itself. (ATSDR)

4. treat as Phenol - OEHHA - Inhalation reference exposure level is 200 µg/m3 (50 ppb), Critical effect(s) twitching, muscle tremors, neurological impairment; elevated serum liver enzymes in rats, Hazard index target(s) Alimentary system; circulatory system; kidney; nervous system. Phenol is classified Group 3 carcinogen by IARC and Group D by US EPA. The assumption is that substitutions with Cl⁻ are listed separately as chlorophenols or polychlorophenols.

Table A1.3: Regulatory information for phenol-based cleaners

Product	Poisons schedule	comments
Medol	Assessment not found *	UK classification - Harmful
Prephen 1-100	Not classified	Due to – Low toxicity due to •Use pattern restricts exposure, packing restricts exposure or industry use only.
Phensol	Schedule 5 poison	Use with Caution – low potential for causing harm if used according to safety directions. (includes wearing of PPE)

•All individual ingredients (where identified) are listed in the Australian Inventory of Chemical Substances. (AICS)

•*Products containing phenolic compounds > 3% usually classified schedule 5 except for therapeutic use, then schedule 2. Some compounds may appear under schedule 6 (poison - Substances with a moderate potential for causing harm, the extent of which can be reduced through the use of distinctive packaging with strong warnings and safety directions on the label).

•Sodium hydroxide classified under schedule 6 for > 5% and schedule 5 for < 5%.

•MSDs carry the appropriate safety phrases in relation to the ingredients.

References

ATSDR – Agency for Toxic Substances and Disease Registry – Atlanta, USA
US EPA – United States Environmental Protection Agency
SUSDP - The Standard for the Uniform Scheduling of Drugs & Poisons – TGA, Australia
NTP – National Toxicology Program - USA
IARC – International Agency for Research into Cancer - France
DEFRA – Department of Environment, Food & Rural Affairs
Toxnet - USA

Appendix 2: Exposure Survey Questions

Government of Western Australia
Department of Health
South Metropolitan Area Health Service
Royal Perth Hospital

Epidemiological investigation of the use of phenol-based cleaning agents

At Royal Perth Hospital

PURPOSE: The Epidemiology Branch at the Department of Health is undertaking an independent analysis to respond to concerns that exposure to phenol-based cleaning agents may affect health.

This questionnaire is going to ask questions of staff who used phenol-based cleaning agents while working at RPH. We require information about how often you used the cleaners or were in areas where they were used, how long you used them for when you did use them and for how many years you worked with phenol-based cleaners, or were in areas where they were used. We require some information about your health and also your consent to link the information provided in the questionnaire with your health records in the Department's health data collections through data linkage.

The study will combine the information from this questionnaire with your health records to investigate whether there are any links between working with phenol-based cleaners and health effects, both short and long term.

PRIVACY STATEMENT: Your participation in this study is *entirely voluntary*. However we hope that you do participate as your information will strengthen the study. The information you provide will be kept strictly confidential. Your name will not be attached to the questionnaire and if you have consented to your information being linked to your health records, this will be done by the Epidemiology Branch using the study ID to further protect your privacy. All analysis will be conducted on de-identified records by the Epidemiology Branch and all reporting will be at a group level. Information on individuals will not be passed back to Royal Perth Hospital management.

If you would like further information or if you have any questions or require help with language to complete this questionnaire, please ring 08 92242350. **SENDING THE QUESTIONNAIRE BACK**: When you have answered all the questions and completed the consent form, please send the questionnaire in the attached reply paid envelope: If you have lost the envelope, then kindly send it back to:

> Epidemiology Branch (Attention Peter Somerford)
> Department of Health, Western Australia
> 189 Royal Street,
> East Perth. WA. 6004.

Please answer the questions below. For each question, tick the box next to the answer (or answers where more than one is needed). When possible, please provide accurate and complete date information but if you are uncertain (e.g. date of first employment at RPH), please provide at least the year.

Q1. Sex: 0 ☐ Female   1 ☐ Male

Q2. Date of Birth: _____/ _____/ _____
                         day   month   year

Q3. In what year did you start working at RPH?

_____

Q4. What positions have held at RPH? You may tick more than one option.

a. Cleaner   0 ☐ No   1 ☐ Yes

b. PCA   0 ☐ No   1 ☐ Yes

c. Orderly   0 ☐ No   1 ☐ Yes

d. Nurse   0 ☐ No   1 ☐ Yes

e. Other   0 ☐ No   1 ☐ Yes *(Go to Q4a)*

4a) Other position(s) held at RPH

_____

_____

Q5. Did/do you work at:

Royal Perth Hospital on Wellington Street   0 ☐ No   1 ☐ Yes

Royal Perth Hospital at Shenton Park   0 ☐ No   1 ☐ Yes

Q6. How many hours a week did you/do you typically work at RPH including the time you worked at both campuses if you worked in more than one site? _____Hours

Q7. Do you still work at RPH? 0 ☐ No 1 ☐ Yes (*Go to Q11*)

Q8. If you no longer work at RPH, in what year did you finish? _____

Q9. How long were you employed by RPH in total? _____ Years _____Months____Weeks

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This section is about what work you did, where you worked and your exposure to cleaning agents containing phenols such as Medol, Prephen, or Phensol

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Q10. Which type of work did/do you do most *(tick all applicable)*

   a. Patient Support Services Department Cleaning services   0 ☐ No 1 ☐ Yes

   b. Patient Support Services Department Housekeeping services   0 ☐ No 1 ☐ Yes

   c. Patient Support Services Department Orderly services   0 ☐ No 1 ☐ Yes

   d. Patient Support Services Department unspecified   0 ☐ No 1 ☐ Yes

   e. Other (*If yes, go to Q 10a*)   0 ☐ No 1 ☐ Yes

10a. If you worked in a department(s) other than the Patient Support Services Department, please list them here

_____

_____

Q11. While at RPH, did you ever work for a contract cleaning company?

   0 ☐ No   1 ☐ Yes

Q12. Did you ever work in MRSA rooms?

0 ☐ No (*Go to Q 14*)   1 ☐ Yes (*Go to Q 13a*)

Q 13a. When working in MRSA rooms did/do you:

   i. Use phenol-based cleaners   0 ☐ No 1 ☐ Yes

   ii. Work in areas cleaned with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q13d*)

   iii. Had/have little contact with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q14*)

Please read the following alternatives carefully and answer as accurately as you can.

Q 13b. In the periods when you use(d) phenol-based cleaners in MRSA rooms, did you use them daily, weekly, monthly or less often? Please tick the most appropriate box and indicate how often you used it, if you used it less than every day.

Daily   0 ☐ No 1 ☐ Yes (*Go to Q 13c*)

Weekly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a week? _____ (*Go to Q 13c*)

Monthly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a month? _____(*Go to Q 13c*)

Yearly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a year? _____

Q13c. On days when using phenol-based cleaners in MRSA rooms, how long did you usually work with them?

_____ minutes _____ hours

Q13d. Thinking about your time working in MRSA rooms, over what period of time would you say that you used or were exposed to phenol-based cleaners in total?

_____days _____ weeks _____months _____years

Q14. Did you ever work in medical engineering and physics department (MEPD) rooms?

0 ☐ No (*Go to Q 16*)   1 ☐ Yes (*Go to Q 15a*)

Q 15a. When working in MEPD rooms did/do you:

   i. Use phenol-based cleaners   0 ☐ No 1 ☐ Yes

   ii. Work in areas cleaned with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q15d*)

   iii. Had/have little contact with phenol-based cleaners 0 ☐ No 1 ☐ Yes (*Go to Q16*)

Please read the following alternatives carefully and answer as accurately as you can.

Q15b. In the periods when you use(d) phenol-based cleaners in MEPD rooms, did you use them daily, weekly, monthly or less often? Please tick the most appropriate box and indicate how often you used it, if you used it less than every day.

Daily   0 ☐ No 1 ☐ Yes   (*Go to Q 15c*)

Weekly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a week? _____ (*Go to Q 15c*)

Monthly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a month? _____(*Go to Q 15c*)

Yearly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a year? _____

Q15c. On days when using phenol-based cleaners in MEPD rooms, how long did you usually work with them?

_____ minutes _____ hours

Q15d. Thinking about your time working in MEPD rooms, over what period of time would you say that you used or were exposed to phenol-based cleaners in total?

_____days _____ weeks _____months _____years

Q16. Did you ever work in the laboratories?

0 ☐ No (*Go to Q 18*)   1 ☐ Yes (*Go to Q 17a*)

Q 17a. When working in the laboratories did/do you:

   i. Use phenol-based cleaners   0 ☐ No 1 ☐ Yes

  ii. Work in areas cleaned with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q17d*)

 iii. Had/have little contact with phenol-based cleaners 0 ☐ No 1 ☐ Yes (*Go to Q18*)

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Please read the following alternatives carefully and answer as accurately as you can.

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Q17b. In the periods when you use(d) phenol-based cleaners in the laboratories, did you use them daily, weekly, monthly or less often? Please tick the most appropriate box and indicate how often you used it, if you used it less than every day.

Daily   0 ☐ No 1 ☐ Yes   (*Go to Q 17c*)

Weekly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a week? _____ (*Go to Q 17c*)

Monthly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a month? _____(*Go to Q 17c*)

Yearly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a year? _____

Q17c. On days when using phenol-based cleaners in the laboratories, how long did you usually work with them?

_____ minutes _____ hours

Q17d. Thinking about your time working in the laboratories, over what period of time would you say that you used or were exposed to phenol-based cleaners in total?

_____days _____ weeks _____months _____years

Q18. Did you ever work in the burns unit?

0 ☐ No (*Go to Q 20*)   1 ☐ Yes (*Go to Q 19a*)

Q 19a. When working in the burns unit did/do you:

   i. Use phenol-based cleaners   0 ☐ No 1 ☐ Yes

  ii. Work in areas cleaned with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q19d*)

 iii. Had/have little contact with phenol-based cleaners 0 ☐ No 1 ☐ Yes (*Go to Q20*)

Please read the following alternatives carefully and answer as accurately as you can.

Q19b. In the periods when you use(d) phenol-based cleaners in the burns unit, did you use them daily, weekly, monthly or less often? Please tick the most appropriate box and indicate how often you used it, if you used it less than every day.

Daily   0 ☐ No 1 ☐ Yes (*Go to Q 19c*)

Weekly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a week? _____ (*Go to Q 19c*)

Monthly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a month? _____(*Go to Q 19c*)

Yearly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a year? _____

Q19c. On days when using phenol-based cleaners in the burns unit, how long did you usually work with them?

_____ minutes _____ hours

Q19d. Thinking about your time working in the burns unit, over what period of time would you say that you used or were exposed to phenol-based cleaners in total?

_____days _____ weeks _____months _____years

Q20. Did you ever work in TB wards (Emergency Department, Intensive Care Unit, 9C)?

0 ☐ No (*Go to Q 22*)   1 ☐ Yes (*Go to Q 21a*)

Q 21a. When working in TB wards did/do you:

   i. Use phenol-based cleaners   0 ☐ No 1 ☐ Yes

   ii. Work in areas cleaned with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q21d*)

   iii. Had/have little contact with phenol-based cleaners 0 ☐ No 1 ☐ Yes (*Go to Q22*)

> # Please read the following alternatives carefully and answer as accurately as you can.

Q21b. In the periods when you use(d) phenol-based cleaners in TB wards, did you use them daily, weekly, monthly or less often? Please tick the most appropriate box and indicate how often you used it, if you used it less than every day.

Daily   0 ☐ No 1 ☐ Yes (*Go to Q 21c*)

Weekly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a week? _____ (*Go to Q 21c*)

Monthly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a month? _____(*Go to Q 21c*)

Yearly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a year? _____

Q21c. On days when using phenol-based cleaners in TB wards, how long did you usually work with them?

_____ minutes _____ hours

Q21d. Thinking about your time working in TB wards, over what period of time would you say that you used or were exposed to phenol-based cleaners in total?

_____days _____ weeks _____months _____years

Q22. Did you ever work in VRE rooms?

0 ☐ No (*Go to Q 24*)   1 ☐ Yes (*Go to Q 23a*)

Q 23a. When working in VRE rooms did/do you:

   i. Use phenol-based cleaners   0 ☐ No 1 ☐ Yes

   ii. Work in areas cleaned with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q23d*)

   iii. Had/have little contact with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q24*)

Please read the following alternatives carefully and answer as accurately as you can.

Q23b. In the periods when you use(d) phenol-based cleaners in VRE rooms, did you use them daily, weekly, monthly or less often? Please tick the most appropriate box and indicate how often you used it, if you used it less than every day.

Daily   0 ☐ No 1 ☐ Yes   (*Go to Q 23c*)

Weekly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a week? _____ (*Go to Q 23c*)

Monthly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a month? _____ (*Go to Q 23c*)

Yearly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a year? _____

Q23c. On days when using phenol-based cleaners in VRE rooms, how long did you usually work with them?

_____ minutes _____ hours

Q23d. Thinking about your time working in VRE rooms, over what period of time would you say that you used or were exposed to phenol-based cleaners in total?

_____ days _____ weeks _____ months _____ years

Q24. Did you ever work in any other department/unit/ward?

0 ☐ No (*Go to Q 24*)   1 ☐ Yes (*Go to Q 23a*)

Q 25a. When working in any other department/unit/ward did/do you:

   i. Use phenol-based cleaners   0 ☐ No 1 ☐ Yes

   ii. Work in areas cleaned with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q25d*)

   iii. Had/have little contact with phenol-based cleaners   0 ☐ No 1 ☐ Yes (*Go to Q26*)

Please read the following alternatives carefully and answer as accurately as you can.

Q25b. In the periods when you use(d) phenol-based cleaners in any other department/unit/ward, did you use them daily, weekly, monthly or less often? Please tick the most appropriate box and indicate how often you used it, if you used it less than every day.

Daily   0 ☐ No 1 ☐ Yes (*Go to Q 25c*)

Weekly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a week? _____ (*Go to Q 25c*)

Monthly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a month? _____(*Go to Q 25c*)

Yearly   0 ☐ No 1 ☐ Yes   <u>If yes</u>, how many days a year? _____

Q25c. On days when using phenol-based cleaners in any other department/unit/ward rooms, how long did you usually work with them?

_____ minutes _____ hours

Q25d. Thinking about your time working in any other department/unit/ward rooms, over what period of time would you say that you used or were exposed to phenol-based cleaners in total?

_____days _____ weeks _____months _____years

Q26. Have you been registered with RPH as Prephen Sensitive?

1 ☐ Yes   0 ☐ No 998 ☐ Unsure/can't remember

Q27. Have you been assessed by the occupational health nurse or risk management department for sensitivity to the cleaning agent Prephen?

1 ☐ Yes   0 ☐ No (*Go to Q29*) 998 ☐ Unsure/can't remember (*Go to Q29*)

Q28. As a result of this, were you placed on alternative duties for any period of time?

1 ☐ Yes   0 ☐ No 998 ☐ Unsure/can't remember

The following are some questions about your health

Q29. Has a doctor ever told you that you have any form of cancer?

1 ☐ Yes   0 ☐ No   998 ☐ Unsure/can't remember

Q30. Has a doctor ever told you that you have asthma?

1 ☐ Yes   0 ☐ No (Go to Q26) 998 ☐ Unsure/can't remember (Go to Q32)

Q31. Have you had symptoms of asthma or taken treatment for asthma in the last 12 months?

1 ☐ Yes   0 ☐ No   998 ☐ Unsure/can't remember

Q32. Other than asthma, has a doctor ever told you that you have a lung or respiratory problem that has lasted 6 months or more?

1 ☐ Yes   0 ☐ No   998 ☐ Unsure/can't remember

Q33. Has a doctor ever told you that you have a skin condition other than skin cancer?

1 ☐ Yes   0 ☐ No   998 ☐ Unsure/can't remember

Q34. In the last four weeks, how often did you have headaches?

5 ☐ Every day
4 ☐ Most days
3 ☐ About half the days
2 ☐ Less than half the days
1 ☐ Less often than monthly
0 ☐ Not at all

Q35. In the last four weeks, how often did you have skin irritations or rashes or eczema?

5 ☐ Every day
4 ☐ Most days
3 ☐ About half the days
2 ☐ Less than half the days
1 ☐ Less often than monthly
0 ☐ Not at all

Q36. In the last four weeks, how often did you have sore or irritated eyes?

5 ☐ Every day
4 ☐ Most days
3 ☐ About half the days
2 ☐ Less than half the days
1 ☐ Less often than monthly
0 ☐ Not at all

Q37. In the last four weeks, how often did you have a cough or sore throat that was not due to a cold or the flu?

5 ☐ Every day
4 ☐ Most days
3 ☐ About half the days
2 ☐ Less than half the days
1 ☐ Less often than monthly
0 ☐ Not at all

Q38. In the last four weeks, how often did you have difficulty breathing?

5 ☐ Every day
4 ☐ Most days
3 ☐ About half the days
2 ☐ Less than half the days
1 ☐ Less often than monthly
0 ☐ Not at all

Q39. In the last four weeks, how often did you have nausea?

5 ☐ Every day
4 ☐ Most days
3 ☐ About half the days
2 ☐ Less than half the days
1 ☐ Less often than monthly
0 ☐ Not at all

Q40. In the last four weeks, how often did you have nose bleeds?

5 ☐ Every day
4 ☐ Most days
3 ☐ About half the days
2 ☐ Less than half the days
1 ☐ Less often than monthly
0 ☐ Not at all

Q41. Is there anything else you would like to tell us about your health or your use or exposure to phenol-based cleaning agents? If so, please write it here.

_____

_____

_____

_____

_____

_____

_____

Data Linkage Consent Form

SIGNING THIS CONSENT FORM IS ENTIRELY VOLUNTARY. PLEASE READ THE INFORMATION BELOW CAREFULLY BEFORE YOU SIGN AND IF YOU STILL HAVE ANY QUESTIONS ABOUT WHAT YOU ARE CONSENTING TO, PLEASE CALL 08 92242350.

This is a consent form that gives us permission to link the information you have provided in this questionnaire with other health records that may contain information about you (e.g. cancer registry, hospitalisation, emergency department presentations). There records are securely stored in WA Department of Health.

I, _____

     (Given Names)   (Surname)

understand that by signing this form, I am consenting to have the information I have given in this questionnaire linked with other health records (e.g. cancer registry, hospitalisation, emergency department presentations) about me that are stored in WA Department of Health datasets.

Signed: _____

Dated: _____/ _____/ _____

          day   month   year

Thank you very much for completing the questionnaire. Your cooperation is appreciated.

Appendix 3: Calculation of exposure

Example: MRSA rooms
1. Calculate total period of time spent working in MRSA rooms using phenol-based cleaners (Q13d). Convert all answers to one standard unit of measurement – working days.

EXAMPLE 1: Worked in MRSA rooms over 4 months and 2 weeks.
4 months x 20 working days in a month = 80 working days
2 weeks x 5 working days in a week = 10 working days
80 + 10 working days = 90 working days.

EXAMPLE 2: Worked in MRSA rooms over 2 years.
2 years x 240 working days in a year = 480 working days.

2. Calculate the proportion of full-time equivalent working time spent working in MRSA rooms using phenol-based cleaners (Q13b). That is, working there daily (5 days a week) would equal 1 and working less than daily would be an equivalent proportion of 1.

EXAMPLE 1: Worked 3 days per week.
3 days per week / 5 working days in a week = 0.6

EXAMPLE 2: Worked 1 day a month.
1 day per month / 20 working days in a month = 0.05.

3. Calculate the number of days actually at work in MRSA rooms using phenol-based cleaners over the total period of time working in MRSA rooms using phenol-based cleaners (Q13b x Q13d).

EXAMPLE 1: Worked 3 days per week over 4 months and 2 weeks in MRSA rooms.
0.6 x 90 working days = 54 days of exposure.

EXAMPLE 2: Worked 1 day a month over 2 years in MRSA rooms.
0.05 x 480 working days = 24 days of exposure.

4. Calculate the time in hours spent working with phenol-based cleaners (Q13c) in MRSA rooms on an average day worked there. Convert all answers to one standard unit of measurement – hours.

EXAMPLE 1: Spends 20 minutes working with phenol-based cleaners on an average day in MRSA room.
20 minutes / 60 minutes = 0.33 hours

5. Calculate total number of hours working with phenol-based cleaners in the total period of time working in MRSA rooms using phenol-based cleaners.

EXAMPLE 1: Spends 0.33 hours working with phenol-based cleaners on an average day in MRSA rooms and has 54 days of exposure.
0.33 hours/day x 54 days = 17.82 hours of exposure

Appendix 4: Calculation of Person-years of Follow-up

Figure A4.1 illustrates the method used to calculate person-years of follow-up time that were used in the report to derive follow-up times for all persons involved in the study.

Figure A4.1: Examples of person-years of follow-up calculations
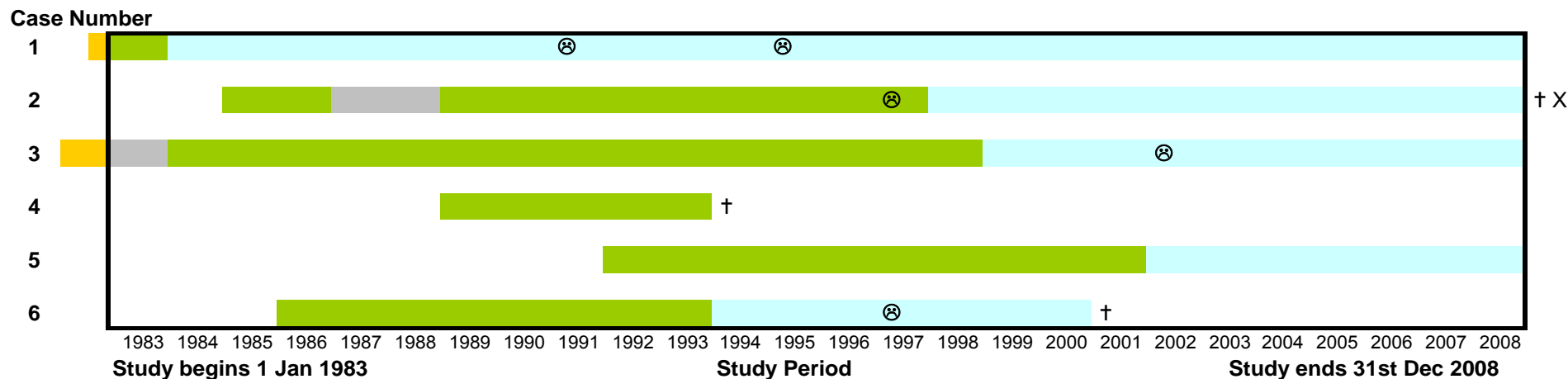
Adapted from figure used in Sitas & O'Connell, 2009

The study period starts in 1983 and continues to 2008. Person-years of follow-up includes time during and after employment, captured in the green and blue regions. Follow-up continues until death (†), out of state or the end of the study period. Follow-up did not stop at cancer (☹) diagnosis as the person could still be at risk of another cancer. For example, case one was diagnosed with two primary cancers and the follow-up time for this individual was 26 years, while for case 6 their cancer follow-up stopped then they died giving a total of 15 years of follow-up. The grey areas include periods when the individual is on extended leave from their employment at RPH (e.g. Long Service Leave or Maternity Leave), these areas are also included in the person-years of follow-up. For example, case 2 has 24 years of follow-up including their extended leave. Yellow areas are not included in the study. The symbol (X) denotes an event that is not included in the analysis.

Appendix 5: Person-years of Follow-up Tables

Table A5.1: Person-years of follow-up for risk of cancer or death, during and after employment, for males

Year of follow-up	Age group at follow-up																	
	0 to 4 yrs	5 to 9 yrs	10 to 14 yrs	15 to 19 yrs	20 to 24 yrs	25 to 29 yrs	30 to 34 yrs	35 to 39 yrs	40 to 44 yrs	45 to 49 yrs	50 to 54 yrs	55 to 59 yrs	60 to 64 yrs	65 to 69 yrs	70 to 74 yrs	75 to 79 yrs	80 to 84 yrs	85 yrs and over
1983	-	-	-	3.0	12.4	24.1	26.7	27.0	19.9	19.2	24.2	27.2	11.3	1.7	-	-	-	-
1984	-	-	-	2.5	13.7	27.6	29.4	29.7	24.1	19.1	27.2	27.4	14.9	2.4	-	-	-	-
1985	-	-	-	1.8	19.9	32.3	42.4	33.6	30.7	23.7	27.7	28.5	16.3	5.0	-	-	-	-
1986	-	-	-	5.0	23.8	39.2	50.8	37.8	34.1	28.6	29.6	27.8	17.6	7.9	-	-	-	-
1987	-	-	-	13.6	27.7	41.2	56.0	41.8	39.2	32.4	30.1	24.9	20.7	10.8	-	-	-	-
1988	-	-	-	16.6	37.1	46.2	55.5	52.5	38.5	36.7	28.5	27.0	23.9	10.3	1.7	-	-	-
1989	-	-	-	15.9	50.9	62.6	61.2	72.6	48.2	42.1	27.8	32.1	24.6	12.6	2.4	-	-	-
1990	-	-	-	9.5	58.8	69.4	66.2	84.3	61.2	45.3	29.6	32.9	25.2	13.5	4.1	-	-	-
1991	-	-	-	3.4	58.4	67.5	75.1	91.0	65.2	44.2	38.7	35.3	25.6	12.3	6.3	-	-	-
1992	-	-	-	7.6	55.6	68.4	76.4	99.9	65.0	53.2	41.6	35.5	25.0	14.3	8.2	-	-	-
1993	-	-	-	6.6	53.3	80.3	79.4	105.1	72.6	60.1	45.2	34.4	27.4	19.1	8.1	0.9	-	-
1994	-	-	-	4.0	45.9	78.2	88.2	96.2	90.7	68.0	49.7	36.6	29.0	22.0	7.9	1.4	-	-
1995	-	-	-	7.8	48.7	87.3	98.8	105.6	99.5	81.5	58.6	40.9	31.9	21.6	6.6	4.0	-	-
1996	-	-	-	7.9	56.5	103.9	103.7	118.7	115.2	88.4	66.5	48.2	37.4	21.9	7.3	6.0	-	-
1997	-	-	-	5.9	56.7	112.0	112.6	112.9	133.3	86.5	80.6	52.6	40.1	22.8	10.8	6.0	-	-
1998	-	-	-	6.3	51.5	109.1	126.9	114.7	136.1	95.0	83.0	59.5	39.3	26.3	15.6	4.1	0.9	-
1999	-	-	-	5.9	52.0	109.4	131.9	118.4	131.5	110.3	88.9	67.1	38.9	28.4	17.3	4.1	1.4	-
2000	-	-	-	4.5	46.3	106.4	137.2	125.2	131.8	119.0	97.5	71.9	43.4	32.0	17.1	4.4	3.2	-
2001	-	-	-	3.5	46.1	93.3	139.6	132.8	136.3	130.6	98.9	78.0	48.2	36.8	19.3	5.7	4.0	-
2002	-	-	-	4.0	44.7	89.4	141.4	145.2	139.5	148.1	103.4	93.2	56.8	36.3	21.4	9.8	4.1	-
2003	-	-	-	5.0	36.3	83.4	145.2	158.5	153.6	155.9	124.8	102.0	67.9	34.8	23.5	13.7	3.0	-
2004	-	-	-	3.8	32.6	80.4	140.1	161.2	163.5	159.2	145.0	114.5	79.5	38.4	24.2	14.9	3.1	0.4
2005	-	-	-	1.9	27.9	76.5	137.3	161.2	171.5	169.3	156.3	127.2	88.2	42.1	25.9	15.1	3.4	2.2
2006	-	-	-	4.5	26.4	70.1	128.8	166.0	173.4	182.1	169.6	132.1	95.3	50.3	28.6	17.2	3.7	2.7
2007	-	-	-	7.0	31.6	67.1	120.5	166.6	181.9	181.0	192.0	126.9	109.8	56.7	30.3	19.0	8.0	2.0
2008	-	-	-	7.9	35.0	65.8	112.4	168.8	188.8	189.9	197.1	144.2	115.1	66.3	33.9	19.2	8.7	2.0

**Table A5.2: Person-years of follow-up for risk of cancer or death, during and after employment, for females**

| Year of follow-up	Age group at follow-up																	
	0 to 4 yrs	5 to 9 yrs	10 to 14 yrs	15 to 19 yrs	20 to 24 yrs	25 to 29 yrs	30 to 34 yrs	35 to 39 yrs	40 to 44 yrs	45 to 49 yrs	50 to 54 yrs	55 to 59 yrs	60 to 64 yrs	65 to 69 yrs	70 to 74 yrs	75 to 79 yrs	80 to 84 yrs	85 yrs and over
1983	-	-	-	1.1	26.7	19.3	21.3	40.9	34.5	45.3	30.0	34.5	13.5	-	-	-	-	-
1984	-	-	-	3.5	33.4	27.3	30.7	43.1	42.7	44.8	34.0	35.3	18.3	0.1	-	-	-	-
1985	-	-	-	3.3	33.5	35.9	38.6	50.0	44.5	51.1	38.8	33.9	23.5	1.6	-	-	-	-
1986	-	-	-	16.5	42.9	43.2	54.8	70.7	54.9	61.9	44.4	33.9	26.3	5.9	-	-	-	-
1987	-	-	-	21.3	55.7	62.8	63.0	78.6	65.5	64.5	51.6	31.9	31.4	11.2	-	-	-	-
1988	-	-	-	21.1	69.9	95.8	72.6	90.3	81.7	74.4	63.4	38.0	35.0	14.5	-	-	-	-
1989	-	-	-	13.9	90.2	114.2	91.4	111.7	101.8	85.3	74.4	45.5	36.7	19.3	0.1	-	-	-
1990	-	-	-	9.1	86.5	116.2	102.8	116.9	115.2	88.7	82.1	52.3	37.1	23.6	1.6	-	-	-
1991	-	-	-	9.6	72.7	115.0	106.6	124.6	122.9	93.1	88.6	54.7	36.5	26.3	5.9	-	-	-
1992	-	-	1.0	9.8	64.9	112.3	111.5	133.7	119.3	104.8	89.3	61.4	35.4	30.6	11.2	-	-	-
1993	-	-	0.8	8.0	57.9	103.8	125.4	124.6	121.6	114.5	94.3	69.9	39.5	32.8	14.5	-	-	-
1994	-	-	-	9.5	40.1	104.0	129.6	113.5	136.7	118.0	95.2	78.5	46.2	33.2	18.6	0.1	-	-
1995	-	-	-	11.7	39.0	106.4	132.6	123.8	141.5	133.0	100.2	88.1	52.7	33.9	22.6	1.6	-	-
1996	-	-	-	9.8	42.2	99.0	135.7	131.1	156.7	145.7	106.9	96.7	55.9	33.2	25.9	5.3	-	-
1997	-	-	-	6.0	37.0	90.7	134.7	140.9	165.0	151.5	121.9	96.7	64.0	33.9	29.0	9.7	-	-
1998	-	-	-	4.4	27.9	94.6	124.8	155.8	153.1	152.8	133.2	102.9	71.9	38.5	30.5	12.5	-	-
1999	-	-	-	2.3	33.3	74.0	125.4	159.5	139.8	173.4	138.2	106.6	80.8	45.8	29.8	17.2	0.1	-
2000	-	-	-	1.4	29.5	60.7	125.6	154.4	148.5	167.9	153.9	107.8	89.4	52.7	30.9	19.6	1.6	-
2001	-	-	-	2.1	23.7	60.9	116.9	149.6	151.7	172.1	162.9	111.6	98.0	55.4	31.6	21.9	5.2	-
2002	-	-	-	2.6	23.3	59.8	108.3	151.8	163.8	180.8	162.4	125.5	97.4	61.9	32.6	24.9	8.5	-
2003	-	-	-	1.6	20.9	51.4	116.0	144.7	189.6	178.6	178.6	142.6	106.1	69.7	36.5	26.5	10.2	-
2004	-	-	-	1.9	22.1	51.8	102.3	148.3	196.6	175.9	209.0	150.8	113.8	79.0	43.5	26.1	13.8	0.1
2005	-	-	-	2.7	23.0	51.4	91.1	153.2	194.6	196.5	204.2	176.3	116.9	87.3	49.7	27.2	13.9	1.0
2006	-	-	-	2.8	27.7	48.7	96.1	146.5	189.9	211.0	213.2	198.1	121.4	95.5	53.1	27.2	17.1	2.4
2007	-	-	-	6.1	35.5	44.8	94.0	146.1	190.2	221.3	227.8	207.7	133.9	99.1	59.8	29.5	19.2	4.4
2008	-	-	-	11.8	43.0	54.7	85.9	166.5	177.5	244.7	226.4	218.8	146.8	109.5	67.3	34.3	19.4	6.3

Appendix 6: Comparing Respondents with Complete and Incomplete Exposure Information

Table A6.1: Comparing respondents with complete and incomplete exposure information

	Respondents with incomplete exposure				Respondents with complete exposure			
	Minimum	Maximum	Mean	95% CI	Minimum	Maximum	Mean	95% CI
Exposure in MRSA rooms								
Total days spent working	1.0	6000.0	1100.3	(500.0 - 1700.5)	1.0	8640.0	1412.1	(1182.2 - 1642.0)
Proportion of time using cleaners	0.0	1.0	0.8	(0.7 - 0.9)	0.0	1.0	0.8	(0.7 - 0.9)
Hours per day using cleaners	0.0	8.0	2.2	(1.4 - 3.1)	0.0	8.0	2.4	(2.1 - 2.8)
Exposure in MEPD rooms								
Total days spent working	15*	15.0	15.0	(N/A - N/A)	1.0	4560.0	949.0	(389.7 - 1507.7)
Proportion of time using cleaners	0.0	1.0	0.9	(0.6 - 1.1)	0.0	1.0	0.7	(0.6 - 0.9)
Hours per day using cleaners	0.4	8.0	3.1	(0.0 - 6.7)	0.1	8.0	2.4	(1.5 - 3.3)
Exposure in laboratories								
Total days spent working	2.0	1920.0	660.7	(0.0 - 3370.9)	1.0	4560.0	907.5	(594.7 - 1220.4)
Proportion of time using cleaners	0.6	1.0	0.9	(0.8 - 1.1)	0.0	1.0	0.8	(0.7 - 1.0)
Hours per day using cleaners	0.4	8.0	3.4	(0.0 - 7.0)	0.0	8.0	2.6	(2.0 - 3.3)
Exposure in burns unit								
Total days spent working	1.0	4800.0	749.2	(108.5 - 1389.9)	1.0	8640.0	642.4	(337.6 - 947.2)
Proportion of time using cleaners	0.3	1.0	0.9	(0.8 - 1.0)	0.0	1.0	0.8	(0.7 - 0.8)
Hours per day using cleaners	0.0	12.0	3.4	(1.3 - 5.5)	0.1	8.0	3.9	(3.2 - 4.7)
Exposure in TB wards								
Total days spent working	1.0	3120.0	582.9	(57.1 - 1108.8)	0.3	5760.0	837.3	(610.8 - 1063.7)
Proportion of time using cleaners	1.0	1.0	1.0	(N/A - N/A)	0.0	1.0	0.8	(0.7 - 0.9)
Hours per day using cleaners	0.3	8.0	3.6	(1.1 - 6.1)	0.1	8.0	3.3	(2.5 - 4.1)
Exposure in VRE rooms								
Total days spent working	1.0	3120.0	796.5	(0.0 - 1630.1)	1.0	5760.0	908.2	(702.8 - 1113.7)
Proportion of time using cleaners	0.0	1.0	0.9	(0.7 - 1.0)	0.0	1.0	0.9	(0.8 - 0.9)
Hours per day using cleaners	0.3	8.0	2.5	(0.9 - 4.2)	0.1	12.0	3.1	(2.6 - 3.6)
Exposure in other area								
Total days spent working	5.0	7200.0	1251.4	(646.8 - 1856.1)	1.0	8640.0	1373.8	(1124.1 - 1623.6)
Proportion of time using cleaners	0.0	1.0	0.9	(0.8 - 1.0)	0.0	1.0	0.8	(0.8 - 0.9)
Hours per day using cleaners	0.1	8.0	3.6	(2.4 - 4.8)	0.0	8.0	3.4	(3.0 - 3.9)

* Based on one person only