Development of a Provincial Exposure Database for Manitoba

Final Report

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Executive Summary

Occupational exposure measurement data can be a valuable resource to occupational health specialists, including epidemiologists, occupational hygienists and policy developers, among others. For example, exposure data can be used in risk assessment, such as epidemiological studies, to evaluate and recommend interventions to reduce exposure, and to identify areas for future research or prioritize regulatory efforts. However, much of the data previously collected by OHS regulators is stored in a form that prevents easy access or analysis, and much historical data is lost through current data retention practice.

This project is one of several aimed at digitizing archived occupational exposure data to preserve it for future research and surveillance efforts, as well as making the data more suitable for analytical use by occupational health specialists. Following two pilot projects to characterize potential data sources in the government of Manitoba, this project set about identifying files (principally in the Workplace Health and safety Division (WHSD) of the Manitoba Ministry of Labor) and abstracting relevant exposure measurement data. The abstracted data was then cleaned and coded using standard coding systems, and summary descriptive statistics was performed. The data was added to the growing national resource (the Canadian Workplace Exposure Database or CWED).

Almost 22,000 measurements were abstracted from paper records, covering a period of 1953-2012. Data from over 200 companies was identified. Almost 200 different substances were measured. The most common substance measured was “dust”, followed by lead and other metals, as well as respirable particulate. Data from mining industries was the

most prevalent, representing about 57% of all the data. The utility of the data was explored by demonstrating time trend analyses for several example substances and by examining whether measurement data volume reflected what we know about carcinogen exposure prevalence in Manitoba.

The data that was abstracted will be added to the CWED, which continues to be developed as a national resource. It is hoped that occupational health and safety agencies from Manitoba will continue to partner with CWED in its development. The CWED project will continue to communicate any updates to the database and tools and procedures for its effective use in reducing occupational exposure and disease risks for Manitobans.

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1. Project Overview & Introduction

1.1. Occupational Exposure Databases

Exposure databases provide an archive of historical exposure data and a benchmark of current exposure data knowledge. They provide crucial data in occupational disease risk assessment, and are a useful tool important in intervention planning, evaluation and policy-making.

Table 1: Examples of national workplace exposure databases

Country	Database	Number of measurements	Number of Substances
United Kingdom	NEDB	200,000	400+
Germany	MEGA	1,000,000	420
France	COLCHIC	400,000	600
US	IMIS	>1,000,000	500+

Large-scale exposure databases have been developed by many organizations in Europe and the United States (Table 1) but their development in Canada has been fragmented and slow. National exposure databases in other countries have been used successfully for many purposes. Databases developed from three occupational exposure surveys conducted by the US National Institute for Occupational Safety and Health (NIOSH) in the 1970s and 1980s have been a primary source of information for NIOSH, regulatory agencies, health professionals, and labor organizations in establishing priorities for prevention strategies, and have been linked to a variety of other databases to document workplace exposure trends (1). They have also been used by the National Toxicology Program to inform their annual reports on carcinogens, and in epidemiologic research examining diseases with long latencies, such as cancer (2).

Germany's Institute for Occupational Safety has used its chemical workplace exposure database (MEGA) for the purposes of occupational disease investigation, epidemiology, and prevention, as well as to inform discussions on the establishment of EU exposure limit values and the validation of exposure modeling for risk assessment with other European exposure database holders (3). NEDB (UK) and COLCHIC (France) have been used in research and surveillance projects on flour dust and formaldehyde, for example (4-5).

1.2. Exposure Data

1.2.1. Exposure Data: Collection and Storage Practices

Since the 1990s there has been a significant decrease in workplace exposure sampling performed by regulatory bodies across Canada - most agencies surveyed by CAREX Canada indicated that they are no longer responsible for collecting the majority of exposure measurements in their jurisdictions (6). Most provinces have legislation which permits hygiene officers to order employers to conduct exposure assessments themselves or via private consultants. Data obtained in this manner is usually kept at the employers' sites and not recorded by the regulatory agency, resulting in poor centralization of provincial exposure data since the 1990s in most cases. This has made the data less accessible from a research perspective.

Feasibility of data access varies widely across provinces, due to the variety of database formats used. Of all the agencies contacted to date by CAREX Canada, only the National Dose

Registry, Human Resources and Skills Development Canada, and organizations in the province of Quebec maintain large computerized exposure databases. Others, such as the BC Ministry of Energy and Mines, and Workplace Health and Safety of Manitoba, are presently storing their data in hardcopy or individual electronic file formats with little or no indices or systematic archiving. Some agencies without electronic exposure databases commented that they were planning to implement them within the next few years; however initially their intent was that only new data will be entered.

Our finding that a significant volume of Canadian exposure data exists only in hardcopy form is not unusual. An industry-wide search conducted across 13 industrialized countries in the mid-1990s for existing exposure measurement data showed that of 31,000 exposure measurements taken in the pulp, paper and paper products industries, only 10% were stored in fully computerized form, with an additional 24% in partly computerized form and 66% in manual form (7)

CAREX Canada's data holder survey findings point to the need for a national database of Canadian workplace exposure measurements to preserve valuable historical data and encourage the input of prospective workplace exposure data in an electronic format.

1.2.2. Retention Practices

Large volumes of occupational exposure data exist and government agencies, industry and research groups continue to generate new data. However, the data typically exists in private databases and is used only once for the purpose at hand, then archived, and destroyed.

A study in the European Union showed that the largest fraction of such data collected by industry (44%) was kept for 5 years or less, and that only 10% was kept indefinitely (8).

The CAREX Canada survey of Canadian regulators showed that the record retention schedule across Canadian agencies was similarly variable (6). Some agencies had already experienced substantial losses of exposure data; for example, contacts at PEI's Workers' Compensation Board and Alberta Human Resources and Employment claimed that both agencies destroyed nearly all exposure measurements collected prior to 1990 (and as neither have conducted exposure monitoring since that time, there is apparently no accessible data from these provincial sources). In contrast, the Manitoba Ministry of Labor (WHSD) continued to store exposure data records dating back to the 1950s. This emphasizes the need for such data to be preserved in a usable form, for example for the assessment of historical exposure in cancer epidemiology studies.

1.3. The Current Project

The investigators are developing a national exposure database for Canada, The Canadian Workplace Exposure Database ("CWED") that houses exposure measurement data from Canadian workplaces, built on previously collected data, and drawn from across the country.

The CWED was initiated as part of the "CAREX Canada" project, a national *CAR*cinogen *EX*posure surveillance project (9), originally funded in 2007 by the Canadian Partnership Against Cancer (CPAC). As part of CAREX Canada, the data in CWED was used to identify where occupational carcinogens were used as well as the chemical concentrations to which workers were exposed. Beginning in 2008, CWED was constructed on data from WorkSafeBC, the

National Dose Registry, and Ontario Ministry of Labor. Since then, the CWED project has become independent of CAREX Canada and continued to add data from the BC Ministry of Energy and Mines, Saskatchewan and the Yukon Territory.

Researchers from the CWED project (based at the University of British Columbia) worked with staff from the Occupational Hygiene Branch, Workplace Safety and Health Division, in the Manitoba Ministry of Labor & Immigration, to identify relevant occupational exposure data held by the Government of Manitoba and to transcribe it into electronic format. The result, a functional electronic provincial database, was to be provided to Manitoba, and the contents added to the CWED. The new provincial database will give Manitoba straightforward access to information reserves for use in regulatory targeting activities, claims adjudications, gap identification, and as a tool to facilitate research and predict future disease burden.

2. Review of Work Completed

Work for this project began with two pilot studies undertaken in 2009 and 2011 to evaluate and describe potential occupational exposure data holdings at the Government of Manitoba. Subsequent to the successful awarding of the Workers' Compensation Board RWIP grant in 2012, the full project was undertaken (Table 2).

2.1. How were objective met?

There were four specific proposed objectives:

1. *The abstraction and entry of Manitoba's provincial regulatory workplace exposure data from its current formats into a searchable electronic database*

   This represented the major proportion of the total effort in this project. Full details of this process are described in a later section of this report. In total, almost 22, 000 exposure measurements were abstracted from paper-based reports and added to the database.

2. *Data cleaning and standardized coding*

   Each record was reviewed and corrected for spelling errors and missing values, and non-standardized text fields such as substance, company, job title were replaced with standardized codes. Units of measure were standardized and values for limit of detection (non-detects) determined.

3. *Preliminary descriptive data analysis*

   Statistics providing a basic description of the data abstracted, as well as some summary analyses of the data are provided in a later section of this report.

4. *Knowledge translation*

   A copy of the database was provided to Manitoba Ministry of Labor and Industry Workplace Health and Safety Division. Several interim knowledge translation events occurred (described later in this report). Importantly, this project will continue to contribute in several ways to ongoing knowledge transfer to Manitobans and other Canadians.

Table 2: Detailed review of work completed

Objective (Time Frame)	**Activity**
Data Negotiation and Staff Hiring (Jan - May 2012)	- Memorandum of Understanding (MOU) between University of British Columbia and Manitoba WSHD - Ethics approval from University of British Columbia - Hiring of project staff (industrial hygienist and data entry clerk)
Data Abstraction and Entry (May - Sep 2012)	- Training staff - Archived record retrieval, LINK[1] system - Archived file retrieval - Data abstraction & electronic entry - Quality assurance
Data Review (Oct 2012 - 2013)	- Data cleaning & gap filling - Quality assurance
Data Analysis (2013)[1]	- Statistical analysis - Literature review - Gap identification
Knowledge Transfer & Exchange (Jan - July 2014)	- Report generation - Papers - Conference presentations - Data holder visits

[1]The project took longer than originally projected mostly because of the benefits afforded by synchronizing the efforts on this project with those of contemporary projects (CAREX Canada, and a similar project funded by WorksafeBC – RS10-OG13)

[1] LINK is the WSHD's electronic system (introduced in 1990) to save gov't correspondence with employers, employee representatives and other stakeholders.

3. Methods

3.1. Abstraction

Building on the work of two pilot projects, researchers interviewed Manitoba Ministry of Labor and Industry Workplace Health and Safety Division (WHSD) staff and an ex-departmental head (Mr. Dennis Nikkel) to help determine potential sources of occupational exposure data. The findings of these interviews are summarized in Table 3.

3.2. Data Entry

Standardized data entry procedures were utilized. All data entry was done using a database front-end designed for the project that guided data abstraction and performed primary validation tests. Training materials were produced for data entry staff. Source files were coded and cross-referenced to each data entry record so that the original paper file could be located in the event of future need.

3.3. Confidentiality and Privacy

In accordance with the Memorandum of Understanding put in place for this project, no individual level identifiers, such as worker names, were abstracted. Where individual level identifiers existed, they were used to assign an anonymous person-identifier so that it is possible to identify repeated measures on an individual, even though the individual remained anonymous. Data was stored on password-protected computers in locked offices.

Table 3: Potential data sources at Manitoba Ministry of Labor and Industry Workplace Health and Safety Division

Source	Search Strategy
Industrial Hygiene reports in the electronic ***LINK*** system.	Current and archived email correspondences within the LINK system were **browsed** based on independent keywords such as "hygiene", "inspection", "chemical", "asbestos", and "indoor air quality". This process was guided by the previous director of the WSHD, All contents were searched for hygiene information (usually in the form of email attachments).
Archived WSHD Industrial Hygiene reports stored in ***Provincial Archive*** warehouse (off-site)	214 archived WSHD boxes were identified, with file contents organized by company name. An initial comprehensive search of 10 random boxes was performed. Subsequently, a list of companies to target was compiled. This consisted of 1) companies which yielded hygiene data on-site at the WSHD and 2) companies identified by Dennis Nikkel as likely to have been sampled historically. All 214 boxes were recalled from archives, and targeted company folders were searched. Green labeled folders (historically used to file hygiene reports) were thoroughly searched.
IH reports stored at the ***Division Archive*** filing room	The archive filing room stores various types of company documentation before this is archived at the provincial warehouse. A complete file-by-file search of this room's files was conducted.
Monitoring reports stored currently at the ***Mines*** Branch	Mines Department safety officers were contacted for inspection reports.
Mines Branch ***Archived*** reports	According to the archiving record [1], archived Mines Branch documents were organized in boxes based on key words. Most documents pertained to safety (rather than hygiene) issues. A thorough search for hygiene reports was conducted for boxes containing files with the following key words: "Environmental Health", "Environment", "Inspection Reports", "Dust and Ventilation" and "Air Quality Monitoring". Dennis Nikkel guided this process by highlighting key words in the archives list likely to produce hygiene reports.
IH reports retained by individual WSHD hygienists	Government hygiene inspectors were briefed on the database project, and were asked for copies of current hygiene reports not yet archived.
Random reports from ***Hudson Bay Mining and Smelting Company*** *(Flin Flon, MB)*	Hudson Bay Mining and Smelting Co. (HBMSC) were contacted and sent their monitoring reports

3.4. Quality Assurance

A minimum of every 50th observation (2% overall) was double data-entered by a second research staff person. Issues arising from quality assurance checks were discussed and procedures changed to improve data entry. Rate of checking was increased when a new data entry person was used.

3.5. Data Cleaning, Standardizing Language, Coding

Data quality issues were addressed where possible, including internal inconsistencies (e.g. invalid unit for substance type), missing values, inconsistent phrasing (different spelling for the same substance), and same substance measured using different analytical techniques. Original (raw) data was always retained, and new variables created with "cleaned" values, meaning no data was lost or overwritten in the data cleaning process. Where different units of measurements (e.g. ppm and Mg/m^3) were used for the same substance these were standardized, if possible. Data were given new codes to logically group them by toxicological category (e.g. hexavalent chromium was grouped separately from other chromium species).

3.5.1. Industry Codes

Using the Company name that was abstracted, we coded the most appropriate standardized industry type using the "North American Industry Classification System 2002" (NAICS 2002) system to the 4- and 6-digit levels.

3.5.2. Occupation Codes

Where provided in original data, we used the job title and task information to code the most appropriate standardized occupation using the "National Occupation Classification - Statistics 2006" (NOC-S 2006) system.

3.6. Data below Limit of Detection

A uniform code of “9999” was assigned in the concentration field for samples below detection limit, and the limit of detection (LOD) value and unit were recorded. Thus decisions regarding how to use <LOD measurements in future analysis is left to the analyst (e.g. replacing with LOD/$\sqrt{2}$).

4. Results

We abstracted a total of 21,964 exposure measurements in total. Table 4 shows a breakdown by data stream. “Number of reports” indicates those that produced data, but the actual number reviewed seeking data was many times larger.

Table 5 shows the data that was available for abstraction. For all measurements, we abstracted a minimum of (i) substance name, (ii) concentration measure, (iii) units, (iv) date of sampling, and (v) technicians’ notes. For the great majority of measurements we also obtained (vi) company name/industry group. For all other variables there was some degree of missing data (details in Table 5). This was to be expected as these “missing” data were probably not required for the initial collection and use of the data. In addition we added a cross-reference variable to allow a user to go back to the original paper file if necessary.

Exposure measurement data covered the period 1953 to 2012 (Figure 1). Several obvious peaks of sampling activity occurred in 1977, 1983-85, 1992-1993, and in 2010-11. Major troughs in sampling prevalence occurred in 1978, and 2000-2004.

Table 4: Summary of data sources by data "stream"

Data source	Number of reports (observations)	Brief description of data
Electronic reports in the WSHD LINK system	11 (560)	Post 2000 samples. Mostly welding fume.
Archived WSHD reports in Provincial Archive (off-site)	186 (3,071)	Mostly surveys done by industrial hygienist of WSHD, which cover a wide range of substances, such as organic matters, welding fumes, particulates, CO and NO. Survey time ranges from 1953 to 1999.
Reports in WSH Division archive filing room	13 (1,531)	Mostly sampled from year 2000 to 2008, which includes welding fume, chlorine compounds, formaldehyde, phenol and acid mist.
Mines Branch current reports	6 (429)	Sampled after 2000. Silica and dust samples.
Mines Branch archived reports	82 (12,113)	Hygiene monitoring in the mines from 1970 to 1995, which includes dust, silica, acid mist, styrene, and asbestos.
Reports retained by individual WSHD hygienists	39 (4,260)	Mostly sampled post 2005. Majority of reports are metal scanning of welding fume exposure. Other hazards include formaldehyde, wood dust, metalworking fluid, phenol.
Total	**337 (21,964)**	

Table 6 shows the number of measurements by industry sector (i.e. NAICS 2-digit level). Exposure measurement data was identified for 79 different industry groups (i.e. NAICS 4-digit level). Table 7 shows the industry group and number of samples for the top 10 industry groups, accounting for over 83% of the measurements. Twenty three industry groups had over 100 measures in the abstracted data, while thirty five had less than 20 measurements.

Table 5: Number of occupational measurements by sector, in decreasing frequency.

Sector (NAICS 2-digit)	Sector Description	Number of samples (%)
21	Mining, quarrying, and oil and gas extraction	12,548 (57.2)
33	Manufacturing – metal, machinery, furniture	7,342 (33.5)
32	Manufacturing – petrochemical, wood-products	455 (2.1)
81	Other services (except public administration)	347 (1.6)
91	Public administration	299 (1.4)
31	Manufacturing – food & Beverage, clothing	192 (0.9)
62	Health care and social assistance	167 (0.8)
53	Real estate and rental and leasing	130 (0.6)
44	Retail	121 (0.6)
41	Wholesale	82 (0.4)
54	Professional, scientific and technical services	78 (0.4)
61	Educational services	52 (0.2)
22	Utilities	51 (0.2)
23	Construction	23 (0.1)
11	Agriculture, forestry, fishing and hunting	21 (0.1)
51	Information and cultural industries	16 (0.1)
48	Transportation and warehousing	15 (0.1)
Total		**21,939 (100)**

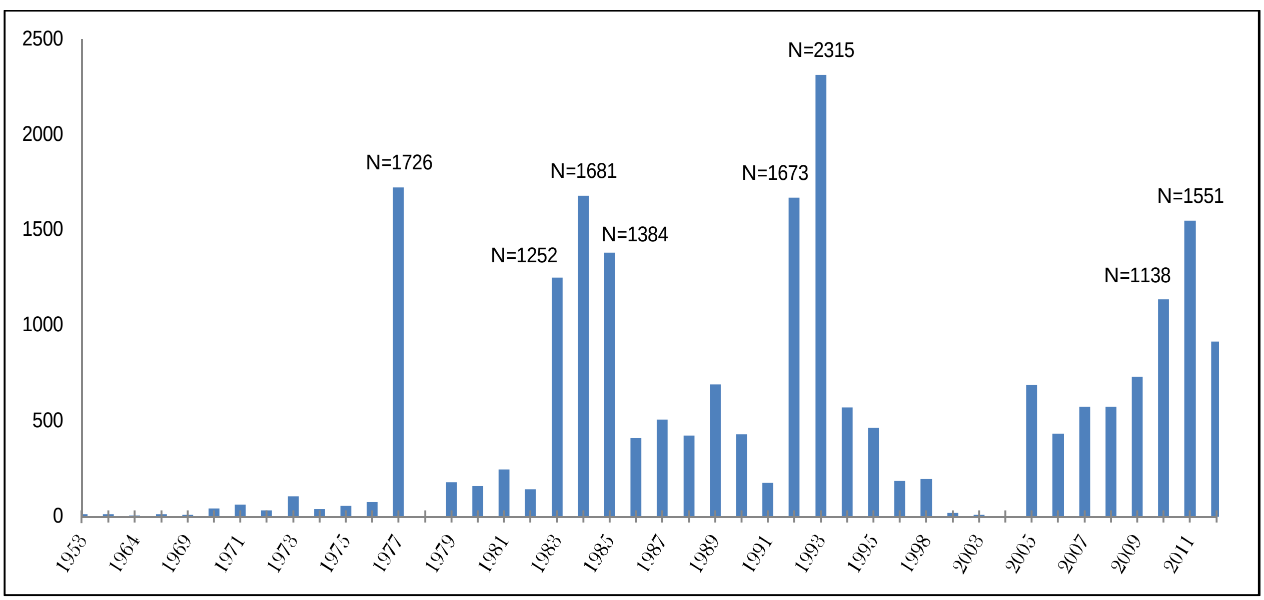

Figure 1: Distribution sample obtained by year. N=21,964

Table 6: Data types abstracted, with amount of missing values

Variable type	Variable description	Missing values
Sample Identifier	Unique anonymous record ID	2,608
	Year of measurement	-[1]
	Month of measurement	-
Company/ Industry	Company name	-
	Name of Site	-
	4-digit NAICS 2002[2] Code	25
	6-digit NAICS 2002 Code	7,704
	Location of site	6,207
	Industry (text)	-
Occupation	Job title	13,604
	Task performed during sampling	15,614
	NOC-S[3] 2006 Occupation code	13,191
Measurement	Substance measured	-
	Exposure measurement	-
	Units for measurement value	-
	Average, peak etc.	7
	Type of sample: Area/personal	109
	Duration of sampling	8,170
	Start of sampling	20,541
	End of sampling	2,578
	Volume of air sampled	16,851
Controls	Ventilation	910
	Personal Protective Equipment	945
Notes	Sampling Technician's notes	-
	Detailed location of sampling	5,521
	Analytical method	14,561
	Sample from a welding fume panel[4]	29
	Anonymous Worker ID	6,624
	Lowest detectable level	17,795
	Units for LOD	17,715

[1] If missing values is "-", all data is available; [2] NAICS: North American Industry Classification System; [3] National Occupational Classification-Statistics; [4]Welding fume panel – testing for broad range of metals from one air sample.

Table 7: Number of measurements obtained for the top 10 industry groups.

Industry group	Number of samples (%)
Metals mining	12,239 (55.8)
Commercial heating and refrigeration equipment manufacturing	2,071 (9.4)
Agricultural/construction/mining equipment manufacturing	928 (4.2)
Metal fabrication	650 (3.0)
Bus fabrication	555 (2.5)
Aerospace	469 (2.1)
Foundry	451 (2.1)
Machine shops	364 (1.7)
Rolling stock manufacturing	314 (1.4)
Non-metallic mineral mining	309 (1.4)
Total	**18,350 (83.6)**

Just over 200 different companies are represented in the database. The single largest contributing company with over 10,000 measurements (46% of the data) was a metal mine under industry code 2122.

Table 8 shows the number of measurements obtained by substance, for all substances with more than 100 measurements.

A total of 8,773 observations had occupation coded. The top 5 occupations represented (with number of observations) were welders (4,155); machine operators (minerals processing etc. -1,299); labourers (minerals processing etc. - 675); machining tool operators (323); and central control and process operators (minerals processing etc. - 248). Other occupations, with more than 100 observations were millwrights, crane operators, material handlers, metal coaters, and assemblers.

Table 8: Number of entries by substance (Substances with fewer than 100 samples not shown).

Substance Name	Number of Entries[2] (%)
Dust	2,184 (9.9)
Lead and its compounds	2,170 (9.9)
Zinc and its compounds	1,786 (8.1)
Copper and its compounds	1,730 (7.9)
Cadmium and its compounds	1,601 (7.3)
Arsenic and its compounds	1,598 (7.3)
Respirable particulates	1,274 (5.8)
Sulfur dioxide	713 (3.2)
Iron and its compounds	535 (2.4)
Acid mist	370 (1.7)
Carbon monoxide	358 (1.6)
Manganese and its compounds	332 (1.5)
Nickel and its compounds	321 (1.5)
Cobalt and its compounds	293 (1.3)
Magnesium and its compounds	279 (1.3)
Aluminum and its compounds	263 (1.2)
Chromium and its compounds	258 (1.2)
Molybdenum and its compounds	248 (1.1)
Vanadium and its compounds	235 (1.1)
Antimony and its compounds	231 (1.1)
Quartz	222 (1.0)
Toluene	215 (1.0)
Formaldehyde	209 (1.0)
Calcium and its compounds	199 (0.9)
Silver	197 (0.9)
Barium and its compounds	195 (0.9)
Tin and its compounds	195 (0.9)
Titanium and its compounds	192 (0.9)
Potassium and its compounds	181 (0.8)
Particulates	180 (0.8)
Sodium and its compounds	180 (0.8)
Beryllium and its compounds	161 (0.7)
Phosphorus and its compounds	161 (0.7)
Zirconium and its compounds	134 (0.6)
Asbestos	132 (0.6)
Styrene	120 (0.5)
Boron	114 (0.5)
Other	2198 (10.0)
Total	**21,694 (100.0)**

Twenty-three percent (5,017) of the samples were below the “limit of detection” (LOD or “non-detects”). For 66% of these (3,301) the value of the LOD was known and recorded. The remaining 34% of samples with LOD’s that are “missing” could potentially be estimated from what is known about the analytical methods, or from other available data on similar substances (a good example of the value of working concurrently on aggregated data from multiple provinces).

Forty percent of measurements (8,768) were “personal” samples (i.e. sampling equipment was worn by the worker); all others were “area” or “static” samples.

The mean duration of measurements was approximately 6 hours (350 minutes).

4.1. Time Trends

Exposure data was gathered across a period spanning 1953 – 2012. Figure 2 demonstrates how 5-year mean exposure levels for 5 selected substances, Lead (Pb), Cadmium (Cd), “dust” and respirable dust, and sulfur dioxide, varied across time. Cadmium levels were very low across time varying between 0.003 mg/m^3 and 0.072 mg/m^3., while lead and respirable dust showed initial increases followed by decline. Interpretation of these data without additional information is difficult as such factors as “reason for sampling,” type of sample (personal vs. area), and industry might all be considered confounders of the time-exposure level relation.

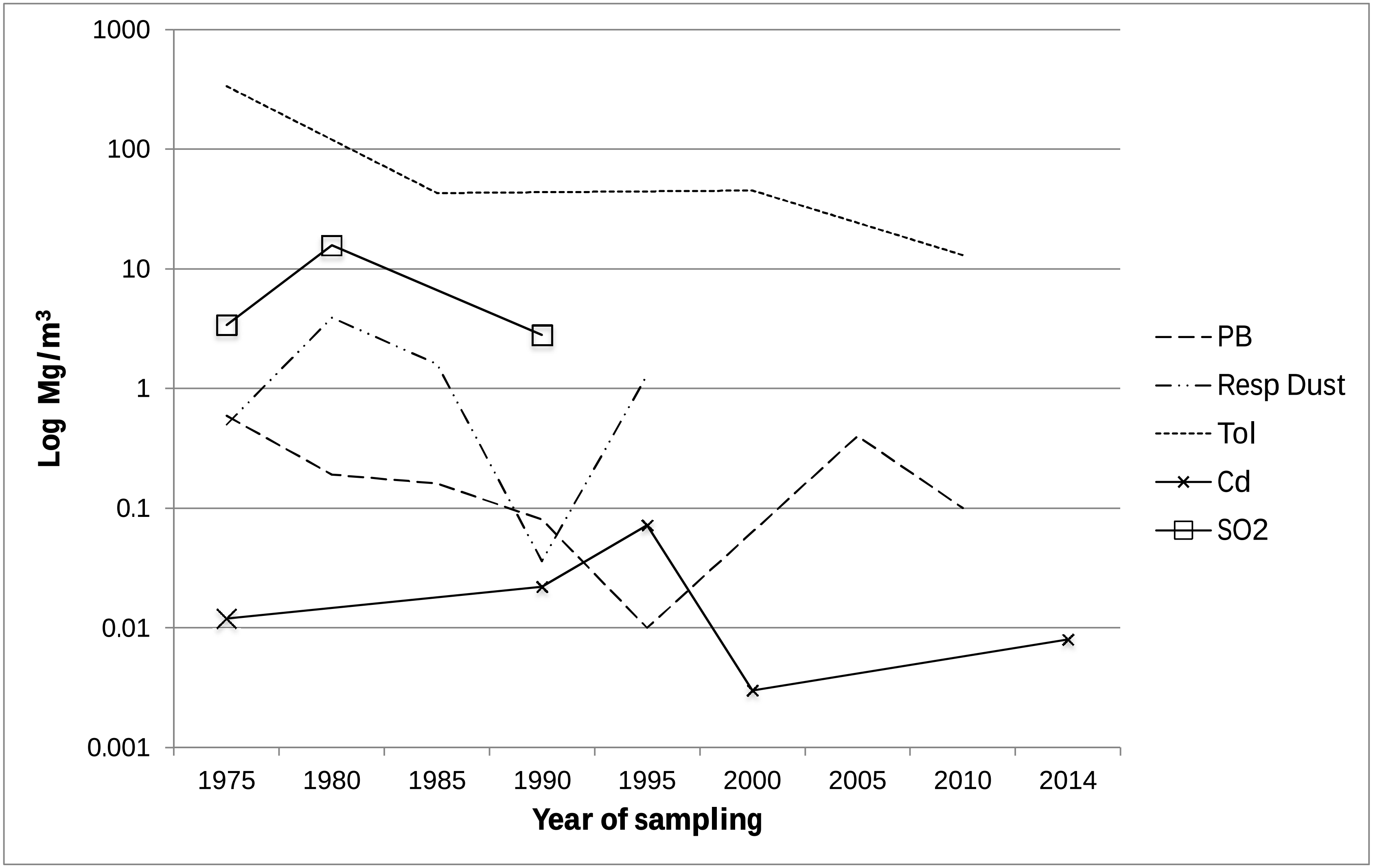

Figure 2: Sample concentration time trends for several example substances: lead (PB), respirable dust (Resp Dust), total dust (Tol), cadmium (Cd), and sulfur dioxide (SO2).

4.2. Potential Data Gaps

In order to demonstrate use of the data in identifying possible knowledge gaps, we looked at where it is thought Manitobans are being exposed to carcinogens, and compared that to the number of exposure measurements abstracted form the WHSD archives and reports.

The prevalence estimates come from CAREX Canada; the resulting rate is "number of exposure measurements per 1,000 carcinogen-exposed persons". The results are shown in Figure 3.

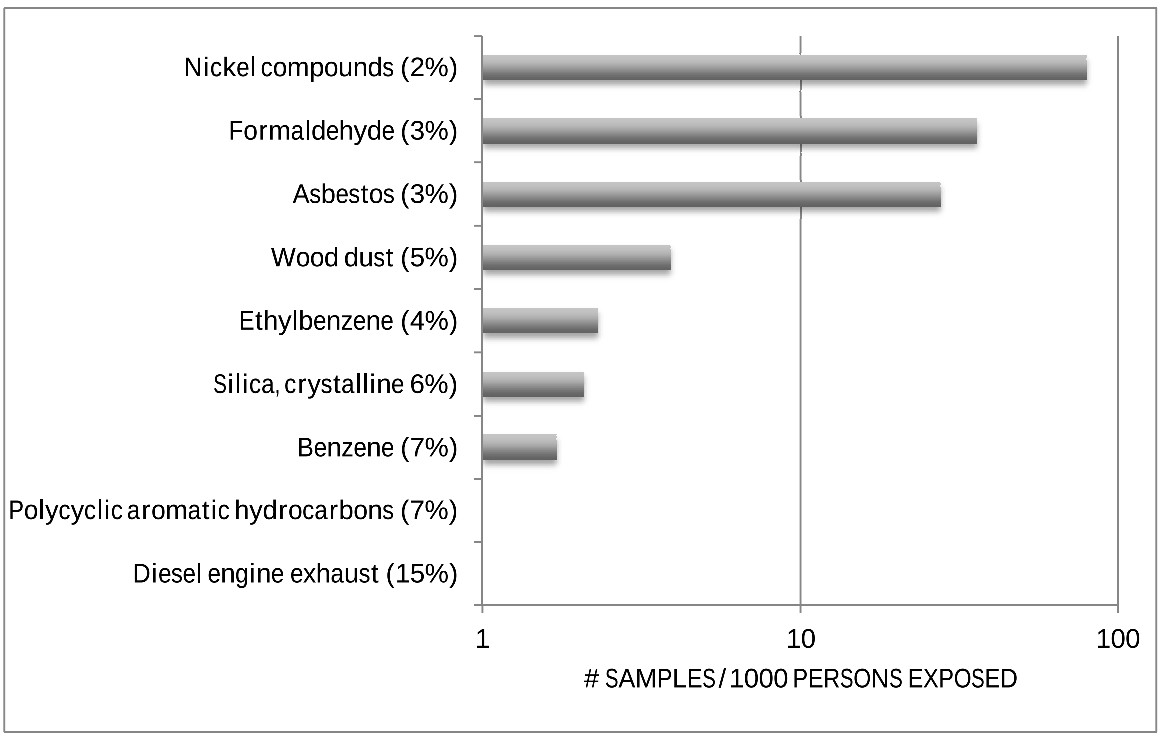

Figure 3: Rate of exposure measurements per 1000 persons exposed. The top 10 chemical carcinogens (by exposure prevalence in MB) are shown (percentage of total carcinogen prevalence in MB is in parentheses).

While this metric is somewhat abstract, it does suggest that some carcinogen exposures (such as lead) are better characterized than others. For the given prevalence of exposure lead has about 10 times as many measurements as asbestos, for example. Lead was also measured in 30 different industries, as opposed to 5 for asbestos. Two of the most prevalent occupational carcinogen exposures – diesel engine exhaust and PAH's were not found to have been measured at all.

4.3. Knowledge translation

An interim copy of the Manitoba occupational exposure database was provided to the Manitoba Ministry of Labor Workplace Health & Safety Division, with accompanying data dictionary, in December 2012.

A Canadian Workplace Exposure Database website has been developed and can be found at http://cwed.spph.ubc.ca

CWED-related peer-reviewed papers published during study period included:

- *Hall, AL., C. Peters, HW Davies, PA Demers, Occupational Exposures in Canadian Veterinary Settings: Findings on antineoplastic drugs and ionizing radiation from a national surveillance project; Can J Pub Health, 2013, 104(7): e460-e465*
- *Hall, AL., C. Peters, PA Demers, HW Davies; Exposed! Or not? The diminishing record of workplace Exposure in Canada, Can J Pub Health, 2014; 105(3):e214-e217*

Conference presentations related to Canadian Workplace Exposure Database undertaken during the study period included:

- *Davies, HW, C Peters, A Hall, PA Demers, Canadian Workplace Exposure Database (CWED): Past, Present and Future; Accepted, CARWH Conference, Saskatoon, Oct 19th, 2014*
- *Demers, P, C Peters, H Davies, J Kim, M Pahwa, C McLeod, AM Nicol, F Labreche, J Levoue, S Hutchings, L Rushton; Incorporating more detailed exposure assessment with quantitative estimates is assessing the burden of occupational cancer. Occup Environ Med. 2014;71*

Suppl 1:A51. 24th International Conference on Epidemiology in Occupational Health EpiCOH meeting, June 2014, Chicago

- *Hall AL, Peters CE, Davies HW, Demers PA. "Occupational exposures in veterinarians: findings from a national surveillance project (CAREX Canada)." 23rd International Conference on Epidemiology in Occupational Health EpiCOH meeting, June 18-21 2013, Utrecht, Netherlands. Oral presentation.*

A summary of other CAREX/CWED interactions in Manitoba included:

- *A tailored webinar "CAREX Overview": WCB Manitoba and Workplace Safety and Health (Government of Manitoba), June 6, 2012 (10 attendees)*
- *A tailored Webinar "CAREX Tools for Occupational Exposure Surveillance in Manitoba": WCB Manitoba and Workplace Safety and Health (Government of Manitoba), May 14, 2013 (8 attendees)*
- *Discussion with Bruce Cielen regarding next steps for CAREX estimates (potential pilot project for occupational disease unit): July 3, 2013 (Bruce Cielen joined CAREX Knowledge Translation Advisory Committee, July 3, 2013*
- *A needs assessment interview: Richard Rusk (Chief Occupational Medical Officer - Workplace Safety and Health, Government of Manitoba), March 15, 2014*
- *Abstract accepted at 2014 CARWH Conference in Saskatoon, SK: ""Canadian Workplace Exposure Database (CWED): Past, Present and Future"; Oct 20-22nd, 2014*

5. Conclusions

In conclusion, we consider the project a success. Almost 22,000 occupational exposure measurements were digitized, cleaned and coded and added to the Canadian Workplace Exposure Database (CWED).

The abstraction cost per measurement was approximately $2, which compares very favourably with the costs observed in similar studies. An earlier UK study estimated £7 per measurement using their most cost-effective method (10). We concur with the authors of that study that *prospective* data entry would be a far cheaper option.

Of the 21,964 measurements abstracted, complete data was available for only a subset of the potential variables (company, date, substance, concentration and units). All other variables suffered some degree of missing values. This was to be expected, as the purpose of the original data collection varied. With no standardized data collection procedure anticipating future needs, the kind of data collected was also highly varied. Nevertheless, we have information on other variable, such as occupation (40% available), work task (29%), and duration of sample (63%). in useful numbers. Exactly what data should be considered “key” has been widely debated and varies depending on the kind of research/surveillance being done (11). Industry and exposure data is sufficient for CAREX Canada purposes for estimating the prevalence of carcinogen exposure, for example. However, to be useful in assessing interventions, additional data on control (e.g. ventilation or personal protective equipment) would be required.

Data covering the period 1953-2012 was abstracted. Periods of data collection appeared cyclical; there were periods of intense data collection but it was not clear the reason for these increased levels of sampling activity. Recording the reason for measurement (e.g. complaint, research, routine inspection) would greatly help with the interpretation of these data.

When examining the amount of exposure data by sector, it is not surprising to see mining and manufacturing leading the way with over 90% of the abstracted exposure measurements. It is perhaps more surprising to see which sectors have historically received much less exposure measurement attention, such as construction, agriculture and transportation for exposure to substances such as crystalline silica, pesticides, carbon monoxide, and diesel engine exhaust.

Regarding substances monitored, the single largest agent was “dust” with almost 2,200 samples, or 10% of all measurements. These were largely (86%) from mines. Metals (lead, zinc, copper, cadmium) were also commonly tested, which is consistent with the most commonly tested occupation being welders.

We showed some time trends for several different substances as a demonstration analysis. Additional data would be needed to make a useful interpretation of these data, but the potential is demonstrated.

In order to explore whether data or knowledge “gaps” existed, we compared the prevalence of carcinogen exposures in Manitoba as estimated by CAREX Canada with the number of sampling measurements made for the same carcinogens. With this metric we can see that compared to lead, other common carcinogens such as benzene and silica are far less likely to be tested. Further, while diesel exhaust and PAH’s represent 33% of estimated carcinogen exposures in Manitoba workers, no occupational measurements were collected throughout our study period.

Of course there may be many reasons for this variability in the rate of testing per exposed population, but this provides a simple tool to help identify where future sampling efforts might need to be made.

6. Future Work and Recommendations

This project is one in a series that has enabled the investigators to digitize occupational exposure data from across Canada for inclusion in a national exposure database. At the same time, exposure data is "mobilized" for the data owner, with the intent of making the data more useful to them in their own work.

Manitobans – through future work in improving and expanding the CWED – will continue to see benefits from this project. Currently, CWED is finalizing data acquisition with ongoing projects in Newfoundland and Nova Scotia, and in discussions with the Federal Government for additional data. Concurrently we are continuing to work with over 420,000 data points to standardize samples across multiple discrete "provincial" (or agency) databases to create an integrated national resource. At the same time we are working on developing tools to allow researchers and policy-makers open access to the data, as well as developing policy and procedures to ensure data access meets all necessary privacy and confidentiality laws and requirements of the data owners.

As part of this development the CWED group will publish a "discussion paper" in 2014 (at or before the Canadian Association for Research on Work and Health – CARWH – conference in Saskatoon in October 2014) that will outline in greater detail the steps necessary to creating CWED as a national resource. The discussion paper will cover issues around what data should be collected and stored, privacy and confidentiality, data access, updating the database with new data, and access tools and protocols. Following publication of the discussion paper and a period of review, CWED will coordinate a national (likely web-based) workshop to discuss the proposals made in the document. We will invite and encourage Manitoba agencies to continue to be a part of the development of the Canadian Workplace Exposure Database (CWED) and we will forward copies of the forthcoming discussion.

Specifically with respect to relevant agencies in Manitoba, we will continue to communicate projects updates, including database updates (such as coding improvements) and data analyses (such as updating CAREX Canada estimates of carcinogen exposure using new exposure data). We also hope to continue to work with Manitoba agencies on the development of new procedures and tools to enhance the value and utility of occupational exposure databases.

We encourage MB Ministry of Labor, Workplace Health and Safety Division, to continue to collect occupational exposure data and to enter it into the exposure database as this is the most cost-effective manner in digitizing exposure measurements. We also recommend that careful consideration be given to the supplementary data that is collected at the time of sampling. Key variables that we have identified for inclusion in the CWED are shown in Appendix A. This should be considered the minimum that is collected, but additional data may be required depending on the proposed use of the data.

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Appendix A: CWED "Key" Variables

CWED Variable	Description
StudyGroupID	Study group identifier
SampleID	Unique identifier for each sample
SampleDate	Date the sample was taken
AnalyteCode **(CAS, CCODE, AnalyteCode)**	Code for substance being measured
AnalyteName	Name of the substance being measured
ResultValue	Sample result measurement value
ResultUnit	Unit of measurement for the sample result
Concentration	Calculated standardized concentration value
ConcentrationUnit	Unit of measurement for the concentration
AirVolume	Total volume of air sampled
Duration	Total time of sample
LimitOfDetection	Limit of detection
LimitOfDetectionUnit	Unit of measurement for the limit of detection
MethodCode	Analytical sampling method code
MethodDesc	Analytical sampling method description
NAICSCode	North American Industry Classification System (2002) code
NOCSCode	National Occupational Classification (2006) code
AreaOrPersonal	Location type of sample: Area, Personal, Unknown
Province	Province
QualControlDone	Quality control check completion indicator
OrigDataHolderID	Identifier of original data holder
DataHolderType	Type of organization holding the original data (regulator, industry, etc)
SizeFraction	Size fraction for particulate samples
CompanyID	Company code
CompanyName	Company name and other information available
CompanyType	Company type information
OtherSampleInfo	Other fields which add information about samples
ReasonForSampling	Reason for sampling
PersonalProtection	Type or sometimes just whether or not personal (or collective) protection equipment is used
WorkAreaDesc	Free form comments on work area
JobDesc	Job description information
Timing	Other fields with timing information
Ventilation	Type of ventilation in place
Eng_controls	Other engineered exposure controls?
Admin_control	Type of administrative controls in place?
PPE	Type of PPE in use