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Comorbid Survival Among Elderly Male Participants of the Canada Health Survey: Relevance to Prostate Cancer Screening and Treatment

Libni Eapen, Paul J Villeneuve, Isra G Levy and Howard I Morrison

Abstract

This study assessed the survival of a nationally representative sample of older Canadian men, taking into account common comorbid conditions. Mortality follow-up between 1978 and 1989 was conducted for male participants of the Canada Health Survey who were at least 60 years of age at baseline. The proportional hazards model and life table methods were used to examine survival by comorbidity status. Comorbid conditions examined included history of stroke and/or heart disease, high blood pressure, chronic bronchitis or emphysema, diabetes and smoking status, but excluded cancer because of small numbers. For those subjects aged 80 and older, comorbidity was not a significant predictor of survival. A large portion of men between the ages of 60 and 79, even those with pre-existing comorbid conditions, survived at least 10 years after interview. In a clinical setting, more detailed information on comorbid conditions can be obtained to better estimate long-term survival. Notwithstanding, our findings may have implications for the administration of population-based health interventions (e.g. the use of prostate-specific antigen [PSA] blood tests for the early detection of prostate cancer). In particular, our results suggest that there may be little benefit in restricting access to PSA screening based on survival probability in men under age 80.

Key words: *Canada; chronic diseases; comorbidity; mortality; proportional hazards model; survival*

Introduction

Comorbid conditions are significant determinants of survival for most chronic diseases. The importance of classifying subjects by comorbidity has been demonstrated in patients with many chronic conditions, including diabetes mellitus,[1,2] end-stage renal disease[3] and breast cancer.[4] The identification and control of comorbid conditions is also essential in the conduct of clinical trials. By properly identifying disorders that threaten survival, patients with an increased risk of death from comorbid condition(s) can be randomized separately from patients with a lower risk.[5] Short-term studies often exclude patients with comorbid conditions, which limits their generalizability.[6,7]

For patients diagnosed with cancer, clinicians must often decide between administering a treatment that may compromise the patients' quality of life versus treating a malignancy in a less aggressive fashion. This is particularly relevant among older cancer patients who have a reduced life expectancy. Given the increased prevalence of comorbid conditions among the elderly, a better understanding of the influence of these conditions on survival may help determine the most appropriate cancer therapy.

Assessing comorbid conditions may be important before using available screening tools, such as prostate-specific antigen (PSA) for the early detection of prostate cancer. For example, the American Cancer Society guidelines recommend PSA screening for men with at least a 10-year

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life expectancy.[8] It may be that neither early diagnosis nor early treatment is necessary for men harbouring moderately or well-differentiated prostate cancer with limited life expectancies.[9] Since the overwhelming majority of prostate cancer is diagnosed in men aged 60 and over,[10] many of these patients have significant co-existing medical conditions that may contribute more in determining longevity than does prostate cancer. At present, it is unusual for clinicians to employ any rigorous methodology to predict longevity. Adjusting for comorbidity is also important in case-control studies of screening efficacy.[9]

The objectives of this study were to assess the individual and combined influence of comorbid conditions on survival among males aged 60 and older and to develop a comorbidity score that could be rapidly and easily applied to broadly determine the likely survival of an elderly man, using the Canada Health Survey.[11]

Methods

The Canada Health Survey

The Canada Health Survey (CHS) was conducted in 1978 and 1979 to aid in the planning of health care, health promotion and disease prevention by examining lifestyle, biomedical and environmental risks to future health. It was designed to represent the non-institutionalized Canadian population, with the exception of the approximately 3% of the population that resided in the territories, Indian reserves and remote areas as defined by the Canadian Labour Force Survey. Sampling was stratified by province, then by area (major city, urban and rural).[11]

A total of 12,218 dwellings were selected to participate in the CHS; of these, 86% took part in the interview component of the survey.[11] A physical measures component was administered to roughly 25% of eligible households, collecting measurements of blood pressure, cardiorespiratory fitness, height and weight.

Three forms were used in the interview section of the CHS. The first, the Household Record Card, recorded particular characteristics of the dwelling and residents. The second form, the Interviewer Administered Questionnaire (IAQ), collected data that, in general, required probing by an interviewer. For this purpose, proxy information was gathered from a suitable member of the household.

The Lifestyle and Your Health Questionnaire (LHQ) gathered information that could be sensitive and only reliably provided by the person involved. Due to its content, this third questionnaire was administered only to persons 15 years of age and over. There was a 16% non-response rate for the LHQ, resulting from subjects who responded to the IAQ but who did not provide a valid response to at least one compulsory item on the LHQ.

Follow-up of the Cohort

We determined the mortality history of the cohort by linking the CHS file to the National Mortality Database maintained by Statistics Canada. Record linkage for deaths occurring between 1978 and 1989 was performed using an iterative probabilistic weighting scheme.[12] Questionable links were resolved manually by inspecting death certificates. Previous studies have demonstrated the ability of these record linkage techniques to identify vital status in longitudinal studies.[13,14]

Selection of Subjects

We examined the mortality experience only of males who were at least 60 years old at the time of interview. In total, 1939 subjects of the CHS met this inclusion requirement. Eighty-four individuals with a previous diagnosis of cancer (excluding non-melanoma skin cancer) were excluded from the analysis. We felt that assessment of the influence of cancer as a comorbid factor could not be made due to the small number of cases and the unavailability of information on the site of cancer diagnosis.

The comorbid conditions examined included history of high blood pressure, heart disease, emphysema or bronchitis, stroke and diabetes. For each subject this information was obtained from both the IAQ and LHQ components of the survey. Each comorbid condition was coded using an indicator variable.

Cigarette smoking information was obtained from the LHQ interview. Approximately 15% of the 1939 subjects who completed the IAQ were dropped from the analysis due to non-response on the LHQ. Subjects for whom smoking status was not available were also excluded from the analysis, resulting in a loss of 9.7% of the remaining subjects. All statistical analyses were performed on the remaining 1417 subjects.

Statistical Analysis

We used the proportional hazards model[15] to assess the role of comorbidity on survival. This model assumes that those patients with comorbid ailments have an increased risk of mortality that remains constant over the follow-up period. In our analyses, the assumption of proportionality was formally tested by examining survival curves generated using the actuarial life table and by testing the significance of a time covariate in the regression model.

Subjects were classified as current, former or never smokers. All other comorbid conditions were coded as a binary variable (0 = absent, 1 = present). Two series of risk estimates were produced with the proportional hazards model. Unadjusted relative risks assessed the risk of mortality for a patient with a given comorbid condition, independent of the presence of other comorbid factors. The second series of risk estimates was further adjusted for the influence of all other comorbid factors and smoking. Both series of risk estimates were adjusted for differences in age at interview by including a categorical variable, denoting five-year age groups, into the proportional hazards model.

TABLE 1

Characteristics of male study subjects, 60 years of age and older, selected from the Canada Health Survey

Number of subjects	1417
Mean age	68.6 (6.64)[a]
Person-years of follow-up	12542
Observed number of deaths	603
Self-reported history of comorbid conditions	
Heart disease	23.0%
High blood pressure	36.6%
Emphysema/Chronic bronchitis	9.3%
Diabetes	6.6%
History of stroke	4.2%
Smoking status	
Never smoker	19.7%
Current smoker	37.7%
Former smoker	42.6%
Proportion of subjects with a comorbid condition other than smoking	
Age 60–69	48.0%
Age 70–79	58.0%
Age 80+	68.2%
Age 60+	55.2%

[a] Standard error (in parentheses)

The adjusted relative risks estimated from the proportional hazards model were used to create a variable that summarized the overall influence of comorbidity on survival. This summary variable was then entered into a proportional hazards model with age to create an index of survival that combined both age and comorbidity. Survival curves were then plotted by the age-comorbidity score, using the actuarial life table method.

Results

The average age of the subjects included in the analysis was 68.6 years, and 80% of them were either current or former smokers (Table 1). The proportion of patients aged 60–69, 70–79 and 80 or older who reported at least one comorbid condition besides smoking was 48%, 58% and 68%, respectively.

As anticipated, long-term survival rates decreased with increasing age (Table 2). The survival rates of those men aged 80 or older were particularly low, with only 26% surviving 10 years of follow-up. Poorer survival was also observed for those subjects reporting comorbid conditions. Among males aged 60–79, after adjustment for the presence of other comorbid factors, the risk of mortality for current smokers was 1.57 relative to those who had never

TABLE 2

Ten-year actuarial survival rates, by comorbid condition and age group, Canada Health Survey, 1978–1989

	Age 60–69		Age 70–79		Age 80+	
Comorbid condition	Subjects	10-year survival rate[a]	Subjects	10-year survival rate[a]	Subjects	10-year survival rate[a]
Smoking status						
Never smoker	148	0.82 (0.03)	92	0.61 (0.05)	39	0.26 (0.07)
Former smoker	348	0.74 (0.02)	207	0.52 (0.03)	49	0.20 (0.06)
Current smoker	371	0.65 (0.02)	141	0.52 (0.04)	22	0.41 (0.10)
History of heart disease						
No	685	0.75 (0.02)	327	0.58 (0.03)	79	0.29 (0.05)
Yes	182	0.57 (0.04)	113	0.52 (0.04)	31	0.16 (0.07)
History of high blood pressure						
No	556	0.73 (0.02)	273	0.58 (0.03)	69	0.28 (0.05)
Yes	311	0.68 (0.03)	167	0.42 (0.05)	41	0.20 (0.06)
Diabetes						
No	810	0.72 (0.02)	414	0.55 (0.02)	100	0.27 (0.04)
Yes	57	0.67 (0.06)	26	0.34 (0.09)	10	0.20 (0.13)
Chronic bronchitis/emphysema						
No	793	0.73 (0.02)	395	0.55 (0.02)	97	0.23 (0.04)
Yes	74	0.49 (0.06)	45	0.44 (0.07)	13	0.23 (0.12)
History of stroke						
No	842	0.72 (0.02)	415	0.56 (0.02)	101	0.29 (0.05)
Yes	25	0.52 (0.10)	25	0.28 (0.09)	9	0.00 (0.00)
ALL SUBJECTS	867	0.71 (0.02)	440	0.54 (0.02)	110	0.26 (0.04)

[a] Standard error of survival rate estimate (in parentheses)

TABLE 3

Relative risk of mortality, by comorbid condition, among 1417 male participants aged 60–79, Canada Health Survey, 1978–1989

Comorbid condition	Number of subjects	Unadjusted relative risk[a]	Adjusted relative risk[b]
Smoking status			
Never smoker	512	1.00 —	1.00 —
Former smoker	555	1.37 (1.09–1.73)	1.27 (1.01–1.60)
Current smoker	240	1.65 (1.31–2.08)	1.57 (1.24–1.99)
History of heart disease			
No	1012	1.00 —	1.00 —
Yes	295	1.66 (1.39–1.98)	1.52 (1.27–1.83)
History of high blood pressure			
No	829	1.00 —	1.00 —
Yes	478	1.40 (1.19–1.64)	1.28 (1.08–1.52)
Diabetes			
No	1224	1.00 —	1.00 —
Yes	83	1.24 (0.92–1.66)	1.17 (0.87–1.58)
Chronic bronchitis/emphysema			
No	1188	1.00 —	1.00 —
Yes	119	1.60 (1.26–2.04)	1.57 (1.23–2.01)
History of stroke			
No	1257	1.00 —	1.00 —
Yes	50	1.99 (1.43–2.76)	1.53 (1.09–2.14)

[a] Relative risk calculated using proportional hazards model and adjusted by five-year age group; 95% confidence interval (CI) in parentheses

[b] Relative risk calculated using the proportional hazards model, adjusted for presence of other comorbid conditions and by five-year age group; 95% CI in parentheses

smoked (Table 3). Similarly, the risks of mortality for subjects with a prior history of heart disease, chronic bronchitis or emphysema, diabetes, high blood pressure and history of stroke were 1.52, 1.57, 1.17, 1.28 and 1.53, respectively, when compared to those with no history of the corresponding comorbid factor (Table 3).

Because comorbidity was not significantly predictive of risk among men aged 80 and older, we calculated age-comorbidity scores only for men aged 60–79. A weighted index was created based on the adjusted estimates of relative risk for men aged 60–79. For those conditions whose relative risk was less than 1.5, the subject was assigned a weight of one if the comorbid condition was present and zero, otherwise. Similarly, conditions with a relative risk greater than or equal to 1.5 were given a weight of two or zero. The assigned weights for each of the comorbid conditions are listed in Table 4. For each subject, the weights of all the comorbid conditions were summed, yielding a summary measure of comorbidity with a range between zero and eight.

TABLE 4

Assigned weights for calculating age-comorbidity index, male participants aged 60–79, Canada Health Survey, 1978–1989

Assigned weight	Comorbidity/age factor
1	Former smoker
1	History of high blood pressure
1	History of diabetes
2	History of stroke
2	Current smoker
2	History of heart disease
2	History of chronic bronchitis or emphysema
2	Age 65–69
4	Age 70–74
6	Age 75–79

A proportional hazards regression analysis was subsequently performed using the summary variable for comorbidity and age as covariates. The risk associated with each five-year increase in age was approximately 1.8 times the risk associated with increasing the comorbidity index by one. An age-comorbidity index of survival was constructed, using the approach outlined by Charlson.[4] Each five-year age group after age 60–64 was assumed to contribute two points of risk. The age-comorbidity score was the sum of the individual scores associated with age and comorbidity (Tables 4 and 5). For example, a 77-year-old cigarette-smoking subject would have a comorbidity score of two, an age score of six and an age-comorbidity score of eight.

Decreased survival was observed with increased levels of comorbidity for subjects aged 60–69 and 70–79 (Figures 1 and 2). There was no clear gradient associated with

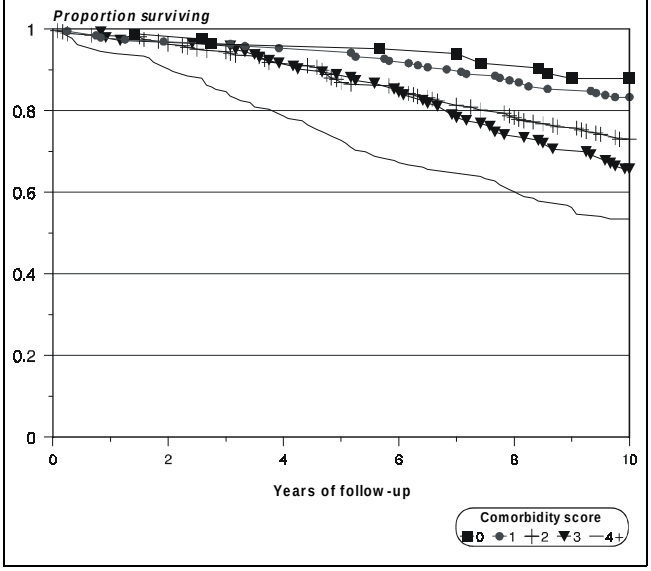
TABLE 5

Relative risk of mortality, by age-comorbidity score, male participants aged 60–79, Canada Health Survey, 1978–1989

Age-comorbidity score	Relative risk[a]	95% confidence interval	10-year survival rate[b]	Survival standard error
0	1.00	—	0.94	0.04
1–2	2.69	(0.98–7.41)	0.83	0.02
3–4	5.75	(2.13–15.50)	0.66	0.03
5–6	7.19	(2.66–19.44)	0.62	0.03
7–8	10.03	(3.71–27.18)	0.49	0.03
9+	14.69	(5.34–40.39)	0.34	0.05

[a] Estimated using the proportional hazards model
[b] Estimated using Kaplan-Meier survival estimates

FIGURE 1
Kaplan-Meier estimates of survival, by comorbidity score, male participants aged 60-69, Canada Health Survey, 1978-1989



comorbidity for subjects aged 80 and older. Ten-year survival rates for men in this age group ranged from 14% to 35% across categories of comorbidity (Figure 3).

The 10-year survival rate for these men with an age-comorbidity score of zero was 94% (Table 5). The relative risk of mortality increased dramatically with higher age-comorbidity scores. Those having an age-comorbidity score of at least nine were approximately 15 times more likely to die during follow-up (Table 5). Kaplan-Meier survival curves are provided in Figure 4 for categories of age-comorbidity scores.

FIGURE 2
Kaplan-Meier estimates of survival, by comorbidity score, male participants aged 70-79, Canada Health Survey, 1978-1989

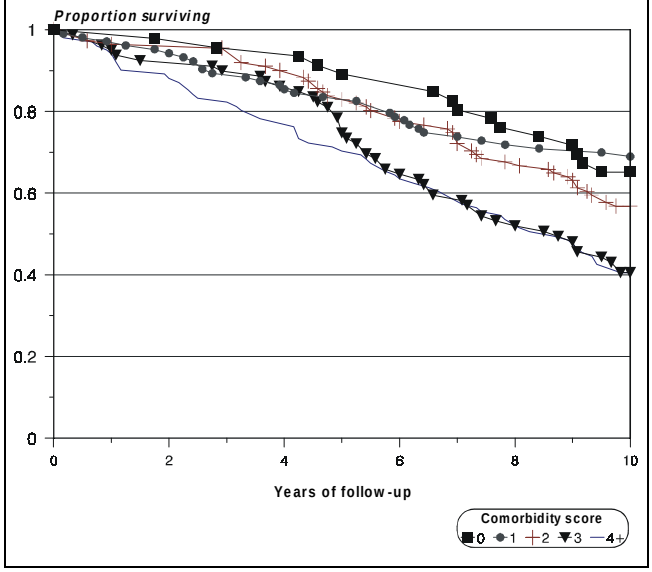
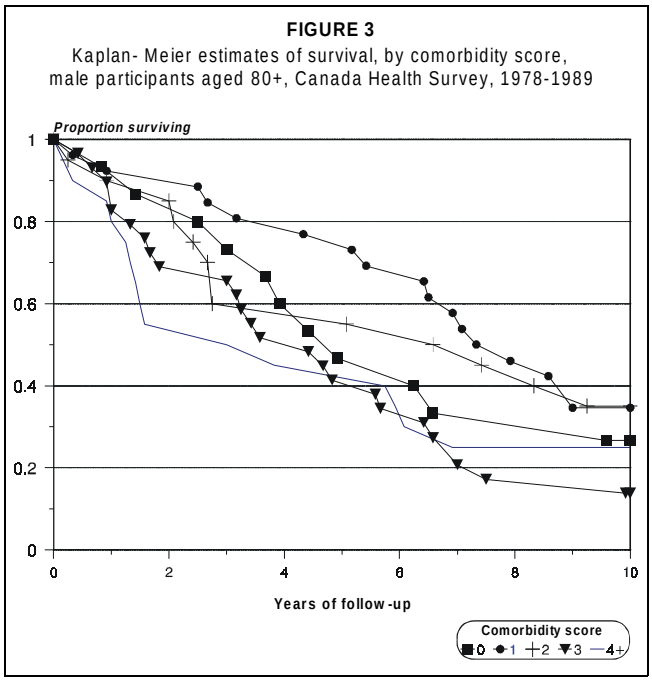


FIGURE 3
Kaplan- Meier estimates of survival, by comorbidity score, male participants aged 80+, Canada Health Survey, 1978-1989

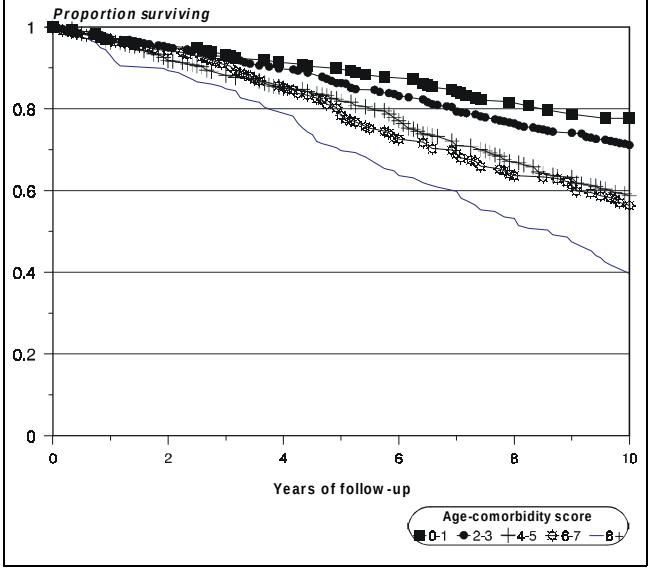


Discussion

The index derived in this study permits the classification of subjects into risk categories that take into account common comorbid conditions, such as smoking and age. Thus, for an elderly man who develops a disease with a poor prognosis, the most appropriate therapy to administer might be one whose primary goal is to maximize quality of life and for which the reduction of long-term consequences of the disease is of secondary interest. Conversely, the

FIGURE 4

Kaplan-Meier estimates of survival, by age-comorbidity score, male participants aged 60+, Canada Health Survey, 1978-1989



proposed index would allow the identification of patients for whom aggressive therapy might be more suitable. Although the model performed quite well in predicting survival, its utility in predicting survival will need to be validated using other population-based cohorts.

Another use of comorbidity scores would be to assess the merits of treating or screening for particular health problems. For example, it is recommended that men with a life expectancy of less than 10 years be advised that both screening and treatment for prostate cancer are unlikely to be beneficial and may decrease quality of life.[8,17] An increasing number of physicians are ordering the PSA screening test for men with neither signs nor symptoms of prostate cancer.[17]

The data used in this study offer several advantages compared with prior research on the role of comorbidity on survival. Previous studies have relied on hospital or clinic data. Because the CHS was designed to represent the Canadian population, the present study should have avoided any potential bias that could have arisen because of referral patterns. The large sample size of the CHS allowed for the analyses to be limited to males 60 years of age and older. The influence of comorbidity on survival in this age group is of particular interest right now, due to the much higher prevalence of chronic diseases in this population coupled with current controversies surrounding the efficacy of PSA testing.

Although the Canada Health Survey was designed to draw from a representative sample of Canadians,[11] a sizeable number of subjects were dropped from our analyses due to missing data. The 10-year survival rate for men excluded from analyses was lower than for those subjects who were retained (55% vs 63%). The difference in survival between these two groups can be partly attributed to differences in age. The mean age of those men removed from analyses was approximately 1½ years greater than the mean age of those included. The net effect of excluding these subjects from our analyses is that our survival estimates may slightly overestimate the mortality experience of the older male Canadian population.

The prognostic value of common comorbid conditions among males aged 60–79 is presented in this study. Among those men aged 80 or older, comorbid conditions were not significant determinants of survival. A more refined characterization of survival could have been done had other baseline characteristics been included in the regression analyses. For example, other important predictors of survival for people with diabetes include type of diabetes (i.e. insulin- or non-insulin-dependent) and onset of diabetic nephropathy.[18] Similarly, the risk of mortality for smokers is associated with duration of use, daily consumption and depth of inhalation.[19] However, we have shown that the scores derived even from simple, unvalidated self-reports on comorbidity status were significantly predictive of survival.

It is likely that the presence of comorbid conditions were underreported by participants of the CHS. As a result, the survival rates presented probably overestimate the true survival of males with comorbid conditions and underestimate survival for males with no comorbid conditions.

The smoking behaviour of some subjects likely changed during the follow-up period. However, the resulting effect on risk of mortality by smoking status should not be substantial. The vast majority of smokers initiate smoking during their teenage years; older smokers usually have been addicted for a longer period and, consequently, are less likely to change consumption patterns.[19] Additional comorbid conditions other than smoking also may have developed during the follow-up period. Such changes do not detract from the comorbidity and age-comorbidity indices, since their value lies in the ability to predict survival given only baseline measures.

Since the initiation of follow-up of the CHS, many improvements have been made in the treatment of chronic diseases and comorbid factors. For example, new hypertensive agents and refinements in therapy have reduced long-term stroke and cardiac complications.[20,21] With continuous progress in the control and prevention of chronic disease, it follows naturally that the long-term survival rates of males who are now over the age of 60 should be higher than the rates of those on whom the analysis was based.

Notwithstanding a lack of endorsement from the Canadian Urological Association,[22] PSA screening is widespread in Canada.[23] Prostate cancer is controversial, in part because some prostate cancers detected by screening

will be indolent and, especially among older men with comorbid conditions, will not affect survival. However, our results demonstrate that a large number of men between the ages of 60 and 79, even those with pre-existing comorbid disease, are likely to survive at least 10 years. Consequently, efforts to restrict access to PSA screening based on survival probability are unlikely to substantially affect the overall costs of mass screening.

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Workshop Report

Health Risks of Drinking Water Chlorination By-products: Report of an Expert Working Group

Christina J Mills, Richard J Bull, Kenneth P Cantor, John Reif, Steve E Hrudey, Patricia Huston and an Expert Working Group

Abstract

Studies of water chlorination by-products have suggested a possible increased risk of bladder and colon cancers, as well as adverse reproductive and developmental effects such as increased spontaneous abortion rates and fetal anomalies. A workshop for an expert working group was convened to advise Health Canada on the need for further action. Participants were given background papers and a set of key questions to review prior to the meeting. At the workshop, experts presented an overview of what was known to date on water chlorination by-products from toxicologic studies, epidemiologic studies of cancer and adverse reproductive/developmental effects, and risk assessment. This paper summarizes the information provided in the background papers and presentations, describes the consensus arrived at regarding assessment of evidence for level of risk and presents a number of suggestions for future research.

Key words: *cancer; chloramination; chlorination; chlorine; disinfection by-products; epidemiology; ozonation; reproductive health; toxicology; trihalomethanes*

Introduction

A number of recent epidemiologic studies, including a 1995 study sponsored by Health Canada, have found a modest increase in the risk of bladder cancer among people who had drinking water that included high levels of chlorination by-products. Other studies of water chlorination by-products have suggested possible increased risks of colon and rectal cancers, as well as adverse reproductive and developmental effects, such as increased spontaneous abortion rates and fetal anomalies.

Chlorination by-products are created as a result of water purification procedures that have been used for decades to prevent the spread of microbial disease. Chlorination has been hailed as one of the most important public health initiatives of the century. Thus, any examination of the need for further action regarding the human health risks from chlorination by-products must not compromise microbial disinfection. In Canada, the currently acceptable level of the most common by-products, the trihalomethanes (THMs), is 100 μg/L. Other disinfectants, such as chloramine and ozone, also create by-products. The toxicity of these by-products has not been extensively studied.

These concerns led the Laboratory Centre for Disease Control to question whether current Canadian policies on chlorination by-products should be re-examined in light of the evolving body of evidence on their risks. Subsequently, a meeting was held in Ottawa on May 1–2, 1997, with leading epidemiologists, toxicologists, public health specialists and water quality experts. The

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Expert Working Group: List of participants at end of article

meeting's objectives were to obtain authoritative advice on cancer and reproductive risks associated with exposure to water chlorination by-products, to determine their likely importance for public health and to advise Health Canada on how to proceed.

A three-step process was undertaken to meet the objectives. Participants were given background papers and a set of key questions to review prior to the meeting. At the workshop, experts presented an overview of what was known to date on water chlorination by-products from toxicologic studies, epidemiologic studies of cancer and adverse reproductive/developmental effects, and risk assessment. Following this, participants responded to key questions and arrived at conclusions and recommendations.

This paper summarizes the information provided in the background papers and presentations, describes the consensus arrived at regarding assessment of evidence for level of risk and presents suggestions for future research.

Toxicology

Richard J Bull

Chlorination of drinking water is the most cost-effective means to prevent the spread of waterborne infections and has been a common public health method for almost a century. In 1974, a major class of chlorination by-products, the trihalomethanes (THMs), was identified as occurring in much higher concentrations in chlorinated water than in source water. THMs are produced from the interaction of chlorine with naturally occurring organic materials.

The many by-products produced by water chlorination have been classified broadly as halogenated or non-halogenated by-products (Table 1). The most commonly occurring halogenated by-products are the THMs; within this group of compounds, chloroform is the by-product found most frequently and at the highest concentrations. A second commonly occurring class of by-products is the haloacetic acids, which include dichloroacetic acid (DCA) and trichloroacetic acid (TCA). Non-halogenated by-products are generally natural substrates or metabolites.

The major determinant of by-product concentration is the level of organic material in the source water. For this reason, water facilities that derive their water from surface waters (lakes, rivers, reservoirs) produce water with higher levels of by-products than facilities that draw from ground waters (wells, springs). After chlorination, THM concentrations range from 30 to 150 µg/L in surface water, and from 1 to 10 µg/L in ground waters. The type and quantity of by-products formed is determined by the amount and character of organic material, as well as the ambient pH and bromide concentration in the water.

TABLE 1

Major classes of chlorination by-products

HALOGENATED COMPOUNDS
Trihalomethanes
chloroform bromodichloromethane dibromochloromethane bromoform
Haloacetates
dichloroacetate trichloroacetate bromochloroacetate dibromoacetate bromodichloroacetate
Haloacetonitriles
dichloroacetonitrile bromochloroacetonitrile
Haloaldehydes
Haloketones
Halohydroxyfuranones
NON-HALOGENATED COMPOUNDS
Aldehydes
Ketones
Carboxylic acids

Animal Studies of Carcinogenesis

A comprehensive toxicologic assessment of chlorination by-products has been difficult due to the many by-products involved and the different modes of action that may result in carcinogenesis. To date, animal studies have focused on by-products with the greatest human exposure or toxicologic concern (Table 2). As a result, the most frequent tumour type observed was liver cancer; this was found in mice and rats after exposure to THMs as well as haloacetates.

The mechanism of cancer induction appears to vary with different by-products and different species. Chloroform, for example, seems to cause cancer by a non-genotoxic (or epigenetic) mechanism and only after massive exposure. Some cancers were species-specific; for example, trichloroacetate produced liver cancer in mice, but not rats. Furthermore, liver cancer from chlorinated by-products has never been found in humans. This suggests that by-products cause liver cancer either through mechanisms that are species-specific or from exposure levels that are much higher than current standards.

Some of the rarer THMs—such as bromodichloro-methane—induce colon cancer in mice. Dibromoacetate has been associated with the development of aberrant crypt foci in the distal colon of rats. These findings are of particular interest because colon cancer has been associated with exposure to high levels of THMs in some epidemiologic studies.

TABLE 2

Cancer and exposure to chlorination by-products: animal studies[a]

Chlorination by-product/ Author (year)	Study animal	Outcome
TRIHALOMETHANES		
chloroform		
National Cancer Institute (1976)	Mice	Liver tumours
National Cancer Institute (1975)	Rats	Kidney tumours
Jorgenson (1985)	Rats	Kidney tumours
bromodichloromethane		
National Toxicology Program (1987)	Rats	Colon and kidney tumours
National Toxicology Program (1987)	Mice	Liver and kidney tumours
chlorodibromomethane		
National Toxicology Program (1984)	Mice	Liver tumours
bromoform		
National Toxicology Program (1989)	Rats	Colon tumours
HALOACETIC ACIDS		
dichloroacetic acid (DCA)		
Herren-Freund (1987), Bull (1990), DeAngelo (1991), Daniel (1992), Pereira (1996)	Mice	Liver tumours
DeAngelo (1996)	Rats	Liver tumours
trichloroacetic acid (TCA)		
Herren-Freund (1987), Bull (1990), Pereira (1996)	Mice	Liver tumours
bromodichloroacetic acid		
Bull	Mice	*Liver and lung tumours*
dibromoacetic acid		
Bull	Mice	*Liver tumours*
So (1995)	Rats	Aberrant crypt foci in colon
bromochloroacetic acid		
Bull	Mice	*Liver tumours*
HALOACETONITRILES		
brominated haloacetonitriles		
Bull (1985)	Mice	Skin tumours

[a] Unpublished studies noted in italics

Animal Studies of Developmental and Reproductive Effects

Most of the toxicologic research on chlorination by-products has focused on carcinogenesis, but in light of recent epidemiologic data, studies of developmental and reproductive effects merit review (Table 3). The most consistent developmental finding was soft tissue abnormalities, including ventricular septal defects. Exposure to haloacetonitriles was associated with embryo death in rats. Degeneration of testicular epithelium has been found in rats and dogs after exposure to haloacetates, but no correlate has been found in human studies.

Although animal evidence demonstrates that high levels of by-product exposure induce cancer in laboratory animals, a number of intriguing issues remain.

TABLE 3

Developmental and reproductive effects and exposure to chlorination by-products (CBP): animal studies

Author (year)	Study animal	Type of CBP	Outcome
Epstein (1992) Smith (1988) Smith (1989)	Rat Rat Rat	Dichloroacetate Trichloroacetonitril Dichloroacetonitrile	Soft tissue defects
Smith (1988) Smith (1989)	Rat Rat	Haloacetonitriles	Embryo death
Toth (1992) Lander (1994)	Rat Rat	Dichloroacetate Dibromoacetate	Degeneration of testicular epithelium
Cicmanec (1991)	Dog	Dichloroacetate	Degeneration of testicular epithelium

No single chlorinated by-product studied in toxicologic studies appears to be carcinogenic at human levels of exposure. Furthermore, evidence for carcinogenesis differs between toxicologic and epidemiologic studies: by-product exposure is most commonly associated with liver cancer in animals and bladder cancer in humans. These differences raise concerns about the appropriateness of current cancer risk estimates derived from animal studies.

It is now recognized that risks from chlorinated drinking water cannot be determined accurately by simply summing up the toxicologic hazards of each individual by-product. Initial toxicologic studies of by-product mixtures have produced little convincing evidence of adverse effect, but this cannot be extrapolated to humans in part because of the diversity in by-product mixtures in treated water currently available. Future research will need to be hypothesis-driven to address this complex issue.

Cancer Epidemiology

Kenneth P Cantor

Over the last 20 years, considerable epidemiologic research has examined possible associations between cancer and water chlorination by-products. The quality of the research has improved greatly over this period, to the point that it is now debatable whether to include earlier studies in a critical overview. The first epidemiologic studies were ecologic, correlating age-adjusted sex- and race-specific regional cancer mortality rates with reported chlorinated surface water supplies versus chlorinated or non-chlorinated well water supplies. The sites of cancers most frequently associated with chlorinated water are bladder, colon and rectum.

The results of earlier studies stimulated a generation of case-control studies using mortality records to identify cases and comparison groups. In most of these studies, the water supply was determined by the last place of residence, as noted on the death certificate. Some used birth place (also recorded on the death certificate) or obtained water exposure histories from interviews with next of kin.

In 1992, Morris and colleagues published a meta-analysis to assess the evidence for a relationship between chlorination of drinking water and neoplastic disease. Ten studies were included in the final analysis. Using statistics provided in each study and a random effects model, the researchers derived a single estimate of relative risk for each organ-specific neoplasm.

The meta-analysis found that exposure to chlorinated surface water was associated with a statistically significant increased relative risk of bladder cancer (odds ratio [OR] = 1.20) and rectal cancer (OR = 1.34). Controlling for available confounding variables, such as smoking, urban living and occupation, did not diminish the risks. The estimated risk for colon cancer was not statistically significant, but incidence increased proportionally with dose.

There were multiple problems with these studies. Many relied on rough estimates of by-product exposure, measurement of confounding variables was inconsistent and some studies suffered from selection bias and poor response rates. Studies have now been conducted that include more accurate exposure data and track additional potential confounding factors, which gives their results more weight.

Tables 4, 5 and 6 highlight these improved epidemiologic studies. Relative risks are inferred from calculations of odds ratios in most studies. For simplicity, we present a single relative risk to summarize a rich and complex body of data. A result greater than 1.0 is interpreted as a positive risk; less than 1.0, as a negative risk. Relative risks are interpreted as "statistically significant" if their associated 95% confidence intervals do not include 1.0 and "not statistically significant" if they do.

Colon Cancer

Table 4 summarizes nine studies assessing the risk of colon cancer after exposure to chlorinated water by-products. Among the seven earlier studies, two showed a significantly positive result. Inconsistent findings emerged from the two most recent studies (Marrett and King [1995] and Hildesheim [1998]), both case-control investigations of newly diagnosed disease.

Marrett and King studied over 5000 people in Ontario; approximately 950 had bladder, colon or rectal cancer. Age- and sex-matched controls were identified from the general population. THM levels were estimated back to 1950 in regional water supplies, using a survey of water treatment facility history and measurements of THM. People with exposure to THMs greater than or equal to 50 μg/L for more than 35 years were 1.5 times more likely to develop colon cancer, and the data demonstrated a dose-response relationship that persisted after accounting for potential confounding factors such as nutrient, caloric and fibre intake.

Hildesheim and colleagues conducted a study in Iowa, identifying 685 colon cancer patients. The control group consisted of 2400 people matched for age, sex and having developed one of five other types of cancer.

TABLE 4

Colon cancer and exposure to chlorination by-products: epidemiologic studies

Author (year)	Exposure measure	Relative risk (CI)[a]	Association	Dose-response	Duration response	Cancer outcome measure
Hildesheim (1998)	THM	1.13 (0.7–1.8)	Positive (NS)	No	No	Incidence
Marrett (1995)	THM	1.5 (1.0–2.2)	Positive (NS)	Yes	N/A	Incidence
Young (1987)	THM	0.73 (0.44–1.21)	Negative (NS)	No	No	Incidence
Zierler (1986)	Chlorine vs chloramine[b]	0.89 (0.86–0.93)	Negative*	N/A	N/A	Mortality
Cragle (1985)	Chlorinated water	3.36 (2.41–4.61)	Positive*	N/A	Yes	Incidence
Gottlieb (1982)	Surface vs ground[b]	1.01 (N/A)	Positive (NS)	N/A	N/A	Mortality
Wilkins (1981)	Surface vs well	0.89 (0.57–1.43)	Negative (NS)	N/A	N/A	Mortality
Brenniman (1980)	Chlorinated groundwater[b]	1.11 (N/A)	Positive (NS)	N/A	N/A	Mortality
Alvanja (1978)	Chlorinated water[b]	1.61 (N/A)	Positive*	N/A	N/A	Mortality

[a] 95% confidence intervals (CI) in brackets. When only stratified results were reported, the relative risk reported here corresponds to the longest exposure period and greatest exposure.
[b] Exposure derived from the residence recorded on the death certificate
* Statistically significant, $p < 0.05$
NS = Not statistically significant
N/A = Not applicable/available

Estimates of exposure to THM and to chlorinated surface water were made for the full lifetime of all subjects and adjustments were made for confounding variables.

In contrast to the Marrett and King study, Hildesheim et al. found no elevated risk of colon cancer. While the methods to estimate THM exposure were somewhat more precise in the Marrett and King study, it is unlikely that this would explain the absence of an association in the Hildesheim study. These contradictory findings are not currently understood. They may be due to chance, to water quality differences between Ontario and Iowa or to other factors.

In conclusion, the evidence for an increased risk of colon cancer from exposure to chlorination by-products is inconclusive.

Rectal Cancer

Table 5 identifies eight studies that address the possible association of rectal cancer with chlorination by-products. Of the six earliest studies, two showed a statistically significant risk of cancer associated with by-product exposure. Once again, the two most recent studies had inconsistent results: the Marrett and King study showed no association, whereas the Hildesheim study showed a statistically significant positive association and a positive duration-response relationship.

In summary, the evidence for an association between rectal cancer and chlorinated by-products is also inconclusive. However, in light of the positive finding in the meta-analysis, the evidence is somewhat stronger for rectal cancer than colon cancer.

Bladder Cancer

Evidence of a link between chlorination by-products and bladder cancer is more consistent than it is for colon and rectal cancers. Table 6 outlines 11 studies that assessed the association of bladder cancer with THM exposure. Three of seven studies published prior to 1990 were statistically significant. King and Marrett's 1996 article reported a relative risk of 1.61 for exposure to an estimated THM level of 50 μg/L or greater for 35 years or more. Excess risk was found only after more than 20 years of exposure, and risk increased with time. Results suggested an increased risk with higher concentrations of by-products and (counter-intuitively) a lower risk in smokers; neither of these trends were statistically significant.

McGeehin et al. (1993) conducted a cancer registry-based study that identified a control group from patients with cancer other than bowel or bladder cancer in order to eliminate recall bias. Their findings were similar to the previous studies: long-term exposure to chlorinated water increased the relative risk of bladder cancer by 1.8. Unlike the King and Marrett study, cigarette smoking was strongly associated with an increased risk of bladder cancer.

After assessing the different variables, McGeehin et al. found that THM was no longer a statistically significant predictor of risk (although years of chlorinated water consumption was) if they took out the 1989 THM concentrations. This suggests that THM may be a surrogate marker rather than the causal agent, or it may simply reflect a statistical design artifact.

Cantor and colleagues conducted two studies in this area. One (1987) was a large case-control study with 3000 cases and 6000 controls. Unfortunately, only half the population came from places with enough regional variability in water supply characteristics to conduct a meaningful analysis. These cases revealed a 1.8 relative risk of bladder cancer in those who had consumed water with high THM levels over a long period of time. This

TABLE 5

Rectal cancer and exposure to chlorination by-products: epidemiologic studies

Author (year)	Exposure measure	Relative risk (CI)[a]	Association	Dose-response	Duration response	Cancer outcome measure
Hildesheim (1998)	THM	1.7 (1.1–2.6)	Positive*	Yes	Yes	Incidence
Marrett (1995)	THM	0.99 (0.5–1.4)	Negative (NS)	No	No	Incidence
Zierler (1986)	Chlorinated water[b]	0.96 (0.89–1.04)	Negative (NS)	N/A	N/A	Mortality
Gottlieb (1982)	Surface vs ground[b]	1.79 (N/A)	Positive*	N/A	N/A	Mortality
Wilkins (1981)	Surface vs well	1.42 (0.70–3.16)	Positive (NS)	N/A	N/A	Mortality
Young (1981)	Chlorine dose	1.39 (0.67–2.86)	Positive (NS)	N/A	N/A	Mortality
Brenniman (1980)	Chlorinated groundwater[b]	1.22 (N/A)	Positive (NS)	N/A	N/A	Mortality
Alvanja (1978)	Chlorinated water[b]	1.93 (N/A)	Positive*	N/A	N/A	Mortality

[a] 95% confidence intervals (CI) in brackets. When only stratified results were reported, the relative risk reported here corresponds to the longest exposure period and greatest exposure.
[b] Exposure derived from the residence recorded on the death certificate
* Statistically significant, $p < 0.05$
NS = Not statistically significant
N/A = Not applicable/available

TABLE 6

Bladder cancer and exposure to chlorination by-products: epidemiologic studies

Author (year)	Exposure measure	Relative risk (CI)[a]	Association	Dose-response	Duration response	Cancer outcome measure
Cantor (1998)	THM	1.5 (0.9–2.6)	Positive (NS)	Yes	Yes	Incidence
Freedman (1997)	Municipal water	1.4 (0.7–2.9)	Positive (NS)	N/A	No	Incidence
King (1996)	THM	1.6 (1.08–2.46)	Positive*	Yes	Yes	Incidence
McGeehin (1993)	THM	1.8 (1.1–2.9)	Positive*	No	Yes	Incidence
Zierler (1988)	Chlorine vs chloramine	1.4 (1.20–2.10)	Positive*	N/A	N/A	Mortality
Cantor (1987)	Chlorinated surface water	1.8 (N/A)	Positive*	N/A	Yes	Incidence
Gottlieb (1982)	Surface vs groundwater[b]	1.2 (N/A)	Positive (NS)	N/A	N/A	Mortality
Young (1981)	Chlorine dose[b]	1.04 (0.43–2.50)	Positive (NS)	N/A	N/A	Mortality
Wilkins (1981)	Surface vs well water	2.2 (0.71–9.39)	Positive (NS)	N/A	N/A	Mortality
	males	1.8 (0.80–4.75)	Positive (NS)	N/A	N/A	Incidence
	females	1.6 (0.54–6.32)	Positive (NS)	N/A	N/A	Incidence
Brenniman (1980)	Chlorinated groundwater[b]	0.98 (N/A)	Negative (NS)	N/A	N/A	Mortality
Alvanja (1978)	Chlorinated water[b]	1.69 (N/A)	Positive*	N/A	N/A	Mortality

[a] 95% confidence intervals (CI) in brackets. When only stratified results were reported, the relative risk reported here corresponds to the longest exposure period and greatest exposure.
[b] Exposure derived from the residence recorded on the death certificate
* Statistically significant, $p < 0.05$
NS = Not statistically significant
N/A = Not applicable/available

was the same for men and women; the association was stronger for non-smokers than smokers.

More recently, Cantor et al. (1998) looked at 1450 bladder cancer cases and 2400 controls in Iowa. They gathered a lifetime residential history, information on other risk factors and estimated THM levels. Bladder cancer risk among current or previous smokers with long-term exposure to chlorination by-products was about twice the risk of smokers who had not been exposed to chlorinated water. A recent study by Freedman (1997) found similar results.

In summary, there were five epidemiologic studies that showed a statistically significant positive association of chlorinated by-product exposure with risk of bladder cancer. King and Marrett (1996) estimated that 14–16% of bladder cancers may be attributable to chlorinated water. Our understanding of this phenomenon, however, remains limited by the fact that all studies relied on retrospective exposure estimates.

Reproductive and Developmental Effects

John Reif

The evidence for reproductive and developmental effects associated with exposure to chlorination by-products is scant. Only five studies on this topic have been published; several others are pending. Most published studies use a case-control method and rely on birth certificates and birth defect registries; all lack important individual data.

If there are true adverse reproductive outcomes due to exposure to chlorination by-products during pregnancy, they should be more readily detectable than true carcinogenic effects because gestation offers a short latent period for by-product exposure.

Spontaneous Abortion, Stillbirth and Pre-term Delivery

Table 7 summarizes findings on the risk of spontaneous abortion, stillbirth and pre-term delivery after exposure to chlorination by-products. Only one study (Savitz [1995]) looked at spontaneous abortion rates. This hospital-based, case-control study included exposure assessment based on interviews and data from five public water supplies. Several confounding variables were taken into account: maternal age, poverty level, smoking and alcohol history. The relative risk of miscarriage in those women exposed to greater levels of chlorination by-products was slightly increased, but was not statistically significant.

Two large studies examined risk of stillbirth after exposure to chlorination by-products. Aschengrau (1993) conducted a hospital-based, case-control study of over 14,000 pregnancies. Exposure assessment was based on the municipal water supply of the mother's place of residence at the time of the pregnancy outcome, and the usual confounding variables were measured. Researchers found a 2.6-fold increase in risk for stillbirth in those exposed to chlorinated surface water, but this was not statistically significant.

The largest study to date, by Bove (1992; 1995), included over 80,000 births and almost 600 fetal deaths. The study revealed a negative correlation between stillbirth and exposure to chlorination by-products, once again not statistically significant.

TABLE 7

Spontaneous abortion, stillbirth, pre-term delivery and exposure to chlorination by-products: epidemiologic studies

Outcome measure/ Author (year)	Exposure measure	Relative risk (95% confidence interval)	Association	Dose-response
Spontaneus abortion				
Savitz (1995)	THM > 80 μg/L	1.2 (0.6–2.4)	Positive (NS)	Yes
Stillbirth				
Aschengrau (1993)	Chlorinated surface water	2.6 (0.9–7.5)	Positive (NS)	N/A
Bove (1992)	THM > 80 μg/L	0.7 (0.4–1.2)	Negative (NS)	Yes
Pre-term delivery				
Kanitz (1996)	Chlorine dioxide	1.8 (0.7–4.7)	Positive (NS)	N/A
	Na hypochlorite	1.1 (0.3–3.7)	Positive (NS)	N/A
Savitz (1995)	THM > 83 μg/L	0.9 (0.6–1.5)	Negative (NS)	No
Bove (1992)	THM > 80 μg/L	1.0 (0.9–1.1)	Unity	Yes
Kramer (1992)	Specific THMs	1.1 (0.7–1.6)	Positive (NS)	N/A

NS = Not statistically significant
N/A = Not available/applicable

Four studies looked at pre-term delivery. In one that was population-based, Kramer et al. (1992) used information from birth certificates to identify the water supply. Each case was matched to five controls and exposure measures included all THMs. After adjusting for age, parity, education, smoking and prenatal care, the researchers found no increased risk of prematurity among those who were exposed to higher THM levels during pregnancy than those who were not.

Kanitz et al. (1996) compared pre-term delivery rates between two towns with similar social and economic characteristics and the same perinatal care services, but different water supplies. One town had chlorinated water with sodium hypochlorite and chlorine dioxide, the other had untreated well water. After adjusting for the usual confounding variables, researchers observed a small increase in risk of prematurity in newborns of mothers who drank the water treated with chlorine dioxide.

Low Birth Weight and Growth Retardation

Table 8 consolidates the findings on low birth weight and growth retardation linked to exposure to chlorination by-products. Four studies examined low birth weight; all found some increase in risk, but only one showed statistically significant risk.

The studies by Bove (1992; 1995) and Kramer (1992) were the only two that looked at growth retardation (small-for-gestational age). Both showed a small and statistically significant increase in risk.

Birth Defects

Some preliminary evidence suggests that exposure to chlorination by-products during pregnancy is associated with birth defects (Table 9). Examining the records of offspring of women exposed to chlorination by-products during pregnancy, Bove (1995) observed a significantly increased risk of total anomalies; neural tube and oral cleft defects were the most common. An increased risk of cardiac defects also appeared (consistent with animal studies), although this was not statistically significant.

Epidemiologic research in the area of reproductive and developmental effects is still at an early stage. The studies to date are inadequate to infer causality. However, on the basis of available studies, there is evidence to suggest a weak association between chlorination by-products and adverse fetal growth and moderate evidence for an association with congenital malformations.

Risk Assessment of Chlorination By-products

Steve E Hrudey

Risk assessment interprets available evidence in a formalized way in order to inform regulatory decision making. For example, risk assessment of chlorination by-products resulted in the development of maximum acceptable concentrations (MACs) as noted in Health Canada's *Guidelines for Canadian Drinking Water Quality*.

The currently acceptable level of THMs (100 μg/L) has been calculated to carry a lifetime cancer risk of less than 4×10^{-6}—an essentially negligible risk. To understand how the acceptable level was derived at, one needs to understand classic cancer risk assessment. Once this is known, the difficulties of applying this to the case of chlorinated by-products will become apparent.

Cancer Risk Assessment

There are two key questions in cancer risk assessment: "How likely is a particular agent to be a human carcinogen?" and "If it is one, what are the cancer risks for a given exposure scenario?"

TABLE 8

Low birth weight, growth retardation and exposure to chlorination by-products: epidemiologic studies

Outcome measure/ Author (year)	Exposure measure	Relative risk (95% confidence interval)	Association	Dose-response
Low birth weight				
Kanitz (1996)	Chlorine dioxide	5.9 (0.8–14.9)	Positive (NS)	N/A
	Na hypochlorite	6.0 (0.6–12.6)	Positive (NS)	N/A
	Both	6.6 (0.9–14.6)	Positive (NS)	N/A
Savitz (1995)	THM > 83 µg/L	1.3 (0.8–2.1)	Positive (NS)	No
Bove (1992)	THM > 80 µg/L	1.3 (1.1–1.5)	Positive*	Yes
Kramer (1992)	Specific THMs	1.3 (0.8–2.2)	Positive (NS)	N/A
Growth retardation				
Bove (1995)	THM > 100 µg/L	1.5 (1.2–1.9)[a]	Positive*	Yes
Kramer (1992)	Chloroform ≥ 10 ppb (µg/L)	1.8 (1.1–2.9)	Positive*	N/A

NS = Not statistically significant
N/A = Not available/applicable
* Statistically significant
[a] 90% confidence interval

The classic approach to risk assessment was established in 1983 by the National Academy of Sciences and includes four stages.

- *Hazard identification* documents previous evidence to determine what adverse outcomes a substance may cause. It should provide some answers to the first question on likelihood.
- *Dose-response assessment* summarizes quantitative data about the dose of a substance and observed adverse outcomes. It usually involves extrapolation of observations from high level exposures in animal studies in order to make predictions for much lower level exposures in humans.
- *Exposure assessment* documents and estimates actual human exposures. This is necessary to determine what doses should be used with the dose-response assessment.
- *Risk characterization* synthesizes the information from the first three stages into a quantitative expression of the risk to hypothetical individuals or populations. (This involves two different approaches, depending on whether the substance is a genotoxic carcinogen or not.) This final step should answer the second question on cancer risks.

Acceptable exposure levels are usually established at doses much lower than experimental levels. Two methods have been used to set such environmental criteria.

- The "*No observed adverse effect level*" (NOAEL) uncertainty factor approach assumes a threshold for a dose-response curve. The method depends upon defining the highest dose at which no adverse effect can be observed in animal studies. A tolerable daily intake or

TABLE 9

Birth defects and exposure to chlorination by-products: epidemiologic studies

Outcome measure/ Author (year)	Exposure measure	Relative risk (95% confidence interval)	Association
All anomalies			
Aschengrau (1993)	Chlorinated surface water	1.5 (0.7–2.1)	Positive (NS)
Bove (1992)	THM > 80 µg/L	1.6 (1.2–2.0)[a]	Positive*
Neural tube defects			
Bove (1992)	THM > 80 µg/L	3.0 (1.3–6.6)[a]	Positive*
Oral cleft defects			
Bove (1992)	THM > 100 µg/L	3.2 (1.2–7.3)[a]	Positive*
Cardiac defects			
Bove (1992)	THM > 80 µg/L	1.8 (1.0–3.3)[a]	Positive (NS)

NS = Not statistically significant
[a] 90% confidence interval
* Statistically significant

reference dose is then calculated by dividing the NOAEL by a product of uncertainty and modifying factors. These uncertainty factors include other considerations such as differences between experimental animals and humans, variability in individual sensitivity and quality of evidence.

- The *Risk Specific Dose* approach typically uses an upper bound estimate on risk derived from a low dose linear extrapolation (through zero dose) derived from rodent bioassays. Most of these studies have been conducted with only two or three doses, the maximum tolerated dose (MTD) and fixed fractions of the MTD. The MTD has been defined as the highest dose that causes no more than a 10% weight loss, no excess mortality, no clinical signs of toxicity and no unexpected pathologic lesions. Recent concerns about the meaning of the model predictions have led to alternate proposals, such as the Tumorigenic Dose 05 (TD05), proposed by Meek and Long (1996).

Risk assessment of chlorination by-products is fraught with uncertainty. Most quantitative health risk assessments are based on single substances and single outcomes. The assessment of chlorination by-products involves many substances and dozens of outcomes. The use of THM as a surrogate marker has been an important limitation; more sophisticated exposure assessments are indicated.

Toxicologic and epidemiologic data are usually both included in risk assessments, but in the case of chlorination by-products they have identified different outcomes. Further research is needed to clarify these differences in order to provide better evidence on which to formulate appropriate water quality levels.

Consensus of the Expert Working Group

After hearing the presentations of the evidence, the Expert Working Group deliberated the two questions below and arrived at the following consensual opinions.

1. Given currently available evidence, how likely is it that chlorination by-products cause cancer/ reproductive effects in humans? If likely (possible or probable), how important a public health problem is it?

Cancer

The Working Group noted that the evidence for this must be reviewed on a site-specific basis. Participants concluded that it was possible (60% of the group) to probable (40%) that chlorination by-products pose a significant risk to the development of cancer, particularly bladder cancer.

The risk of bladder cancer, and possibly other cancers, poses a risk to public health; this is a moderately important public health problem.

Reproductive and Developmental Effects

There is presently insufficient evidence to establish a causal relationship between exposure to chlorinated by-products and adverse reproductive outcomes in humans. However, further research is warranted.

If the suggested findings of the limited data are confirmed, chlorinated by-products in current surface water supplies could pose an important health problem. Even a relatively small excess risk of adverse reproductive outcomes associated with chlorinated by-products may contribute to a large absolute number of adverse outcomes since these outcomes are quite common: 10–20% of all pregnancies terminate in spontaneous abortion; birth defects occur in 1–2% of all live births.

2. Given the state of the current evidence, are there enough quantitative data to be useful in an in-depth quantitative risk/benefit/cost evaluation?

There are not enough quantitative data at this time to conduct an in-depth quantitative risk/benefit/cost evaluation. However, a mechanism to monitor the human health risks, such as an Expert Working Group, should be established to advise Health Canada and make recommendations as to when the evidence has accumulated to the point that a more in-depth evaluation is warranted.

Recommendations Regarding Future Research

Throughout the meeting, there were suggestions from participants regarding research needs and priorities. These suggestions, summarized in Table 10 according to risk factor categorization for thematic consistency, were not systematically discussed or approved by the Expert Working Group as a whole and do not represent a consensus on research priorities.

TABLE 10

Recommendations (non-consensual) of Expert Working Group for future studies on health risks of drinking water chlorination by-products

Hazard identification

1. Integrate toxicologic and epidemiologic research—specifically, future toxicologic research should test hypotheses generated from epidemiologic findings, and future epidemiologic studies should test hypotheses and mechanisms identified in toxicologic studies
2. Conduct human cell studies on bladder and colon cells to elucidate why these tissues are susceptible to tumour transformation with exposure to chlorination by-products
3. Examine underlying mechanisms and activation issues (which may be different)
4. Elucidate the different modes of action for individual carcinogens
5. Characterize the level and type of mutagenicity in water sources
6. Investigate by-product mixtures (i.e. interactions between by-products)

Exposure assessment

1. Account for *variability in water mixtures* by:
   a) Estimating specific THM concentrations
   b) Including other major types of chlorination by-products, such as the haloacetic acids
   c) Assessing important master variables such as pH, total organic content and bromide levels

2. Account for *variability in individual exposure* by:
   (This is *essential* for short-term studies, such as those looking at reproductive outcomes)
   a) Measuring all sources of exposure: drinking tap water (boiled or not) vs bottled water, other sources of water (such as soft drinks), showering, bathing and swimming in pools
   b) Measuring water composition at individuals' homes (due to changes that may occur in distribution system and from the use of home filtration systems)
   c) Accounting for variability in seasonal exposures

3. Examine *individual response* to chlorination by-product exposure by:
   a) Studying the uptake and elimination of different chlorination by-products
   b) Assessing if there is a genetic predisposition contributing to observed outcomes
   c) Analyzing possible interactions of chlorination by-products with such things as smoking

4. Improve our understanding of the *possible outcomes* of exposure to chlorination by-products by:
   a) Doing more in-depth studies on bladder cancer:
   – examine the effect of different chlorination by-products on bladder epithelium
   – correlate human urine characteristics with water quality characteristics
   b) Conducting further studies to resolve the question of whether or not there is an increased risk of rectal or colon cancer
   – include measures of appropriate confounding factors, such as diet
   c) Determining whether or not early studies suggesting an increased risk of adverse reproductive and developmental effects are correct
   d) Conducting epidemiologic studies to follow up on toxicologic data that suggest chlorination by-products have an effect on male fertility

Risk characterization

1. Focus on understanding the differences between the toxicologic and epidemiologic evidence so that risk characterization can better guide research needs and determine appropriate drinking water guidelines
2. Establish guidelines for the haloacetic acids, bromate and chlorate/chlorite
3. Develop methods to conduct risk assessments of by-product mixtures
4. Conduct interaction studies to examine whether amplification of risks from individual compounds can occur at concentrations normally found in drinking water

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Position Paper

Safe Drinking Water: A Public Health Challenge

Donald T Wigle

Abstract

Disinfection of drinking water through processes including filtration and chlorination was one of the major achievements of public health, beginning in the late 1800s and the early 1900s. Chloroform and other chlorination disinfection by-products (CBPs) in drinking water were first reported in 1974. Chloroform and several other CBPs are known to cause cancer in experimental animals, and there is growing epidemiologic evidence of a causal role for CBPs in human cancer, particularly for bladder cancer. It has been estimated that 14–16% of bladder cancers in Ontario may be attributable to drinking water containing relatively high levels of CBPs; the US Environmental Protection Agency has estimated the attributable risk to be 2–17%. These estimates are based on the assumption that the associations observed between bladder cancer and CBP exposure reflect a cause-effect relation. An expert working group (see Workshop Report in this issue) concluded that it was possible (60% of the group) to probable (40% of the group) that CBPs pose a significant cancer risk, particularly of bladder cancer. The group concluded that the risk of bladder and possibly other types of cancer is a moderately important public health problem. There is an urgent need to resolve this and to consider actions based on the body of evidence which, at a minimum, suggests that lowering of CBP levels would prevent a significant fraction of bladder cancers. In fact, given the widespread and prolonged exposure to CBPs and the epidemiologic evidence of associations with several cancer sites, future research may establish CBPs as the most important environmental carcinogens in terms of the number of attributable cancers per year.

Key words: *cancer; chlorination; chlorine; disinfection by-products; epidemiology; ozonation; reproductive health; risk assessment; toxicology; trihalomethanes*

Disinfection of Drinking Water: Historical Perspective

In the 19th century, major outbreaks of waterborne diseases were common in Canada, the United States and other developed nations. Beginning in the early years of the 20th century, the provision of chlorinated drinking water virtually eliminated typhoid fever, cholera and other waterborne diseases, representing one of the great achievements of public health.

Chlorine was discovered in 1774 by the Swedish chemist Karl Wilhelm Scheele and confirmed to be an element in 1810 by Sir Humphry Davy.[1] Use of chlorine as a disinfectant was first introduced by Semmelweis on the maternity ward of the Vienna General Hospital in 1846 to clean the hands of medical staff and prevent puerperal fever. In 1881 Koch showed that pure cultures of bacteria were destroyed by hypochlorites.[1]

The first continuous usage of chlorination in the US began in 1908 for the water supply to Jersey City, New Jersey, and at a site that served the Chicago Stockyards to control sickness in livestock caused by sewage-contaminated water.[1] In Canada, the earliest use of chlorination found by this author was in Peterborough, Ontario, in 1916.[2] Chlorination has been the main method of disinfecting drinking water in Canada, the United States and many other countries for several decades and has proven effective against most waterborne pathogens.

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Health Effects of Chlorination Disinfection By-products

Chlorine's potent oxidizing power causes it to react with naturally occurring organic material in raw water to produce hundreds of chlorinated organic compounds, referred to generically as chlorination disinfection by-products (CBPs). One of the most commonly occurring groups of CBPs, the trihalomethanes (THMs), was first identified at higher concentrations in chlorinated drinking water than in natural raw water by Rook[3] and by Bellar et al.[4]

Raw drinking water supplies were found to have low background levels of mutagenic activity with relatively large increases in mutagenicity after chlorination.[5] The mutagenic activity of chlorinated water is caused mainly by reactions of chlorine with natural humic substances released by the breakdown of vegetation in the source waters.[6] Recently, the chlorinated hydroxyfuranones (e.g. MX) have been shown to be responsible for a major part of the mutagenic activity. Other CBPs, including brominated THMs and haloacetic acids, are also mutagenic. The concentration of THMs correlates strongly with the amount of organic precursors in raw water and, although imperfect, it can be a useful indicator of the level of total CBPs in treated water.

Although numerous CBPs have been identified in chlorinated drinking water, very few have been subjected to carcinogenicity bioassays. Chloroform induced significant increases in kidney tumours in male rats when administered in high concentrations in drinking water.[7] Chloroform also produced kidney tumours in male rats and liver tumours in male and female mice when administered by gavage in corn oil.[8] Unlike the brominated THMs, chloroform appears not to be carcinogenic through a direct DNA reactive mechanism, acting instead through regenerative cell proliferation, possibly with an exposure threshold.[9] In studies of the three other THMs, bromoform administered by corn oil gavage induced intestinal tumours in male and female rats; chlorodibromomethane by corn oil gavage produced liver tumours in both sexes of mice; and bromodichloromethane by corn oil gavage induced intestinal and kidney tumours in male and female rats, kidney tumours in male mice and liver tumours in female mice.[10–12]

After the THMs, the most commonly occurring group of CBPs in drinking water is the haloacetic acids (HAAs). Comparing published results from the two most studied HAAs, dichloroacetate in drinking water induced hepatic tumours in both rats and mice, but trichloroacetate induced hepatic tumours only in mice.[13–17] Both compounds appear to act as tumour promoters, but likely via different mechanisms: trichloroacetate has been shown to be a peroxisome proliferator, whereas dichloroacetate affects cell cycle kinetics.[18] While none of the brominated HAAs have been tested in carcinogenicity bioassays, preliminary screening tests have indicated a potential for the induction of liver tumours by bromochloroacetate, dibromoacetate and bromodichloroacetate; lung tumours by bromodichloroacetate; and colonic tumours by dibromoacetate.[18,19]

MX (3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone) is a CBP and is one of the most potent known mutagens as determined by the Ames assay.[20] MX is reported to occur at much lower concentrations than the THMs or HAAs, yet it appears to account for about one third of the mutagenicity of chlorinated drinking water.[21] DeMarini et al.[22] found that MX produced 50–70% hotspot 2-base deletions and 30–50% complex frameshifts; no other compound or mixture is known to induce such high frequencies of complex frameshifts. MX caused several types of cancer or benign tumours in rats, including thyroid, liver, adrenal gland, lung, pancreas, breast, lymphomas and leukemias.[23]

As noted in the following report, results of the epidemiologic studies of cancer have been most consistent in showing an association between exposure to THMs and bladder cancer. Conflicting results have been observed with respect to cancers of the colon and rectum. In 1996, King and Marrett[24] reported the results of a large population-based case-control study of bladder cancer conducted in Ontario. Persons exposed to chlorinated surface water for 35 or more years had an increased risk of bladder cancer compared with those exposed for less than 10 years (odds ratio = 1.41, confidence interval [CI] = 1.10–1.81)). Persons exposed to THM levels of at least 50 μg/L for 35 or more years had 1.63 times the risk of those exposed for less than 10 years (CI = 1.08–2.46). The authors concluded that the risk of bladder cancer increases with both duration and concentration of exposure to chlorination by-products, with population-attributable risks of about 14–16% for Ontario. Approximately 1150 persons in Ontario will be diagnosed with bladder cancer in 1998.[25] If CBPs do cause bladder cancer, then roughly 160–185 cases of bladder cancer per year in Ontario are attributable to such exposure.

There have been about 20 case-control and cohort epidemiologic studies of CBPs and cancer risk since 1978. The US Environmental Protection Agency (EPA) reviewed these studies[26] and identified 5 case-control studies (including the King and Marrett study) that met the criteria of being population-based, well designed and having adequate exposure assessment. The EPA concluded that, based on the entire cancer epidemiology database, bladder cancer studies provide better evidence than other types of cancer for an association between exposure to chlorinated surface water and cancer.

The EPA recognized that a causal relationship between chlorinated surface water and bladder cancer

has not yet been demonstrated conclusively by epidemiologic studies, but concluded that the *assumption* of a potential causal relationship is supported by the weight of evidence from toxicology and epidemiology. Based on this assumption, the EPA estimated that the attributable risk of bladder cancer due to exposure to chlorinated water in the US is in the range of 2–17%; the annual number of bladder cancer cases attributable to such exposure was estimated to be in the 1100–9300 range. The EPA also stated that it believes that the overall evidence from available epidemiologic and toxicologic studies on chlorinated surface water continues to support a hazard concern and a prudent public health protective approach for regulation.[26]

The expert working group convened by the Laboratory Centre for Disease Control (see Workshop Report in this issue) observed that the few available epidemiologic studies of CBP exposure and pregnancy outcome indicated associations between exposure to THMs and spontaneous abortion, growth retardation and birth defects. However, these studies were weak in exposure assessment and control of potential confounders. When tested in rats, rabbits and mice, chloroform was not teratogenic, but both bromodichloromethane and chlorodibromomethane have shown evidence of fetotoxicity. Other CBPs have produced adverse effects on the testes and on sperm production in male rats and congenital heart defects in rats exposed in utero.

Recently, a prospective study[27] that included concurrent trihalomethane sampling data showed that women who drank at least five glasses per day of cold tap water containing at least 75 μg/L total THMs had an adjusted odds ratio of 1.8 for spontaneous abortion (CI = 1.1–3.0). Of the four individual THMs, only high bromodichloromethane exposure (consumption of at least five glasses per day of cold tap water containing at least 18 μg/L of bromodichloromethane) was associated with spontaneous abortion, both alone (adjusted OR = 2.0, CI = 1.2–3.5) and after adjustment for the other trihalomethanes (adjusted OR = 3.0, CI = 1.4–6.6).

The expert group concluded that it was possible (60% of the group) to probable (40% of the group) that CBPs pose a significant cancer risk, particularly of bladder cancer. The group concluded that the risk of bladder and possibly other types of cancer is a moderately important public health problem. They also determined that there was insufficient evidence to establish a causal relationship between CBPs and adverse reproductive outcomes in humans, but that confirmation of the available limited data could establish CBPs as an important health problem. Finally, the group concluded that there were not enough data available to conduct a quantitative risk/benefit/cost evaluation and recommended that developing health risk data be monitored to determine when such an evaluation would be possible.

To the extent that epidemiologic studies randomly misclassify individual exposures to CBPs, the resulting risk estimates may be lower than the true risks. It is likely that many of the epidemiologic studies published to date have misclassified individual exposures to chlorinated water or CBPs. To lessen the impacts of this type of misclassification, Lynch et al.[28] recommended that future epidemiologic studies of this type should quantify exposures more extensively.

Next Steps

In most areas of Canada, the provinces, territories and local governments are responsible for providing safe drinking water. The Federal-Provincial Subcommittee on Drinking Water (DWS) of the Committee on Environmental and Occupational Health establishes and publishes *Guidelines for Canadian Drinking Water Quality*.[29] Health Canada acts as the secretariat for DWS and provides health and safety advice with regard to drinking water health risks in Canada. In 1993, DWS lowered the Canadian drinking water guideline for THMs from a maximum level at any one time of 350 ug/L to a maximum annual average, based on at least quarterly measurements, of 100 ug/L and recommended that THM levels be reduced as much as possible whenever treatment plants are expanded or upgraded. The THM guideline was based on a combination of risk assessment and risk management considerations, as is the case for all drinking water guidelines.

The *Guidelines for Canadian Drinking Water Quality* have no legal weight per se; however, they are used by the provinces and territories to establish their own drinking water regulations. In the US, the EPA promulgates drinking water standards that are legally binding on water supplies throughout the US that serve more than 10,000 persons.

The supporting document for the THM drinking water guideline states that the preferred method for controlling disinfection by-products is precursor removal, i.e. use of methods such as flocculation and filtration to remove organic material prior to disinfection. For surface waters in particular, use of filtration and postchlorination greatly reduces CBP levels.

Other options for reducing CBPs include ozone, chloramine and charcoal filters. Ozone has been used for water treatment in Europe for over 90 years, particularly in France and Switzerland.[1] If a sufficient dose of ozone is applied, its use does not lead to the creation of mutagenic compounds in drinking water and can even eliminate the initial mutagenicity of the water.[30] Combined treatment of ozone and activated carbon also decreases the chlorine consumption of treated water and reduces the formation of CBPs. DeMarini et al.[22] compared water treated by different methods: chlorination, chloramination or ozonation alone and

ozonation followed by chlorination or chloramination. Ozone alone produced the lowest levels of mutagenic activity in treated water, and chlorine alone, the highest levels. However, ozonation disinfection by-products include bromate, a genotoxic carcinogen. Also, the effectiveness of ozonation in reducing microbial and CBP risks varies with the characteristics of raw water (e.g. pH, temperature, particulate matter, bromide concentration) and ozonation alone does not give residual disinfective capacity in distribution systems.

Chlorine is still the most widely used disinfectant in Canada and the United States because of its low cost, ability to form a residual and effectiveness at low concentrations. The continued occurrence of waterborne disease outbreaks demonstrates that contamination of drinking water with pathogenic bacteria, viruses and parasites still poses a serious health risk. A single outbreak of Cryptosporidium in Milwaukee, Wisconsin, in 1993 resulted from a breakdown in filtration and led to an estimated 400,000 cases of acute gastroenteritis and 100 deaths.[31] Microbiologically contaminated drinking water is a special risk to children, the elderly and persons with compromised immune systems.

In November 1998, the EPA will promulgate a disinfectants/disinfection by-products rule originally proposed in 1994. The rule will reduce the maximum contaminant level (MCL) for total THMs from 100 to 80 μg/L and establish new MCLs for other by-products such as HAAs, bromate and chlorite. The new rule will also establish enhanced coagulation requirements for precursor removal, which should help to reduce both the number of microbes and the level of CBP precursors. The EPA is also establishing an extensive national information collection effort on contaminant occurrence, CBP levels and microbiological contaminants.[32]

The EPA has requested $1.9 billion to help state, tribal and local jurisdictions construct the facilities required to comply with federal requirements. Infrastructure plans include installation of sensors for real-time monitoring of important distribution system quality indicators such as disinfectant residual, water pressure, flow direction, microbial densities and total organic halides.

A 1994 national survey[33] showed that 19.5% of households in Canada reported using a filter or purifier for their drinking water compared with 13.9% in 1991, while 21.9% of households purchased bottled drinking water in the month before survey compared with 16.1% of households in 1991. Similarly, in a 1997 survey, one third of US consumers used a home water treatment device other than bottled water, an increase from 27% in 1995.[34] The use of devices such as pour-through water pitchers with carbon filters grew more than any other type of water treatment device. These data are consistent with increasing public concern about the safety and quality of drinking water.

There is an urgent need for co-ordinated epidemiologic and toxicologic research to seek definitive evidence on the nature of the association between exposure to CBPs in drinking water and outcomes such as cancer, spontaneous abortion and related adverse reproductive outcome conditions. Future epidemiologic studies should focus on associations between diseases and high potency CBPs identified in animal bioassays, for example, brominated THMs and HAAs. The effects of CBPs and CBP metabolites could be examined in vitro with human bladder epithelial cells.

Biomarkers of susceptibility, exposure and outcome would strengthen epidemiologic studies of CBP exposures and disease risks. Biomarkers such as DNA adducts or specific types of mutations may eventually support the attribution of individual cancer cases to exposure to specific CBPs, leading to more accurate risk estimates and targeted, effective control measures. For example, MX reacts with DNA in vitro to form a unique adduct;[35] although the biologic significance of such adducts is unknown, they may prove to play an important role as biomarkers of specific exposures.

Despite the undisputed benefits of chlorination in controlling waterborne infectious diseases, the epidemiologic evidence now available clearly suggests that CBPs pose a cancer risk to humans, particularly a risk of bladder cancer. Given the wide and prolonged exposure of Canadians to this risk, public health authorities must decide if the available evidence warrants actions to at least reduce public exposure to CBPs while safer alternatives are sought. In his report of the Commission of Inquiry on the Blood System in Canada,[36] Justice Krever emphasized the importance of a valuable tenet in the philosophy of public health, namely, "action to reduce risk should not await scientific certainty."

In the process of public health risk assessment and risk management, scientific experts must be satisfied that the "weight of evidence" exceeds a certain threshold before they can reach consensus and recommend action. With this end in mind, Health Canada set up the Chlorination Disinfection By-product Task Group in July 1998. The new group has multi-stakeholder representation in order to plan and oversee a co-ordinated effort involving epidemiologic, toxicologic, water treatment and other types of expertise to estimate the risks from CBPs and to develop risk management recommendations.

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Cross-country Forum

The Canadian Agricultural Injury Surveillance Program: A New Injury Control Initiative

Lisa Hartling, William Pickett and Robert J Brison

Abstract

The Canadian Agricultural Injury Surveillance Program (CAISP) is a national system, established in 1996, for monitoring injuries among the agricultural community. The program involves ongoing collection, analysis, interpretation and dissemination of injury data. These data are an important tool for the development and evaluation of Canadian farm safety programs. The ultimate goal of the program is to enhance the health and safety of Canadian farm workers and their families through preventive measures based upon a better understanding of the occurrence of farm injuries. This report provides a brief history of the surveillance system; a description of the program in terms of its objectives and the methods used for case identification and data collection; an overview of products from the initiative; and a discussion of some of the challenges encountered in developing a national surveillance system.

***Key words**: Agriculture; surveillance; wounds and injuries*

Introduction

Farming has been recognized as one of the most dangerous occupations in Canada with respect to work-related injury.[1,2] Each year, approximately 120 Canadians die and an additional 1200 require hospitalization due to farming injuries.[3] Deaths to farmers and farm workers represent 13% of all occupational fatalities in Canada.[4] Despite these facts, there are limited data (both in Canada and abroad) that can be used to describe the epidemiology of farm-related injuries. Such data are essential for the development and assessment of injury control initiatives.

The Canadian Agricultural Injury Surveillance Program (CAISP) is a new research initiative with the ultimate goal of enhancing the health and safety of farm workers and their families. CAISP is working toward this goal through the development of a registry of farm-related injuries in Canada and through the provision of accurate and timely analyses of registry data. The registry contains information on injuries resulting in death or admission to hospital, as well as problems treated in the outpatient setting. This paper provides a brief description of the program's history and mandate, representing one effort to inform the research community about its existence.

The Canadian Agricultural Injury Surveillance Program: A Brief History

Planning for this national initiative began in 1995. The planning phase resulted in the description of existing data sources that could be used for surveillance purposes; identification of existing farm injury surveillance initiatives in Canada and elsewhere; and establishment of a network of Canadians with an interest in agricultural injury surveillance. A protocol was then developed for building a national surveillance system.

The full surveillance program began in July 1996. A national steering committee was formed with members from all provinces as well as the federal government. The committee has representation from varied backgrounds, including researchers, government officials and others from the Canadian agricultural sector.

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Provincial and regional farm injury surveillance initiatives have existed in Canada for some time.[5,6] Prior to CAISP, there was no such system co-ordinated at a national level. Our view is that the new, national system is an important advance. First, it ensures that data are collected, coded and disseminated in a standard manner across the country. Second, interprovincial collaboration results in the pooling of expertise and avoidance of duplication. Combining data into a single registry has increased the number of injuries on which to base analyses and from which to discern trends. Finally, the national registry allows for interprovincial, inter-industry and international comparisons.

Objectives

The primary aim of CAISP is to collect and interpret information on agricultural injuries resulting in death or hospitalization in Canada. A secondary aim is to evaluate existing outpatient surveillance programs in order to assess their utility within a national system. Specific objectives of CAISP are these.

- Develop a co-ordinated system for the assembly of farm injury data
- Ensure that the information is interpreted and communicated in forms that are acceptable to potential data users
- Ensure that the surveillance system is sustained in the long term

Identification and Description of Farm Injuries

CAISP has developed standard approaches for the collection of fatal and hospitalized farm injuries. All provinces are working toward meeting the desired goal of standardization.

Fatal Farm Injuries

CAISP defines fatal farm injuries (farm fatalities) as unintentional, acute injuries resulting in death that occurred during activities related to the operation of a farm or that involved any hazard of a farm environment.

Within each province, a list is assembled of provincial agencies that can identify cases of fatal farm injury. Examples include occupational health agencies, offices of the chief provincial coroner, provincial departments of vital statistics, farm safety associations and police. A list of fatalities is then compiled and combined into a comprehensive provincial registry.

Detailed case reports are then sought for review and standardized data abstraction. Sources of information used are coroners' reports, investigation reports from occupational safety and health agencies, and RCMP or provincial police reports. Data are then sent to the national CAISP office for checking and analysis. The CAISP fatality registry is notable in that it contains detailed information not generally available elsewhere (Table 1).

TABLE 1

Standard data elements for fatality and hospitalization data abstraction

Data elements	Fatality database	Hospitalization database
Age / Date of birth	X	X
Sex	X	X
Relationship of injured person to farm owner	X	
Cause of injury (e.g. fall, machinery)	X	X
Type of machinery (where applicable)	X	X
Mechanism of injury (e.g. tractor rollover)	X	X
Nature of injury (e.g. fracture)	X	X
Body part involved	X	X
Immediate location of injury (e.g. barn)	X	X
Location of death (e.g. found dead)	X	
Method of discovery	X	
Who found deceased	X	
Time between when deceased found and when last seen	X	
Date of injury:		
time of day	X	
day of week	X	X
month	X	X
year	X	X
Description of circumstance of injury event	X	X
Activity at time of injury	X	X
Institution number		X
Date of admission		X
Date of discharge		X
Readmission		X
Length of hospital stay		X
Admission category (e.g. urgent, elective)		X
Ambulance required		X
Main diagnosis (N-code)		X
External cause of injury (E-code)		X
Province	X	X
Region of province	X	X
Residence code		X

The national registry currently has data from all 10 Canadian provinces for the period 1990–1996.

Hospitalized Farm Injuries

Hospitalized farm injuries are defined as acute, unintentional injuries resulting in hospitalization that occurred during activities related to the operation of a farm or that involved any hazard of a farm environment.

The basic data collection protocol within provinces begins with obtaining a file of selected hospital discharges from the respective provincial agencies (e.g. ministries of health). These files are selected using inclusion criteria

based upon external cause-of-injury codes (i.e. ICD-9 E-codes).[7,8] Supplemental data collection (Table 1) is then carried out for each case by mailing a brief questionnaire to hospital medical records departments. In Ontario (where this approach has been used for many years), virtually all hospitals comply with requests for supplemental data.[9] At present, CAISP collaborators have negotiated access to records from the Canadian Institute for Health Information (CIHI) or analogous records in 8 of the 10 provinces, and initial data collection is ongoing. We anticipate having a national registry of hospitalized farm injuries by the fall of 1998 for the years 1991–1995.

Farm Injuries Treated in Outpatient Settings

To supplement the data on fatal and hospitalized injuries, CAISP compiles information on cases of farm injury presented to selected outpatient facilities. Outpatient injuries include those that are treated in emergency departments or in the offices of family physicians and other health care professionals. Data are analyzed from existing regional programs in Manitoba, Saskatchewan and Alberta in order to provide a broader perspective on the farm injury problem and to explore the utility of these data as a tool for farm injury surveillance on a wider scale.

Products from this Initiative

CAISP products currently include the data registry itself, reports, peer-reviewed articles and fact sheets.

The data registry has great potential as a source of information about broad and specific patterns of farm injury in Canada and can be used to set priorities and direct the development of prevention programs. It can also help to answer specific questions from the agricultural industry, farm safety specialists and the media. Finally, the registry provides a foundation from which more in-depth and focused epidemiologic research can be undertaken.

A national CAISP report entitled "Fatal Farm Injuries in Canada, 1991–1995"[3] has been released to the general public. Similar reports describing hospitalized farm injuries and outpatient injuries will be released in the fall of 1998. Peer-reviewed articles include a national overview of fatal agricultural injuries (in press)[10] and focused papers on harvest-related injuries[11] and farm injuries among the elderly (under review). Fact sheets are being produced and distributed through a Canadian coalition of agricultural health and safety specialists. Each fact sheet discusses the magnitude of a specific farm injury problem (e.g. tractor rollovers, entanglement in agricultural machinery) and the groups affected, describes how the events are occurring and offers recommendations for intervention.

Challenges

Two issues that CAISP has struggled with are whether to limit the registry solely to work-related farm injuries and whether to include injuries that occur at off-farm work locations. Developing standard inclusion and exclusion criteria for agricultural injuries is problematic, and consensus is difficult to achieve.

One factor contributing to this difficulty is the unique nature of the farm work environment, in that it often doubles as a place of residence and/or a place of recreation. To limit the surveillance system solely to work-related injuries would overlook many injuries that occur as a result of the working environment but that may not necessarily be strictly work-related (e.g. children playing in close proximity to agricultural machinery; drownings in dugouts, ponds, lagoons). Injuries related to farm work can also take place in locations other than the farm (e.g. traffic crashes on public roads involving agricultural machinery). Such injuries are important to include in the surveillance of farm-related injuries, but they pose problems with respect to their comprehensive identification.

The completeness of the CAISP registry depends upon the accuracy of the data sources used. For example, the identification of farm-related fatalities is based upon the coding of location of death and/or occupation on the death certificate. A major challenge for CAISP is to ensure that provincial variations are eliminated in the application of rules for inclusion and description of injury events.

It is also difficult to accurately define and identify the agricultural population at risk. Denominator data are needed to describe rates of injury. CAISP presently uses denominator data from the Canada Census of Agriculture;[12] however, this does not capture all persons who work on Canadian farms, nor is it updated on an annual basis. Also, the Census only superficially describes the types and amounts of hazardous exposures experienced by individual respondents.

Summary

The primary objectives of the new Canadian Agricultural Injury Surveillance Program are to develop standard methods for the identification and description of agricultural injuries within Canada and to assemble these data into a national injury registry. The program's ultimate aim is to contribute to the well-being of the Canadian farm population by supplying objective and credible information about their injury experiences on an ongoing basis. Our aim in developing this descriptive paper was to inform the health community about the program's existence.

The efforts required to develop a collaborative research initiative such as CAISP should not be underestimated. The program is a work in progress, and its accomplishments should be judged in this light. As a collaborative group, CAISP has been successful in establishing standards for case identification, data collection, analyses and publication. Each province is represented and contributes to this process. The collaborative group has evolved over time, with representation from the agricultural, health and research sectors. The first CAISP report was widely distributed and used. We hope that this progress continues

and that the CAISP registry becomes an important resource for farm injury prevention in Canada.

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Resource File

A Summary of Cancer Screening Guidelines

Tammy L Lipskie

Introduction

Screening, as defined in *A Dictionary of Epidemiology*,[1] "sorts out apparently well persons who probably have a disease from those who probably do not. A screening test is not intended to be diagnostic. Persons with positive or suspicious findings must be referred to their physicians for diagnosis and necessary treatment."

Guidelines and programs for the early detection of cancer or cancer screening are based on the premise that outcomes are improved if the cancer is diagnosed and treated at the early stages of disease. However, there are also disadvantages to the early detection of cancer that must be considered when evaluating and establishing guidelines and programs. Prorok et al.[2] summarized the benefits and disadvantages of screening for cancer as follows in the table below.

The Cancer Bureau of the Laboratory Centre for Disease Control at Health Canada has compiled a summary of existing guidelines for the early detection of various cancers. Recommendations have been provided by governmental organizations, non-governmental organizations, health agencies and professional associations. Many organizations base their guidelines on current evidence and periodically update them as new evidence becomes available. Therefore, it is our intention to revise this compilation in the future to reflect any updates.

Guidelines for the early detection of cancer are listed in the tables that follow for 12 different cancer sites: breast, cervical, prostate, colorectal, ovarian, skin, testicular, gastric, lung, pancreatic, bladder and oral cancers.

Benefits	Disadvantages
Improved prognosis for some cases detected by screening	Longer morbidity for cases whose prognosis is unaltered
Less radical treatment needed to cure some cases	Overtreatment of borderline abnormalities
Reassurance for those with negative test results	False reassurance for those with false negative results
	Unnecessary morbidity for those with false positive results
	Hazard of screening test
Resource savings	Resource costs

Source: Table I in Prorok PC, Chamberlain J, Day NE, Hakama M, Miller AB. UICC workshop on the evaluation of screening programmes for cancer. *Int J Cancer* 1984;34(1):1–4
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TABLE 1

Breast cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
MAMMOGRAPHY AND CLINICAL BREAST EXAMINATION (CBE)			
Mammography should not be introduced unless the resources are available for effective and reliable screening of 70% of the 50–69 age group; much of the benefit is obtained by screening once every 2–3 years	Assessment of current scientific evidence	World Health Organization	1995(3)
Ages 50–70, mammography every 1–3 years can reduce mortality Cost-effectiveness of screening every 2–3 years compares well with many other medical procedures Clinical breast examination (CBE) may not be a cost-effective adjunct to mammography in a high-quality program	Assessment of current scientific evidence	UICC (International Union Against Cancer)	1990(4)
There is evidence of a beneficial effect of mammographic screening in women over age 50 Insufficient evidence to determine the effect of CBE	Assessment of current scientific evidence	*Advances in Cancer Screening*	1996(5)
CBE to be included in routine physical examination Over age 40, annual mammogram Over age 50, might lengthen interval to 2 years Special attention to those at higher risk	Assessment of current scientific evidence	*Cancer Medicine*	1997(6)
Ages 50–69, offer and encourage participation in mammography, CBE and breast self-examination (BSE) [taught and monitored] every 2 years at dedicated centres	Assessment of current scientific evidence	Canadian position Canadian Public Health Association	1989(7) 1989(8)
Over age 20, annual CBE Ages 50–74, mammogram every 2 years at dedicated centres Over age 70, continue annually if in good health Ages 40–49, welcome at dedicated centres after consideration of known effects of screening women in this age group	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)
Mammography at dedicated centres should be complemented by CBE and BSE Under age 50, mammography not routinely recommended Ages 40–49, annual mammogram if at additional risk Ages 50–70, annual mammogram Over age 70, continue annually if in good health	Committee discussion and consensus regarding current scientific evidence	College of Physicians and Surgeons of British Columbia	1995(10)
Ages 50–69, mammogram and CBE every 2 years Insufficient evidence at this time to extend to women under age 50	Assessment of current scientific evidence	Conseil d'évaluation des technologies de la santé du Québec	1998(11)

(continued)

TABLE 1

Breast cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
Ages 50–69, annual CBE and mammogram at dedicated centres	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
Ages 50–69, mammography alone or with CBE every 1–2 years	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
	Assessment of current scientific evidence	American Academy of Family Physicians	1997(14)
Ages 40–49, counsel about risks and benefits of mammography and CBE	Assessment of current scientific evidence	American Academy of Family Physicians	1997(15)
Ages 50–69, mammogram every 2 years in combination with annual CBE (women at higher risk should personalize schedule with their physician)	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Cancer Society	1996(16)
		Ontario Division of Canadian Cancer Society and Ontario College of Family Physicians	1995(17)
Ages 40–49, screening is not recommended Ages 50–69, mammogram every 2 years in centres designated for such purposes Over age 70, the attending physician should decide on the relevance of screening All ages, annual CBE	Assessment of current scientific evidence	Collège des médecins du Québec	1997(18)
Over age 50, annual CBE and screening mammogram	Not available	British Columbia Medical Association	1994(19)
Over age 50, mammogram at least every 2 years Annual mammogram starting before age 50 for those with a strong family history	Board decision after committee and expert discussion of current scientific evidence	Medical Society of Prince Edward Island	1990(20)
Ages 40–50, mammogram every 1–2 years Over age 50, annual mammogram Include CBE as part of annual general health evaluation	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	American College of Obstetricians and Gynecologists	1993(21)
Over age 40, regular mammogram every 1–2 years Ages 50–69, there is strong evidence that regular mammography reduces breast cancer mortality Over age 70, there is insufficient information on the effectiveness of mammography Physicians should be aware that some palpable breast cancers are not visible on mammograms	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1997(22) 1998(23)
Personalized schedule if over age 40 with history in first-degree relative, family history with onset before age 40, over age 70, radiation exposure at a young age	Executive decision based on a combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	College of Physicians and Surgeons of Manitoba	1998(24)
Ages 20–40, CBE every 3 years, then every year over age 40 Starting at age 40, annual mammogram*	Assessment of current scientific evidence	American Cancer Society	1992(25) 1997(26)*
	Endorses those of the American Cancer Society	American College of Radiology	1998(27)

(continued)

TABLE 1

Breast cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
Target 70% of women aged 50–69 years to receive annual mammograms and propose to increase prevalence of screening mammography through universal access to dedicated centres	Not available	British Columbia Ministry of Health and Ministry Responsible for Seniors	1997(28)
A national cancer control program should evaluate (if possible) CBE for women aged 40–60	Assessment of current scientific evidence	World Health Organization	1995(3)
BREAST SELF-EXAMINATION (BSE)			
A national cancer control program should encourage BSE	Assessment of current scientific evidence	World Health Organization	1995(3)
Over age 19, counsel about BSE	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	American College of Obstetricians and Gynecologists	1998(29)
Women should be encouraged to do monthly BSE	Assessment of current scientific evidence	*Cancer Medicine*	1997(6)
All ages, encourage to perform BSE	Assessment of current scientific evidence	Collège des médecins du Québec	1997(18)
Over age 20, BSE every month a few days after the end of menstruation	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Cancer Society	1996(16) 1994(30)
Over age 20, monthly BSE	Not available Assessment of current scientific evidence	BC Medical Association American Cancer Society	1994(19) 1992(25)
Encourage monthly BSE at the same time or one week after menstruation	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)
Evidence for the value of BSE is limited; it is considered a supplement to, rather than a substitute for, screening by CBE and mammography	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1998(23)
CANADIAN PROVINCIAL BREAST CANCER SCREENING PROGRAMS			
Target ages 50–79 for annual mammogram Will accept ages 40–49 and 80+	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	British Columbia	1998(31)
Target ages 50–69 for mammogram every 2 years along with BSE information and/or instruction Will accept ages 40–49 and 70+ with verbal or written physician referral	Advisory Committee decision based on assessment of current scientific evidence Not available	Alberta New Brunswick	1998(31) 1998(31)
Target ages 50–69 for mammogram every 2 years along with CBE and BSE information and/or instruction	Not available Not available Provincial expert committee's assessment of current scientific evidence	Manitoba Yukon Newfoundland and Labrador	1998(31) 1998(31) 1998(31)
Target ages 50–69 for mammogram every 2 years along with BSE information and/or instruction Will accept ages 70+	Not available	Saskatchewan	1998(31)

(continued)

TABLE 1

Breast cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
Target ages 50–69 for mammogram every 2 years along with CBE and BSE information and/or instruction Will accept ages 70+	Not available	Ontario	1998(31)
Target ages 50–69 for mammogram every 2 years Will accept ages 40–49 and 70–74 with physician referral	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Quebec	1998(31)
Target ages 50–69 for mammogram every 2 years along with breast examination and BSE information and/or instruction Will accept ages 40–49 and 70–74	Not available Not available	Nova Scotia Prince Edward Island	1998(31) 1998(31)

TABLE 2

Cervical cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
If resources are limited, aim for every woman to have a Pap test between ages 35 and 40 years If more resources are available, increase frequency to every 10 and then every 5 years for women aged 35–55 Ideally, a Pap test every 3 years for ages 25–60	Assessment of current scientific evidence	World Health Organization	1995(3)
Almost maximal effectiveness is achieved by a program with high coverage starting Pap test at age 25 every 3–5 years to age 60	Assessment of current scientific evidence	UICC (International Union Against Cancer)	1990(4)
Pap test starting at age 25 or 30 every 5 years to age 60 provides practically maximal reduction in the risk of cervical cancer	Assessment of current scientific evidence	*Advances in Cancer Screening*	1996(5)
Pap test once sexually active or age 18, after 2 normal annual smears then every 3 years to age 69 and consider more frequently for those with risk factors of intercourse before age 18, many sexual partners, smoking or low socio-economic status (SES)	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
Pap test once sexually active or age 18, after 2 normal annual smears then every 3 years to age 69	Not available	National Workshop on Screening for Cancer of the Cervix	1991(32)

(continued)

TABLE 2

Cervical cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
Pap test once sexually active or age 18, after 2 normal smears then every 3 years to age 69 predicated on the presence of a system for recall and quality assurance within an organized screening program Over age 67 and never screened then 2 smears at 6-month intervals, may then cease if normal	Assessment of current scientific evidence	Cervical Cancer Prevention Network	1998(33)
Over age 18 or sexually active should have regular Pap tests and physical exams, frequency to be discussed with physician Evidence strongly suggests a decrease in mortality from regular screening with Pap tests but the upper age limit at which such screening ceases to be effective is unknown	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1997(34) 1998(35)
Pap test for sexually active women (or starting at age 18) with a cervix at least every 3 years until age 65 if regular previous screenings were consistently normal	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
There is insufficient evidence regarding use of cervicography or colposcopy or for screening for human papilloma virus infection	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
Over age 18 or sexually active, should have a Pap test at frequency as discussed with a physician but most recommend a Pap test annually to age 35 and, if normal, every 3 years to age 69	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Cancer Society	1994(30)
Pap test once sexually active or age 18, after 2 normal annual smears then every 3 years to age 69 Annually in the absence of an organized program and if unlikely to return without a formal reminder	Assessment of current scientific evidence	Government of Saskatchewan	1997(36)
Regular Pap tests once sexually active until age 69	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Ontario Division of Canadian Cancer Society and Ontario College of Family Physicians	1995(17)
Pap test once sexually active or over age 18, after 3+ annual consecutive normal tests then every 3 years until age 69 and consider more frequently for those with risk factors of intercourse before age 18, many sexual partners, smoking, low SES or sexually transmitted diseases (STDs)	Executive decision based on a combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	College of Physicians and Surgeons of Manitoba	1998(24)
After 3 consecutively negative annual Pap tests, then test every 2 years until age 69	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)

(continued)

TABLE 2

Cervical cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
Pap test and pelvic examination once sexually active or by age 18, after 3+ annual consecutive normal tests then reduce frequency at the discretion of the physician	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion Assessment of current scientific evidence Assessment of current scientific evidence	American College of Obstetricians and Gynecologists American Cancer Society *Cancer Medicine*	1993(21) 1992(25) 1997(6)
Offer a Pap test at least every 3 years to women who are sexually active and have a cervix	Assessment of current scientific evidence	American Academy of Family Physicians	1997(14)
There is no need to screen women who have never had sexual intercourse and women who have had a hysterectomy for benign conditions	Assessment of current scientific evidence	Government of Saskatchewan National Workshop on Screening for Cancer of the Cervix	1997(36) 1991(32)
If had hysterectomy, should discuss continuation of Pap tests with physician	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1998(35)
Target Pap tests to groups with low participation rates	Not available	BC Ministry of Health and Ministry Responsible for Seniors	1997(28)

TABLE 3

Prostate cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
Include screening in a national cancer control program only as a demonstration or research project to evaluate effectiveness	Assessment of current scientific evidence	World Health Organization	1995(3)
Current state of knowledge does not permit a truly informed decision with regard to routine prostate cancer screening	Assessment of current scientific evidence	*Advances in Cancer Screening*	1996(5)
Screening cannot be recommended given the likelihood of over treatment	Assessment of current scientific evidence	UICC (International Union Against Cancer)	1990(4)
Further studies and follow-up are important in assessing the ultimate value of prostate-specific antigen (PSA)	Assessment of current scientific evidence	*Cancer Medicine*	1997(6)
Ages 50–70, there is insufficient evidence to advocate the use of digital rectal examination (DRE) but there is also insufficient evidence to recommend excluding it if it is regularly done PSA testing not be used due to low positive predictive value and risk of adverse affects associated with treatment There is no evidence to advocate the use of transrectal ultrasound (TRUS)	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)

(continued)

TABLE 3

Prostate cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
Insufficient evidence to establish whether a decrease in mortality from prostate cancer occurs with screening by DRE, TRUS or serum markers including PSA	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1998(37)
Over age 50, DRE during periodic health examination Educate self and discuss with physician the benefits and risks of PSA	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Cancer Society	1996(38)
Age 50–70, annual DRE in fit men PSA only as part of a randomized study	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)
Discourage the use of PSA as a screening test except in the context of a formal clinical trial	Not available Consensus conference considered reports of recognized experts	BC Ministry of Health and Ministry Responsible for Seniors Canadian Workshop on Screening for Prostate Cancer	1994(39) 1994(40)
PSA should not be used to screen asymptomatic men of any age	Assessment of current scientific evidence Assessment of current scientific evidence Committee discussion and consensus regarding current scientific evidence	Government of Saskatchewan BC Office of Health Technology Assessment College of Physicians and Surgeons of British Columbia	1995(41) 1993(42) 1995(10)
Potential health gains are too slight to justify the adverse health effects and cost of regular PSA testing	Assessment of current scientific evidence	Conseil d'évaluation des technologies de la santé du Québec	1995(43)
PSA should not become part of a routine checkup without discussion of advantages and disadvantages	Assessment of current scientific evidence	Collège des médecins du Québec and Quebec Urological Association	1998(44)
Since DRE and PSA increase the early detection of clinically significant prostate cancer, men should be aware of potential benefits and risks to make an informed decision	Not available	Canadian Urological Association	1996(45)
Over age 40, if at risk, and over age 50 then educate and provide opportunity for annual DRE and PSA PSA to continue until less than 10 years of life expectancy	Not available	American Urological Association	1995(46)
Over age 50, discuss the need for regular PSA testing and DREs with health care provider Men at high risk may want to consider beginning PSA testing and getting a DRE before age 50	Assessment of current scientific evidence Endorses those of the American Cancer Society	American Cancer Society American College of Radiology	1997(47) 1998(27)
Men should be made aware of the benefits and risks of early detection using PSA and DRE so they can make an informed decision	Consensus conference considered reports of recognized experts	National Prostate Cancer Forum	1997(48)
PSA effectiveness as a screening tool remains controversial	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Ontario Division of Canadian Cancer Society and Ontario College of Family Physicians	1995(17)

(continued)

TABLE 3

Prostate cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
Use of PSA in asymptomatic men is not recommended until evidence of benefit is available but recommend its use if over age 40 and risk factors of family history, nodule on DRE and indurated gland and follow-up after treatment	Executive decision based on a combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	College of Physicians and Surgeons of Manitoba	1998(24)
There is unproven benefit of the use of PSA as a routine screening test but it should be discussed with those at high risk or if patients express an interest and include DRE if the decision is to proceed with screening	Provincial interdisciplinary working committees assess the current scientific evidence	Alberta Medical Association	1997(49)
Routine screening with DRE, PSA or TRUS is not recommended	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
Over age 40, counsel of risks and unknown benefits of screening	Assessment of current scientific evidence	American Academy of Family Physicians	1997(15)
Research has not yet been completed to determine whether screening extends lives	Assessment of current scientific evidence	US Office of Technology Assessment	1995(50)

TABLE 4

Colorectal cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
Include screening by fecal occult blood testing (FOBT) or sigmoidoscopy in a national cancer control program only as a demonstration or research project to evaluate effectiveness	Assessment of current scientific evidence	World Health Organization	1995(3)
Screening for colorectal cancer or its precursors is not justified	Assessment of current scientific evidence	UICC International Union Against Cancer)	1990(4)
Over age 40, there is insufficient evidence regarding FOBT due to insensitivity, high false positivity and limited feasibility	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
	Executive decision based on a combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	College of Physicians and Surgeons of Manitoba	1998(24)
Hemoccult® FOBT is the only test proven to reduce mortality, however it has low sensitivity	Assessment of current scientific evidence	*Advances in Cancer Screening*	1996(5)

(continued)

TABLE 4

Colorectal cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
Use of FOBT at the discretion of the physician but rationale for testing is strong, particularly for those at increased risk (i.e. first-degree relatives with colorectal cancer, history of breast, ovarian or endometrial cancer)	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)
There is no strong evidence to recommend screening unless at high risk, then should consult the physician	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Ontario Division of Canadian Cancer Society and Ontario College of Family Physicians	1995(17)
Over age 50, annual FOBT and/or sigmoidoscopy (insufficient evidence to determine which alone or in combination)	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
Over age 50, annual FOBT Ages 50–80, guaiac-based FOBT every 1 or 2 years decreases mortality from colorectal cancer	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1994(51) 1998(52)
For those at average risk (i.e. over age 50, no life-limiting disease and no family history), FOBT as part of the periodic health examination	Executive decision based on a combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	College of Physicians and Surgeons of Manitoba	1998(24)
Over age 40, there is insufficient evidence regarding sigmoidoscopy and colonoscopy There is fair evidence to support colonoscopic screening of individuals with Family Cancer Syndrome	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
A recommendation for flexible sigmoidoscopy screening is premature	Assessment of current scientific evidence	*Advances in Cancer Screening*	1996(5)
Over age 50, regular screening by sigmoidoscopy may decrease mortality from colorectal cancer Insufficient evidence to determine the optimal interval	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1998(52)
Over age 40, there is insufficient evidence to advocate (non)use of colonoscopy/sigmoidoscopy Fair evidence to include colonoscopy in high-risk individuals Flexible sigmoidoscopy plus air-contrast enema may be equivalent to colonoscopy	Executive decision based on a combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	College of Physicians and Surgeons of Manitoba	1998(24)
Flexible sigmoidoscopy can also be considered for those at increased risk (i.e. first-degree relatives with colorectal cancer, history of breast, ovarian or endometrial cancer) Colonoscopy for those at higher risk (i.e. colorectal cancer history, polyp history, ulcerative colitis of 10+ years duration and total colonic involvement, relatives with familial polyposis)	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)

(continued)

TABLE 4

Colorectal cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
Colonoscopy may be included in an individual screening program for those at high risk	Executive decision based on a combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	College of Physicians and Surgeons of Manitoba	1998(24)
Insufficient evidence regarding use of digital rectal examination (DRE), barium enema or colonoscopy	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
Over age 50, annual DRE Those at high risk should consult their physician	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Cancer Society	1994(30) 1996(38)
Over age 50, include DRE in annual pelvic examination, annual FOBT and sigmoidoscopy every 3–5 years	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion Assessment of current scientific evidence	American College of Obstetricians and Gynecologists *Cancer Medicine*	1993(21) 1997(6)
Over age 50, annual FOBT, flexible sigmoidoscopy every 5 years and colonoscopy every 10 years or double contrast barium enema every 5–10 years If adenomatous polyp diagnosis, total colon examination by colonoscopy or double contrast barium enema 3 years after polyp removal, then every 5 years if polyps were large or multiple but as above if normal and there was only one initial polyp More intense screening for those at higher risk	Assessment of current scientific evidence Endorses those of the American Cancer Society	American Cancer Society American College of Radiology	1997(53) 1998(27)
Over age 40, FOBT (annually), sigmoidoscopy, colonoscopy or barium enema	Assessment of current scientific evidence	American Academy of Family Physicians	1997(15)

TABLE 5

Ovarian cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
Include screening in a national cancer control program only as a demonstration or research project to evaluate effectiveness	Assessment of current scientific evidence	World Health Organization	1995(3)
Screening cannot be recommended because there is a lack of data on the effect of screening	Assessment of current scientific evidence	UICC (International Union Against Cancer)	1990(4)

(continued)

TABLE 5

Ovarian cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
There is fair evidence against screening by means of abdominal examination (unless being done for another reason), pelvic or transvaginal sonography or CA 125 levels	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
Those with one or more first-degree relatives with ovarian cancer should be referred to an academic research centre for follow-up	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
Screening by ultrasound, serum tumour markers or pelvic examination is not recommended	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
There are no effective screening tests	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	British Columbia Cancer Agency American College of Obstetricians and Gynecologists	1997(9) 1993(21)
Insufficient evidence for or against screening women without a family history of ovarian cancer	Assessment of current scientific evidence	American Academy of Family Physicians	1997(54)
Insufficient evidence to establish that screening with serum markers such as CA 125 levels, transvaginal ultrasound or pelvic examinations would result in a decrease in mortality from ovarian cancer	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1998(55)
Include examination in cancer checkup every 3 years if over age 20 and annually over age 40	Assessment of current scientific evidence	American Cancer Society	1992(25)

TABLE 6

Skin cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
Systematic self-examination could be useful in early detection	Assessment of current scientific evidence	World Health Organization	1995(3)
Until data are available, screening is not recommended	Assessment of current scientific evidence	UICC (International Union Against Cancer)	1990(4)
Systematic skin examination of the general population is not recommended, but it is recommended for those at considerable increased risk since evidence suggests it is likely to improve outcome	Assessment of current scientific evidence	*Advances in Cancer Screening*	1996(5)

(continued)

TABLE 6

Skin cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
Total body skin examination is not recommended unless there is a history of Family Melanoma Syndrome (then it should be considered) There is insufficient evidence regarding periodic self-examination	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
There is insufficient evidence regarding periodic skin examination either by individuals or physicians	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force National Cancer Institute (US)	1996(13) 1998(56)
People should be alert to any unusual skin condition and have it checked by a physician	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Cancer Society	1997(57)
Examination may be part of a checkup	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Ontario Division of Canadian Cancer Society and Ontario College of Family Physicians	1995(17)
Include skin examination as part of annual general health evaluation	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion Assessment of current scientific evidence	American College of Obstetricians and Gynecologists *Cancer Medicine*	1993(21) 1997(6)
Include examination in cancer checkup every 3 years if over age 20 and annually over age 40	Assessment of current scientific evidence	American Cancer Society	1992(25)

TABLE 7

Testicular cancer screening guidelines

(continues next page)

Guideline	Established by	Organization	Year/(Source)
There is insufficient evidence regarding self- or physician examination	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination US Preventive Services Task Force	1994(12) 1996(13)
Screening should be discussed with those with a history of cryptorchidism, orchiopexy or testicular atrophy	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination US Preventive Services Task Force	1994(12) 1996(13)
Testicular self-examination (TSE) education should be encouraged and clinical testicular examination should be part of the routine physical examination	Assessment of current scientific evidence	*Cancer Medicine*	1997(6)
Regular self-examination and examination may be part of regular checkup	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Cancer Society	1996(38) 1994(58)

(continued)

TABLE 7

Testicular cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
Monthly self-examination if at high risk (i.e. affected first-degree relative, delayed or undescended testis, previous history) Also regular clinical examination if previous history	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)
Examination may be part of a checkup	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Ontario Division of Canadian Cancer Society and Ontario College of Family Physicians	1995(17)
Include examination in cancer checkup every 3 years if over age 20 and annually over age 40	Assessment of current scientific evidence	American Cancer Society	1992(25)
Insufficient evidence to establish that screening would result in a decrease in mortality from testicular cancer	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1998(59)

TABLE 8

Gastric cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
Include screening in a national cancer control program only as a demonstration or research project to evaluate effectiveness However, if incidence of disease is high, radiography may useful	Assessment of current scientific evidence	World Health Organization	1995(3)
Screening programs should continue in regions with high stomach cancer incidence Screening cannot be recommended in other countries	Assessment of current scientific evidence	UICC (International Union Against Cancer)	1990(4)
There has been little systematic screening for gastric cancer outside Japan	Assessment of current scientific evidence	*Advances in Cancer Screening*	1996(5)
Insufficient evidence to establish that screening would result in a decrease in mortality from gastric cancer in the United States population	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1998(60)
Screening is not applicable but there should be a high index of suspicion of those at high risk (i.e. family history of stomach cancer, pernicious anemia, gastric polyps, birth in a country of high incidence, previous partial gastrectomy)	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)

Note that procedures used for the early detection of gastric cancer include air-contrast barium x-rays (widely used in Japan), exfoliative lavage cytology, urinary cytology or endoscopy.

TABLE 9

Lung cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
Include screening in a national cancer control program only as a demonstration or research project to evaluate effectiveness since use of x-ray and cytological examinations have failed to establish effectiveness	Assessment of current scientific evidence	World Health Organization	1995(3)
Screening cannot be recommended unless a reduction in mortality can be demonstrated	Assessment of current scientific evidence	UICC (International Union Against Cancer)	1984(2)
There is no evidence that lung cancer screening is effective	Assessment of current scientific evidence	*Advances in Cancer Screening*	1996(5)
Cytologic examination of sputum has been shown to be an ineffective screening method	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination Ontario Division of Canadian Cancer Society and Ontario College of Family Physicians	1994(12) 1995(17)
Elimination of annual chest radiography	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion Executive decision based on a combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination Ontario Division of Canadian Cancer Society and Ontario College of Family Physicians College of Physicians and Surgeons of Manitoba	1994(12) 1995(17) 1998(24)
There is strong evidence that chest radiography in asymptomatic high-risk groups does not reduce mortality	Assessment of current scientific evidence	Government of Saskatchewan	1997(61)
Screening with chest radiography or sputum cytology is not recommended	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion Assessment of current scientific evidence	US Preventive Services Task Force American Academy of Family Physicians	1996(13) 1997(54)
The value of periodic chest x-ray has not been settled	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)
There are no effective screening tests	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	American College of Obstetricians and Gynecologists	1993(21)

TABLE 10

Pancreatic cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
No suitable screening tests exist	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
Screening using abdominal palpation, ultrasonography or serologic markers is not recommended	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
	Assessment of current scientific evidence	American Academy of Family Physicians	1997(54)

TABLE 11

Bladder cancer screening guidelines

Guideline	Established by	Organization	Year/ (Source)
Include screening in a national cancer control program only as a demonstration or research project to evaluate effectiveness Where incidence is high, urinary cytology has been advocated but its value may be limited	Assessment of current scientific evidence	World Health Organization	1995(3)
Screening cannot be recommended unless a reduction in mortality can be demonstrated	Assessment of current scientific evidence	UICC (International Union Against Cancer)	1984(2)
Routine use of urine cytology to screen for hematuria is not recommended	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
Routine use of urine dipstick, microscopic urinalysis or urine cytology is not recommended	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
	Assessment of current scientific evidence	American Academy of Family Physicians	1997(54)
Routine cytologic evaluation of urine is not recommended unless high risk (i.e. exposure to industrial toxins, previous history)	Tumour-Specific Work Groups consider current scientific evidence and reports of recognized experts	British Columbia Cancer Agency	1997(9)

TABLE 12

Oral cancer screening guidelines

Guideline	Established by	Organization	Year/(Source)
Earlier detection in a national cancer control program should encourage "look a friend in the mouth" or self-examination and allied health worker examination of adults who smoke or chew tobacco (if resources permit)	Assessment of current scientific evidence	World Health Organization	1995(3)
Screening cannot be recommended unless a reduction in mortality can be demonstrated	Assessment of current scientific evidence	UICC (International Union Against Cancer)	1984(2)
Insufficient evidence to establish that screening would result in a decrease in mortality from oral cancer	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	National Cancer Institute (US)	1998(62)
Physicians and/or dentists should consider examination of those over age 60 with risk factors	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	Canadian Task Force on the Periodic Health Examination	1994(12)
There is insufficient evidence regarding screening for oral cancer by primary care clinicians	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	US Preventive Services Task Force	1996(13)
Include examination of oral cavity in annual general health evaluation	Combination of assessment of current scientific evidence, reports of recognized experts and professional opinion	American College of Obstetricians and Gynecologists	1993(21)
	Assessment of current scientific evidence	*Cancer Medicine*	1997(6)
Include examination in cancer checkup every 3 years if over age 20 and annually over age 40	Assessment of current scientific evidence	American Cancer Society	1992(25)

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Status Report

Child Mortality Analysis Project

Sharon Bartholomew and Gordon Phaneuf

Current data collection practices used in Canada concerning child deaths may discourage child deaths due to maltreatment from being captured as such. The Child Maltreatment Division of Health Canada's Bureau of Reproductive and Child Health is currently funding research focusing on this problem.

The Child Mortality Analysis Project will consist of three sections. First, the existing data collection procedures, techniques and practices utilized by the various professions who intervene in cases of child death will be examined, with a focus on those cases where maltreatment is suspected or substantiated. The next step will be to conduct a comparative analysis of these practices. With the results of these two parts of the project in mind, the third activity will be to develop a model for multidisciplinary child death review teams, including recommendations for data collection.

The research will be conducted by surveying child welfare systems, chief coroners and chief medical examiners, and law enforcement systems at the provincial and territorial level. Two instruments will be administered to these key stakeholders to accomplish two major tasks: examining and analyzing the processes used to investigate child deaths at the provincial and territorial level.

Goals

- To contribute to a better understanding of how data relating to suspicious child deaths are captured
- To develop a model to help inform multidisciplinary responses to child deaths

Objectives

- To examine how suspicious child deaths are classified in Canada
- To document the obstacles to child mortality data collection
- To provide a description of the procedures, techniques and practices that would facilitate better identification, classification and data capture of the incidence of child mortality where child maltreatment is suspected
- To provide recommendations regarding the advisability and feasibility of graduating toward improved national collection of child mortality data
- To provide valuable policy and operational insights for stakeholders involved with the issue of responding to child deaths where child maltreatment is suspected
- To develop a model for child death review in Canada
- To better understand the role of selected disciplines in responding to child deaths (e.g. child protection, social work, forensic science, medicine and child mental health)

Uses for Resulting Information

It is anticipated that the information and knowledge generated by this project will serve to enhance our understanding of the obstacles to data collection in this subject area and provide recommendations regarding the advisability and feasibility of graduating toward a national child mortality data collection strategy.

A further goal is to provide a description of the procedures, techniques and practices that would facilitate better identification, classification and data capture of the incidence of child mortality where child maltreatment is suspected. The analysis should provide valuable policy and operational insights for stakeholders involved with the issue of responding to child deaths where child maltreatment is suspected.

A range of professions concerned with the issue of child death will be targeted with the model, including law enforcement, child protection, mental health, medicine, public health, forensic science, policy and program analysis and the judiciary. The model should serve to assist coroners

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and child death review teams to collect more accurate data on child mortality and thus improve the consistency of national child mortality data. Issues such as data collection, role definition and multidisciplinary integrated response will be examined.

Project Team

The project is being undertaken by Jan Christianson-Wood, a social worker and Special Investigator in Manitoba's Office of the Chief Medical Examiner, and Jane Lothian Murray, a criminologist and researcher at the University of Winnipeg. A multidisciplinary project advisory committee will be formed to provide advice on the project. ■

Book Reviews

Risk, Health and Health Care: A Qualitative Approach

Edited by Bob Heyman
London: Arnold, 1998;
ISBN 0 340 66201 8; $40.50 (CAN)

This book is well organized into three sections. Part One, "Risk Rationality," deals with the theory of risk (risk perception, risk management, cognitive psychology and processes, values and ethics) in a fair amount of detail. Various authors examine several perspectives on the concept of risk—those of the lay individual, the "scientific expert" and the institution.

The detailed examination of the ethical issues and value judgements that are often implicit in our everyday experiences of risk evokes a personal self-examination of how we interpret others' risk management techniques. This creates a base for the rest of the book, challenging the reader to reflect on how and why people make the decisions that they do.

For public health practitioners and for others involved in trying to influence behaviour, the book's challenge to examine one's own value system and that of other people when dealing with risk provides good insight into considering all options before embarking on any behavioural change programming.

Part One also contains a chapter that uses HIV/AIDS as an example to illustrate the issue of risk imagery.

Part Two ("Researching Risk Rationality in Health and Social Care") looks at specific clinical situations and discusses how individuals in these situations deal with health risks, describing the details in a qualitative fashion. These clinical situations cover the risk management process for older and younger pregnant women, people with diabetes, people with serious mental health problems, people with learning difficulties, people with dementia and the elderly, as well as risk management issues for nurses and midwives and in blood pressure measurement.

Part Three offers more in-depth discussion of risk management in a number of fields of health and social care. An interesting chapter entitled "Reconceptualising Risk in Health Promotion" completes the book with a discussion of the mind–body connection in health and describes how it is often ignored in traditional health promotion practice.

Overall rating:	Good
Strengths:	Part One applies to anyone dealing with risk Parts Two and Three could help health professionals dealing with specific subgroups to gain insight into their particular patient group or health-care worker group
Weaknesses:	Heavy on the psychology and philosophy jargon, which can be confusing at times Descriptions of the risks of health promotion could be more complete Certain areas are aimed only at very specific readers dealing with specific population groups (e.g. the chapter "Freedom of the Locality for People with Learning Difficulties")
Audience:	Public policy makers involved in risk management and behavioural change issues, health care workers, social workers and anyone else using risk management in their day-to-day work

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Critical Appraisal of Epidemiological Studies and Clinical Trials (Second Edition)

By J Mark Elwood
Oxford: Oxford University Press Inc, 1998;
ISBN 0 19 262744 9; $79.95 (CAN)

This book is a useful resource for health care providers and managers who wish to learn a basic approach to critical appraisal of medical literature. It is not a quick, "how-to" guide but will appeal to the more serious student of epidemiology who wishes to have a reasonable understanding of the theory behind critical appraisal and the "diagnosis of causation." By moving much of the statistical material to appendices, the book remains accessible to individuals who lack the interest in or aptitude for this aspect of epidemiology.

The first eight chapters of the book provide the basic theory needed for critical appraisal. Chapters focus on causation, study design, analysis of results, study subject selection, error and bias, confounding, chance variation and meta-analysis. Concepts are generally explained in a clear and concise manner, avoiding unnecessary jargon and complex mathematics. Examples from real or contrived data are used frequently and are helpful in demonstrating key concepts. The occasional reference to examples from previous chapters are a minor irritant, particularly if the book is not read in sequence.

Chapter 9 incorporates information from the previous chapters to provide a framework for the "diagnosis of causation." This framework integrates the review of methodologic issues related to the study and criteria for causation. The resulting tool, which consists of 20 questions, helps the reader make "reasoned and probabilistic judgements" related to the significance of studies under consideration. As in previous sections, the approach encompasses both intervention and observational studies of all types, with specific issues highlighted as necessary for particular types of study. This approach is academically appealing but may complicate matters for the reader who wants easy access to information on specific types of studies.

Chapters 10–15 provide examples of how the approach can be applied to actual studies from medical journals. These examples are an excellent addition to the book and assist the reader in consolidating knowledge.

This book presents often complex information with concise and accessible explanations, making frequent use of examples that help the reader appreciate the practical application of information. Moving complicated mathematics to appendices makes the book accessible to a broader audience without sacrificing completeness. I found it difficult to review selected chapters until I had read the book in sequence. Overall, this book is a very good resource for health practitioners, managers and policy makers who wish to enhance their ability to make sound judgements regarding the use of published information.

Overall rating:	Very good
Strengths:	Clear and concise explanations Avoidance of complex mathematics Frequent use of examples from published studies
Weaknesses:	Difficult to read single chapters or sections out of sequence
Audience:	Health care practitioners, managers and policy makers wanting a moderately advanced understanding of critical appraisal—should be considered for introductory epidemiology courses for students in these fields

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Risk of Death in Canada: What We Know and How We Know It

By Simon P Thomas and Steve E Hrudey
Edmonton: University of Alberta Press, 1997;
ISBN 0-88864-299-7; $19.95 (CAN)

Why another book on the risks of death from human diseases and health problems? According to the authors, they wanted to "provide a summary of accessible health risk information" to explain the sources of evidence and inference, and the degree of (un)certainty of the underlying data. They wished to focus on "accessible Canadian information."

The book is based on the first author's research for his Master's thesis at the University of Alberta's program of Environmental Risk Management, of which the second author has been the Eco-Research Chair. Hrudey has a PhD in Public Health Engineering and is a professor of Environmental Health Sciences. At the time of the book's publication, Thomas was working for the company that treats and supplies drinking water to the City of Edmonton and its environs.

Why limit the discussion of health risks to the outcome of death? As the authors explained, "so much ... data was available that we needed to limit consideration to mortality"—to keep the project "manageable." It is good they noted this at the beginning because the explanations of basic epidemiology and toxicology in this book are obviously applicable to determining the risks of human morbidity (disease incidence, etc.) as well as mortality.

The authors divided the book into three parts (excluding Part Four's discussion and summary), based on their typology of the sources of health risk information: "Part One: Direct Evidence," "Part Two: Indirect Evidence and Inference" and "Part Three: Predictive Inference." *Direct evidence* is defined as "information collected from individuals," i.e. the information on death certificates that is supposed to be completed for everyone in the population. The authors define *indirect evidence* as the findings from epidemiologic studies (on samples of the total population) from which causation (of disease or death) can be inferred. Finally, *predictive inference* is the authors' term for the results of toxicologic risk assessment, including the

extrapolation of experimental animal outcomes to human health outcomes.

While there is internal logic to the authors' terminology for evidence, an obvious shortcoming is their limitation of the scope of epidemiology to the causal inferences drawn from epidemiologic studies (*indirect evidence*). Yet the field of epidemiology very much includes the issues surrounding what the authors have called *direct evidence*: the collection, collation and interpretation of the data on death certificates; the matter of the (shaky) reliability and validity of the recorded underlying cause of death; and the systems of coding and classification.

Thus, to an epidemiologist, it seems unusual that, after Part One explains death certificates and the International Classification of Diseases, and shows many graphs and tables of the major causes of death in Canada, Part Two begins with what looks like a "crash course" in "Epidemiology 101," and goes on to a very broad overview of all the possible risk factors for the major causes of mortality. In fact, this is *all* epidemiology.

Likely reflecting their professional and educational backgrounds, the authors do a more commendable job of explaining the basics of toxicologic risk assessment (*predictive inference*) in Part Three. They focus on cancer bioassays and the models of carcinogenesis (threshold versus non-threshold, extrapolation from high to low dose, etc.). The authors proceed step by step to show how quantitative estimates of cancer incidence are predicted, based on the model used, the levels and routes of human exposure and the carcinogenic potency derived from carcinogen slope factors and unit risk factors. They emphasize the wide range of uncertainty in this process.

Many new terms are introduced in the chapter on toxicologic risk assessment, and some are not explained. Although it is possible to understand them in context, the reader who is unfamiliar with toxicology may find Part Three to be somewhat "slow going." It would also help if the most important terms were printed in boldface in the text.

Key epidemiologic terms should also have been highlighted in Part Two ("Indirect Evidence and Inference"). The authors summarize basic epidemiologic concepts, quite succinctly—in 12 pages (Chapter 6). However, a lack of original research is revealed by frequent referrals to secondary sources of information, for example, the textbook *Basic Epidemiology* by Beaglehole, Bonita and Kjellstrom (1993). This leads to an omission of fact when Thomas and Hrudey state the following, without any mention of the original author of this concept (Lawrence Green) and his "PRECEDE" model of health education.

> *Beaglehole et al. (1993) summarized four factors that play a part in causing disease:*
> *1. predisposing factors ...*
> *2. enabling factors ...*
> *3. precipitating factors ...*
> *4. reinforcing factors ...*

There are some factual inaccuracies or omissions in Part Two, but the main problem is that the authors try to cover all the possible risk factors for the major causes of death in only 38 pages. This leads to some cursory coverage of important risk factors. For example, the section on sex and reproductive risk factors is only three sentences long! There is a pervasive sense of "breadth rather than depth" in Part Two.

Returning to Part One ("Direct Evidence"), I think the authors do a creditable job of explaining how population data are gathered in Canada, the nature of the death certificate and the International Classification of Diseases (ICD). They take care to discuss the sources of uncertainty in both the definitions of data (including changes in disease classification) and the collection of data (particularly in death certificates). The rest of Part One consists of numerous graphs showing the numbers and rates of deaths (crude and age-standardized) for the year 1994 and for the period 1930–1990, for the total Canadian population and for subpopulations defined by demographics and causes of death (ICD-9 codes).

Part One's main drawback is that too much text is spent just describing the figures and tables. At the same time, the authors offer little explanation of why age-standardized death rates have increased for some diseases (e.g. certain cancers) and have gone down for others (e.g. cardiovascular). Other than a summary of the familiar "artefactual" versus "real" reasons for changes in mortality trends (Lilienfeld et al.), Thomas and Hrudey make almost no comments about the changes in diagnosis and treatment of major diseases, and their subsequent overview of risk factors in Part Two does not refer back to the mortality trends that they depict in Part One.

A significant deficiency in this book is that the discussion of *risk perception* is only 2 1/2 pages long (in Chapter 1), describing four factors that influence risk perception: "framing", "choice", "timing" and "characteristics and context." From a book that seeks to explain the "risks of death in Canada", however, one would expect *major* discussions of the principles of risk perception and risk communication and their applications to human health risk management.

In summary, Thomas and Hrudey make an original attempt to "marry" the perspectives of epidemiology and toxicology in discussing the risks and major causes of death in the Canadian population. They are mostly successful, but could have improved the book by spending fewer pages on the many graphs and tables in Part One, which contain information that can be found in Statistics Canada or Health Canada publications and other population health references. As a result, the overview of epidemiology is broad but lacking in depth. Those familiar with the principles of epidemiology, in particular, or toxicology would find the

book to be a “quick read.”

Overall rating:	Fairly good
Strengths:	Attractive, modern appearance; easy-to-read text (good writing style), tables and figures Good overview of how population data and cause-of-death data are collected in Canada and classified by the ICD system; leading causes of death in Canada; and uncertainties in quantitative estimates of mortality rates and risks Good *introductory* overview of basic epidemiology and toxicology (particularly section on toxicologic risk assessment)
Weaknesses:	Three major parts of the book could have been better linked Authors narrowly define *epidemiology* as the inference of causation from studies (*indirect evidence*) when, in fact, it includes the issues of what they call *direct evidence* Excessive text describing mortality graphs; more analysis needed of the *reasons* behind changing trends for the major causes of death More discussion of risk perception and risk communication needed
Audience:	3rd- or 4th-year undergraduate students in Health Sciences or Environmental Sciences and practising professionals in clinical health or environmental sciences/engineering, *if* they have only rudimentary knowledge of toxicology and, especially, of epidemiology

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Abstract Reprints

1. Knowledge, perception and behaviour of the general public concerning the addition of fluoride in drinking water

Patrick Levallois, Jacques Grondin, Suzanne Gingras
***Can J Public Health** 1998;89(3):162–5*

A telephone survey was carried out in 1994, in the Quebec City region, among 1006 people living in two municipalities where tap water is fluoridated and 1003 people living in two municipalities where there is no fluoridation. Knowledge of the main benefit associated with the use of fluoride (prevention of tooth decay) in drinking water was not different in fluoridated versus non-fluoridated municipalities (20.4% vs 19.4%, p = 0.57). Knowledge of its main disadvantage (increase of dental fluorosis) was very low and similar in both groups (3.1% vs 2.0%, p = 0.11). Opposition to fluoridation was slightly higher in fluoridated areas (22.0% vs 18.3%, p = 0.04), and the use of fluoridated supplements for children was much less important in fluoridated areas (4.4% vs 12.4%, p = 0.001). No changes in the measures of association (odds ratios) were found after adjustment for the different characteristics of the participants (age, family income, education). Opposition to fluoridation was lower among those who believed their tap water was fluoridated (even if not): 19.9% vs 34.5%, p < 0.001. This study demonstrates that there is still need for public health education on the uses of fluorides.

2. Trihalomethanes in drinking water and spontaneous abortion

Kirsten Waller, Shanna H Swan, Gerald DeLorenze, Barbara Hopkins
***Epidemiology** 1998;9(2):134–40*

Trihalomethanes (chloroform, bromoform, bromodichloromethane, and chlorodibromomethane) are common contaminants of chlorinated drinking water. Although animal data indicate that these compounds may be reproductive toxicants, little information exists on their relation to spontaneous abortion in humans. We examined exposure to trihalomethanes and spontaneous abortion in a prospective study of 5,144 pregnant women in a prepaid health plan. Seventy-eight drinking water utilities provided concurrent trihalomethane sampling data. We calculated total trihalomethane levels by averaging all measurements taken by the subject's utility during her first trimester. We calculated exposures to individual trihalomethanes in an analogous manner. Women who drank ≥ 5 glasses per day of cold tapwater containing ≥ 75 μg per liter total trihalomethanes had an adjusted odds ratio (OR) of 1.8 for spontaneous abortion [95% confidence interval (CI) = 1.1–3.0]. Of the four individual trihalomethanes, only high bromodichloromethane exposure (consumption of ≥ 5 glasses per day of cold tapwater containing ≥ 18 μg per liter bromodichloromethane) was associated with spontaneous abortion both alone (adjusted OR = 2.0; 95% CI = 1.2–3.5) and after adjustment for the other trihalomethanes (adjusted OR = 3.0; 95% CI = 1.4–6.6).

3. Exposure to trihalomethanes and adverse pregnancy outcomes

Michael D Gallagher, John R Nuckols, Lorann Stallones, David A Savitz
***Epidemiology** 1998;9(5):484–9*

Exposure during pregnancy to disinfection by-products in drinking water has been hypothesized to lead to several adverse reproductive outcomes. We performed a retrospective cohort study to examine the relation of trihalomethane exposure during the third trimester of pregnancy to low birthweight, term low birthweight, and preterm delivery. We matched Colorado birth certificates from January 1, 1990, through December 31, 1993, to historical water sample data with respect to time and location of maternal residence based on census block groups. After excluding births from all census block groups with no trihalomethane sample data and restricting to singleton white births with 28–42 weeks of completed gestation (>400 gm), we studied 1,893 livebirths within 28 census block groups. We found a weak association of trihalomethane exposure during the third trimester with low birthweight (odds ratio = 2.1 for the highest exposure level; 95% confidence interval = 1.0–4.8); a large increase in risk for term low birthweight at the highest level of exposure (odds ratio = 5.9; 95% confidence interval = 2.0–17.0); and no association between exposure and preterm delivery (odds ratio = 1.0 for the highest exposure level; 95% confidence interval = 0.3–2.8). The small number of adverse outcomes reduced the precision of risk estimates, but these data indicate a potentially important relation between third trimester exposure to trihalomethanes and retarded fetal growth.

4. Female breast cancer and trihalomethane levels in drinking water in North Carolina

Pamela M Marcus, David A Savitz, Robert C Millikan, Hal Morgenstern
***Epidemiology** 1998;9(2):156–60*

Some studies indicate that chlorination by-products in drinking water may contribute slightly to breast cancer risk. This ecologic study describes the association between total trihalomethane levels in publicly supplied water and the incidence of female invasive breast cancer. We included 71 North Carolina water suppliers serving at least 10,000 customers in the summer of 1995 as the units of analysis. We estimated incidence rates using 6,462 cases who were either white or black and between 35 and 84 years old and were linked by zip codes to the water supplier. We treated ecologic measurements of age, income, education, urban status, and race as potential confounders. Total trihalomethane levels were not associated materially with breast cancer risk, adjusting for potential confounders. The rate ratio for 80.0 parts per billion (ppb) or more *vs* less than 40.0 ppb total trihalomethanes was 1.1 [95% confidence interval (CI) = 0.9–1.2]. When stratified by race, the observed association for the aforementioned total trihalomethane category was not very different in black

women (rate ratio = 1.2; 95% CI = 0.8–1.8) than in white women (rate ratio = 1.1; 95% CI = 0.9–1.3). These ecologic data are compatible with trihalomethanes in drinking water being either unrelated or weakly related to breast cancer risk.

5. Case-control studies of cancer screening: theory and practice

Kathleen A Cronin, Douglas L Weed, Robert J Connor, Philip C Prorok
***J Natl Cancer Inst** 1998;90(7):498–504*

This review summarizes methodologic theories for the design of cancer screening case-control studies and examines the methods applied in studies published in English from 1980 through 1996. In addition to summarizing state-of-the-art methodologic approaches, we identify areas where obvious gaps exist between theory and practice, and we recommend potential areas where theory and methodology may need further development. In particular, we focus on three major areas: 1) the selection of case and control subjects, 2) the definition of exposure (i.e., exposure to the screening test), and 3) bias. Each area is considered carefully by summarizing current theory, reviewing cancer screening applications, and linking recommended methodologic approaches to those used in practice to identify areas where inconsistencies exist. In general, we found methodologic theory and practice in this field of research to be consistent. However, discrepancies were identified in the area of exposure definition, including the use of screening frequency and the use of a detectable, curable preclinical phase for case subjects as the exposure measures. Even when recommended methods were followed, a number of difficulties arose in practice. Specific concerns included the ability to carry out the following: identifying all case subjects within a source population, defining eligibility criteria to ensure that case and control subjects had equal access to screening during the exposure period, distinguishing between symptomatic and diagnostic tests, and controlling for self-selection bias. Careful scrutiny is warranted in all aspects of the design of cancer screening case-control studies, and caution is advised in the interpretation of study results.

6. The effect of the urban ambient air pollution mix on daily mortality rates in 11 Canadian cities

Richard T Burnett, Sabit Cakmak, Jeffrey R Brook
Can J Public Health 1998;89(3):152–6

Objective: Determine the risk of premature mortality due to the urban ambient air pollution mix in Canada.

Methods: The number of daily deaths for non-accidental causes were obtained in 11 cities from 1980 to 1991 and linked to concentrations of ambient gaseous air pollutants using relative risk regression models for longitudinal count data.

Results: Nitrogen dioxide had the largest effect on mortality with a 4.1% increased risk ($p<0.01$), followed by ozone at 1.8% ($p<0.01$), sulphur dioxide at 1.4% ($p<0.01$), and carbon monoxide at 0.9% ($p = 0.04$) in multiple pollutant regression models. A 0.4% reduction in premature mortality was attributed to achieving a sulphur content of gasoline of 30 ppm in five Canadian cities, a risk reduction 12 times greater than previously reported.

Conclusions: Ambient air pollution generated from the burning of fossil fuels is a risk factor for premature mortality in 11 Canadian cities.

7. Age at puberty and risk of testicular germ cell cancer (Ontario, Canada)

Hannah K Weir, Nancy Kreiger, Loraine D Marrett
***Cancer Causes Control** 1998;9(3):253–8*

Objectives: Incidence rates of testicular cancer are increasing among postpubescent men. This suggests that putative exposures may operate early in life and have changed over time. The age at which endocrine activity accelerates (age at puberty) may be such an exposure. This study was undertaken to investigate the relationship between age at puberty and testicular cancer risk.

Methods: A population-based case-control study was conducted in the province of Ontario, Canada which included males, aged 16 to 59 years, diagnosed with testicular germ cell cancer between 1987 and 1989, and age-matched controls. Data were collected on 502 cases, 346 case mothers, 975 controls, and 522 control mothers. Surrogate measures for age at puberty included age at starting to shave, appearance of hair, growth spurt, and voice change.

Results: A protective effect of later puberty was evident for all four measures of puberty as reported by both subjects and mothers, and greater protection was conferred when the greatest number of later puberty events were reported. Risk associated with earlier puberty was inconclusive.

Conclusions: As age at puberty is decreasing in the population, the proportion of boys experiencing the protective effect of later puberty may be diminishing. This may help explain the increasing incidence of testicular cancer.

8. Mercury levels in the Cree population of James Bay, Quebec, from 1988 to 1993/94

Charles Dumont, Manon Girard, François Bellavance, Francine Noël
***Can Med Assoc J** 1998;158(11):1439–45*

Background: High levels of mercury in the Cree population of James Bay, Que., have been a cause of concern for several years. This study examines changes in mercury levels within the Cree population between 1988 and 1993/94 and identifies potential determinants of high mercury levels.

Methods: Data on mercury levels among the Cree were obtained through a surveillance program undertaken by the Cree Board of Health and Social Services of James Bay. In 1988 and again in 1993/94 surveys were carried out in all 9 Cree communities of northern Quebec. Hair samples were obtained and analysed for mercury content. Analyses were carried out to determine the proportion of people who had mercury levels in excess of established norms. Changes in mercury levels between 1988 and 1993/94 and determinants of high levels were estimated by means of regression methods.

Results: The proportion of the Cree population with mercury levels in excess of 15.0 mg/kg declined from 14.2% in 1988 to 2.7% in 1993/94. Wide variations in mercury levels were observed between communities: 0.6% and 8.3% of the Eastmain and Whapmagoostui communities respectively had mercury levels of 15.0 mg/kg or greater in 1993/94. Logistic regression analyses showed that significantly higher levels of

mercury were independently associated with male sex, increasing age and trapper status. There was a correlation between the mercury level of the head of the household and that of the spouse.

Interpretation: Mercury levels in the Cree of James Bay have decreased in the recent past. Nevertheless, this decrease in mercury levels may not be permanent and does not necessarily imply that the issue is definitively resolved.

9. Comments on a meta-analysis of the relation between dietary calcium intake and blood pressure

Nicholas J Birkett
***Am J Epidemiol** 1998;148(3):223–8*

The role of dietary calcium in the etiology of hypertension is controversial. In 1995, Cappuccio et al. (*American Journal of Epidemiology*, 1995;142:935–45) examined this issue in a meta-analysis of observational studies published between 1983 and 1993. The author of the present paper reviewed the original studies underlying this meta-analysis and discovered that data from one study had been inappropriately extracted and converted, leading to an understatement of the calcium-blood pressure relation by a factor of about 30. This review also raised questions about the extraction and conversion of data from several other studies and about the statistical methods used. The author repeated the meta-analyses and discovered an unadjusted regression slope between dietary calcium and systolic blood pressure of –0.34 mmHg/100 mg per day (95% confidence interval (CI) –0.46 to –0.22) for men, –0.15 mmHg/100 mg per day (95% CI –0.19 to –0.11) for women, and –0.39 mmHg/100 mg per day (95% CI –0.47 to –0.31) for men and women. For diastolic blood pressure, the pooled regression slope for men was –0.22 mmHg/100 mg per day (95% CI –0.32 to –0.13), while for women it was –0.051 mmHg/100 mg per day (95% CI –0.090 to –0.012); for men and women it was –0.35 mmHg/100 mg per day (95% CI –0.67 to –0.02). These slopes are still modest but are larger than those reported in the original analysis. However, since all of these analyses were based on zero-order correlations or regressions, extreme caution must be exercised in interpreting the results.

10. Socioeconomic position, lifestyle and health among Canadians aged 18 to 64: a multi-condition approach

John Cairney, Robert Arnold
***Can J Public Health** 1998;89(3):208–12*

Although a sizeable literature documents the link between socioeconomic position and health in Britain and the United States, much less work has been conducted in Canada. Moreover, what work has been done has been limited to single outcomes such as self-rated health or age-adjusted mortality. Very little has been conducted using multiple health outcomes, although doing so has been advocated. Using the 1991 General Social Survey on Health, we extended an earlier analysis to explore whether or not "condition-specific" relationships exist between socioeconomic position, lifestyle, and health among working age Canadians. We distinguished four patterns in terms of education and income adequacy. The effects of occupation did not fit into any simple pattern. Measures of lifestyle appear to mediate the relationship between education and morbidity, but not between income adequacy and morbidity. Findings are discussed in terms of the theoretical, methodological and policy implications of a condition-specific approach.

11. Improvement in cumulative response rates following implementation of a financial incentive

Erin Gilbart, Nancy Kreiger
***Am J Epidemiol** 1998;148(1):97–9*

Risk estimates arising from case-control studies can be unreliable if the level of response to mailed questionnaires is inadequate. Several studies have reported improved early response rates to mailed questionnaires following the implementation of financial incentives. Improvements in cumulative response rates at the completion of the follow-up period, however, have not been as pronounced. A financial incentive of $5.00 was implemented among control subjects in a large population-based case-control study of Ontario, Canada, women. Required follow-up time and effort were decreased for the controls who received the incentive compared with those who did not. More importantly, cumulative response rates after more than 20 weeks were 20 percent higher among controls who received the incentive.

12. Smoking in the home: changing attitudes and current practices

Mary Jane Ashley, Joanna Cohen, Roberta Ferrence, Shelley Bull, Susan Bondy, Blake Poland, Linda Pederson
***Am J Public Health** 1998;88(5):797–800*

Objectives. Trends in attitudes and current practices concerning smoking in the home were examined.

Methods. Data from population-based surveys of adults in Ontario, Canada were analyzed.

Results. Between 1992 and 1996, the percentage of respondents who agreed that parents spending time at home with small children should not smoke increased from 51% to 70%. In 1996, 34% of the homes surveyed were smoke-free. Smoke-free homes were associated with nonsmoking respondents and with the presence of children and no daily smokers in the home. Only 20% of homes with children and any daily smokers were smoke-free.

Conclusions. Efforts are needed to assist parents in reducing children's exposure to environmental tobacco smoke in the home.

13. Survivors of sexual abuse: clinical, lifestyle and reproductive consequences

T Kue Young, Alan Katz
***Can Med Assoc J** 1998;159(4):329–34*

Background: In recent years, an increase in the prevalence of sexual abuse of women has been reported in Canada and elsewhere. However, there are few empirical data on the extent of the problem in Canadian aboriginal populations. The authors investigated the presence of a reported history of sexual abuse and other health determinants in a sample of women attending a community health centre with a substantial aboriginal population. This allowed determination of whether reported sexual abuse and its

associated demographic and health-related effects were different for aboriginal and non-aboriginal women.

Methods: A sample of 1696 women was selected from women attending a community health centre in a predominantly low-income inner-city area of Winnipeg for a cross-sectional survey designed to study the association between sexual behaviour and cervical infections. The survey was conducted between November 1992 and March 1995 and involved a clinical examination, laboratory tests and an interviewer-administered questionnaire. A substudy was conducted among 1003 women who were asked 2 questions about sexual abuse.

Results: The overall response rate for the main study was 87%. Of the 1003 women who were asked the questions about sexual abuse, 843 (84.0%) responded. Among the respondents, 368 (43.6%) were aboriginal. Overall, 308 (36.5%) of the respondents reported having been sexually abused, 74.0% of the incidents having occurred during childhood. The prevalence was higher among aboriginal women than among non-aboriginal women (44.8% v. 30.1%, $p < 0.001$). Women who had been sexually abused were younger when they first had sexual intercourse, they had multiple partners, and they had a history of sexually transmitted diseases. In addition, non-aboriginal women who had been sexually abused were more likely than those who had not been abused to have been separated or divorced, unemployed and multiparous and to have used an intrauterine device rather than oral contraceptives. Aboriginal women who had been sexually abused were more likely than those who had not been abused to have had abnormal Papanicolaou smears. The proportion of smokers was higher among the abused women than among the non-abused women in both ethnic groups.

Interpretation: A history of sexual abuse was associated with other clinical, lifestyle and reproductive factors. This suggests that sexual abuse may be associated with subsequent health behaviours, beyond specific physical and psychosocial disorders. Aboriginal and non-aboriginal women who have suffered sexual abuse showed substantial differences in their subsequent health and health-related behaviours.

14. Short-term effects of population-based screening for prostate cancer on health-related quality of life

Marie-Louise Essink-Bot, Harry J de Koning, Hubert GT Nijs, Wim J Kirkels, Paul J van der Maas, Fritz H Schröder
***J Natl Cancer Inst** 1998;90(12):925–31*

Background: Population-based screening for prostate cancer is currently being evaluated in randomized clinical trials in the United States and in Europe. Side effects arising from the process of screening and from the earlier treatment of screen-detected prostate cancer may be important factors in the evaluation. To examine health-related quality of life (or health status) among men screened for prostate cancer, we conducted a longitudinal study of 626 attenders to the Rotterdam (The Netherlands) prostate cancer screening program and of 500 nonparticipants. *Methods*: Attenders of the screening program and nonparticipants completed self-assessment questionnaires (SF-36 [i.e., Medical Outcomes Study 36-Item Short-Form Health Survey] and EQ-5D [i.e., EuroQol measure for health-related quality of life] health surveys) to measure generic health status, as well as an additional questionnaire for anxiety and items relating to prostate cancer screening. *Results*: Physical discomfort during digital rectal examination and during transrectal ultrasound was reported by 181 (37%) of 491 men and by 139 (29%) of 487 men, respectively; discomfort during prostate biopsy was reported by 64 (55%) of 116 men. Mean scores for health status and anxiety indicated that the participants did not experience relevant changes in physical, psychological, and social functioning during the screening procedure. However, high levels of anxiety were observed throughout the screening process among men with a high predisposition to anxiety. Similar scores for anxiety predisposition were observed among attenders and nonparticipants. *Conclusions*: At the group level, we did not find evidence that prostate cancer screening induced important short-term health-status effects, despite the short-lasting side effects related to the biopsy procedure. However, subgroups may experience high levels of anxiety. The implication is that unfavorable health-status effects of prostate cancer screening occur mainly in the treatment phase.

15. Improving the accuracy of death certification

Kathryn A Myers, Donald RE Farquhar
***Can Med Assoc J** 1998;158(10):1317–23*

Background: Population-based mortality statistics are derived from the information recorded on death certificates. This information is used for many important purposes, such as the development of public health programs and the allocation of health care resources. Although most physicians are confronted with the task of completing death certificates, many do not receive adequate training in this skill. Resulting inaccuracies in information undermine the quality of the data derived from death certificates.

Methods: An educational intervention was designed and implemented to improve internal medicine residents' accuracy in death certificate completion. A total of 229 death certificates (146 completed before and 83 completed after the intervention) were audited for major and minor errors, and the rates of errors before and after the intervention were compared.

Results: Major errors were identified on 32.9% of the death certificates completed before the intervention, a rate comparable to previously reported rates for internal medicine services in teaching hospitals. Following the intervention the major error rate decreased to 15.7% ($p = 0.01$). The reduction in the major error rate was accounted for by significant reductions in the rate of listing of mechanism of death without a legitimate underlying cause of death (15.8% v. 4.8%) ($p = 0.01$) and the rate of improper sequencing of death certificate information (15.8% v. 6.0%) ($p = 0.03$).

Interpretation: Errors are common in the completion of death certificates in the in-patient teaching hospital setting. The accuracy of death certification can be improved with the implementation of a simple educational intervention.

16. Preventing disability from work-related low-back pain

John Frank, Sandra Sinclair, Sheilah Hogg-Johnson, Harry Shannon, Claire Bombardier, Dorcas Beaton, Donald Cole
***Can Med Assoc J** 1998;158(12):1625–31*

Despite the publication in the mid-1990s of comprehensive practice guidelines for the management of acute low-back pain, both in the United States and elsewhere, this ubiquitous health problem continues to be the main cause

of workers' compensation claims in much of the Western world. This paper represents a synthesis of the intervention studies published in the last 4 years and is based on a new approach to categorizing these studies that emphasizes the stage or phase of back pain at the time of intervention and the site or agent of the intervention. Current thinking suggests that medical management in the first 3–4 weeks after the onset of pain should be generally conservative. Several studies of rather heterogeneous interventions focusing on return to work and implemented in the subacute stage (3–4 to 12 weeks after the onset of pain) have shown important reductions in time lost from work (by 30% to 50%). There is substantial evidence indicating that employers who promptly offer appropriately modified duties can reduce time lost per episode of back pain by at least 30%, with frequent spin-off effects on the incidence of new back-pain claims as well. Finally, newer studies of guidelines-based approaches to back pain in the workplace suggest that a combination of all these approaches, in a coordinated workplace-linked care system, can achieve a reduction of 50% in time lost due to back pain, at no extra cost and, in some settings, with significant savings.

Calendar of Events

November 15–18, 1998 **Ottawa/Hull, Canada**	"Partnerships for Health: A Work in Progress" 5th Canadian Conference on International Health Web site: <http://www.csih.org/ccih/ccih.html>	*Information* Conference Co-ordinator Canadian Society for International Health One Nicholas Street, Suite 1105 Ottawa, Ontario K1N 7B7 Tel: (613) 241-5785, ext 306 Fax: (613) 241-3845 E-mail: ccih@csih.org
November 15–18, 1998 **Halifax, Nova Scotia**	Canadian Heart Health Network Meeting Organized by Heart Health Nova Scotia, Heart and Stroke Foundation of Canada, Heart and Stroke Foundation of Nova Scotia and Health Canada	*Information* Conference Secretariat Agenda Management Inc. Tel: (902) 422-1886 Fax: (902) 422-2535 E-mail: agenda@ns.sympatico.ca
December 8–10, 1998 **Atlanta, Georgia** **USA**	"Prevention: Translating Research into Public Health Practice" 13th National Conference on Chronic Disease Prevention and Control Sponsored by the Centers for Disease Control and Prevention and the ASTCDPD	*Information* Tel: (303) 280-1112 Web site: <http://www.cdc.gov/nccdphp>
January 29–30, 1999 **Toronto, Ontario**	"Better Breathing '99" The Ontario Thoracic Society's Annual Scientific Conference on Respiratory Health	*Information* The Ontario Thoracic Society 201 – 573 King Street East Toronto, Ontario M5A 4L3 Tel: (416) 864-9911 Fax: (416) 864-9916 E-mail: ots@titan.tcn.net Web site: <http://www.on.lung.ca>
April 12–16, 1999 **Sao Paulo, Brazil**	XVth World Congress on Occupational Safety and Health Theme: "Safety, Health and Environment — A Global Challenge" Organized by Brazil's Ministry of Labour, the International Labour Office and the International Social Security Association	*Information* Secretaria do XV Congresso Mundial Rua Capote Valente, 710 05409-002 - São Paulo - SP BRASIL Web site: <www.fundacentro.gov.br>
April 26–29, 1999 **Albuquerque, New Mexico** **USA**	1999 CDC – Diabetes Translation Conference Centers for Disease Control and Prevention	*Information* Margaret R Hurd CDC, NCCDPHP, DDT 4770 Buford Hwy NE, Mailstop K-10 Atlanta, Georgia USA 30341-3724 Tel: (770) 488-5505 Fax: (770) 488-5966 E-mail: mrh0@cdc.gov

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