Mesothelioma in Northeastern Minnesota and Two Occupational Cohorts: 2007 Update

December 7, 2007

Center for Occupational Health and Safety

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Protecting, maintaining and improving the health of all Minnesotans

December 7, 2007

Dear Fellow Minnesotans:

To further address the long-standing concerns about elevated rates of mesothelioma on Minnesota's Iron Range, the Minnesota Department of Health (MDH) has prepared this important new publication, "Mesothelioma in Northeastern Minnesota and Two Occupational Cohorts: 2007 Update."

Mesothelioma is a fatal form of asbestos-related cancer. Some of the mesotheliomas diagnosed in northeast Minnesota have occurred in people who worked at the former Conwed asbestos tile plant in Cloquet. However, that group does not account for all of the elevation in mesothelioma rates.

Mesothelioma rates are also elevated in a group of 72,000 former mine workers we have been following at MDH. So far, 58 workers in that group have been diagnosed with mesothelioma. While some have theorized that taconite dust might be the cause, we currently have no scientific confirmation of that theory. An earlier study done by MDH has suggested that commercial asbestos – which has been used in a variety of industrial settings, not just mining – could also account for the elevated occurrence of mesothelioma in the miners.

Our new report has helped us answer a number of questions about the 58 ill miners:

- **How long did they work in the mining industry?** Their length of employment varied greatly, from less than a year to more than 30 years.
- **How long after they first went to work in the mines were they diagnosed with mesothelioma?** None of the miners was diagnosed less than 28 years after they first went to work in the industry. In five cases, the time interval was more than 60 years.
- **Did the miners work in any one particular part of the Range?** No – they worked at locations all across northeastern Minnesota.
- **Could exposure to asbestos at the Conwed plant explain these cases?** No. Only three of 58 miners ever worked at Conwed. However, that does not rule out the possibility that they were exposed to asbestos at some other location outside the mining industry.
- **What else does the report tell us?** All 58 of the miners were men, which is consistent with exposure to a cancer-causing agent in the workplace, rather than some general hazard in the broader environment.

These findings are important, but we need additional information. Governor Pawlenty and I strongly support work that MDH is currently doing with the University of Minnesota to address the mesothelioma issue. Protocols are now being developed for three different studies, each of which is designed to address a different set of questions:

1. **Work Experience Study**. How does the work experience of these 58 people differ from that of other miners? Are there factors that would explain why they developed mesothelioma and the others did not? Was it the types of jobs they did? What they were exposed to on the job? Other factors?
2. **Respiratory Health Study**. Do current and former miners show any early indications of asbestos exposure, based on patient interviews or clinical test results such as chest x-rays or lung tests?
3. **Mortality Study**. Do miners tend to die from different causes than the rest of us? What can we learn from the information on death certificates?

We wish we already had the answers to these and many other questions about the mesothelioma issue. The Governor and I are eager to move ahead with studies that will provide those answers, working with the Legislature and others to find the necessary resources. We hope we can count on your support in these efforts. Thank you.

Sincerely,

Sanne Magnan

Sanne Magnan, MD, PhD
Minnesota Commissioner of Health

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Purpose of This Report

This document provides a brief summary and update of the rates and characteristics of mesothelioma cases in three populations: (1) Northeast (NE) Minnesota (comprised of the seven counties: Aitkin, Carlton, Cook, Itasca, Koochiching, Lake, St. Louis; (2) a cohort of approximately 72,000 iron miners ever employed in taconite mining in NE Minnesota in or prior to 1983; and (3) a cohort of approximately 5,200 workers employed at the Conwed Corporation (Wood Conversion Co.) plant in NE Minnesota anytime between 1958 and 1974.

Mesothelioma Rates in Northeast Minnesota.

Four previous reports from the Minnesota Department of Health (MDH) have examined cancer rates in NE Minnesota. While overall cancer rates have been comparable to statewide rates, a statistically significant excess of malignant mesothelioma among males has consistently been found in NE Minnesota. The findings from these previous reports are summarized in Table 1. The last row of the table shows the results from the most recent update through 2006. As with the previous analyses, the mesothelioma rate among males remains approximately two-fold higher than the state average for the period 1988-2006 (146 cases vs. 69 expected cases). Among females, the rate remains slightly (30%) lower than the state average (13 cases vs. 18 expected), although this difference is not statistically significant.

The excess among males, but not females, in NE is also reflected in the sex distribution of cases compared to other regions of the State. Only 8% of cases in NE are females, compared to 24% of cases elsewhere in the state, a highly significant difference. In four of the seven NE counties, all of the cases were males. Another representation of the disparity between male and female cases in NE is that while approximately 6.5% of the state's population for both males and females reside in NE (2000 census), female mesothelioma cases in NE account for about 5% of the state total of female cases, while male mesothelioma cases in NE account for about 17% of the statewide male cases.

As has been shown in previous NE cancer reports, the highest county rate in the state among males remains in Carlton County, with 27 cases identified since 1988. That rate is over four-fold higher than the rate found elsewhere in Minnesota.

Figure 1 shows that that the NE region is the only region significantly elevated compared to the statewide average (figure is based on data through 2002). Figure 2 compares the three-year averaged rates of mesothelioma for males in NE, for all Minnesota, and for National Cancer Institute data from 13 population-based cancer registries in the US. These data show that while the rates among Minnesota males overall have been consistently comparable to rates elsewhere in the US, the rates in NE Minnesota have remained consistently elevated.

Figure 3 shows mesothelioma rates by age category among NE Minnesota males compared to all Minnesota males. In addition to showing the sharp rise in rates with age, the figure shows that the higher rates in NE males includes virtually all age categories over age 50.

As has been discussed since the first NE cancer report (MCSS, 1997), the large excess among males is consistent with an occupational exposure. Most of this excess appears attributable to two large and unique industries in NE Minnesota – iron ore mining and processing and the manufacturing of asbestos-containing ceiling tiles (Conwed Corporation plant in Carlton County). Workers in both industries experienced potential exposures to commercial asbestos, although the role of other mineral dusts in the taconite industry remains under investigation. As described further below, due to previous efforts to identify workers employed in these industries and to the statewide cancer registry, it has been possible to compare these records and ascertain to what extent mesothelioma cases in NE Minnesota (or anywhere else in the state) were previously employed in these industries. Some 43 of the 58 mesothelioma cases among miners, and 23 of the 25 cases among former Conwed workers were residing in NE Minnesota at the time of diagnosis. Since three cases worked in both industries, at least 63 male cases, or 82% of the excess cases among males in NE are attributable to these industries. The actual contribution is likely to be even higher since the databases containing the rosters of workers are not complete and include many records with missing or erroneous demographic data (such as social security number or date of birth) that is used in matching records.

Mesothelioma Among 72,000 Iron Miners

The original comparison between the iron mining cohort (N=72,000) and the MCSS mesothelioma database was undertaken following the passage and funding of the Occupational Respiratory Disease Information System (ORDIS) by the 1998 Minnesota legislature. The purpose of ORDIS was to investigate the mesothelioma excess in NE Minnesota and more generally address occupational respiratory disease issues in miners and other workers.

The initial record linkage study identified 17 miners who were diagnosed with mesothelioma between 1988 and 1996 in the state of Minnesota. This was the first report to link mesothelioma with employment in the taconite industry. A subsequent study of potential exposures to commercial asbestos among these 17 miners (MDH, 2003; Brunner et al, in press) was conducted with ORDIS resources and completed in 2003 (ORDIS was repealed and defunded in February 2002). Two other studies could not be completed following the defunding of ORDIS: a pilot study in NE Minnesota of using medical records for surveillance of occupational respiratory diseases and a mortality follow-up study of the iron mining cohort.

As has been previously reported (MDH press releases March 28, 2007 and June 20, 2007), two additional updates of mesothelioma incidence among iron miners have been conducted since the 2003 study. The March 2006 linkage study identified an additional 35 cases diagnosed after 1996. The June 2007 linkage study identified 6 additional cases. Consequently, since 1988 (the start of the MCSS), the total number of mesotheliomas among miners residing in Minnesota was 58; this is 41 more cases than were included in the original 2003 study (case count based on MCSS data as of June 2007; 2006 data was not considered final at the time of the linkage). Figure 4 shows the number of mesothelioma cases among miners by year of diagnosis. Demographic characteristics of the 58 cases are shown in Table 2 and work-related characteristics are shown in Tables 3 and 4.

All of the 58 cases were males, consistent with the large percentage of males historically employed in this industry. Most of the cases (75%) still resided in NE Minnesota at the time of diagnosis, thus contributing to the continuing excess in that region of the state among males. Cases ranged in age from 47 to 90 years, with an average of 71.4, which is not significantly different than the average age among males with mesothelioma (70.4) elsewhere in the state. As with mesothelioma generally among males in Minnesota, the great majority of cases were pleural mesotheliomas.

As shown in Table 3, the length of employment in the mining industry (prior to 1984 when the personnel records were obtained) ranged from less than one year (24%) to over 30 years (29%). Overall, 76% of the cases worked at least one year in mining based on the available records.

Mesothelioma is a cancer that has an exceptionally long latency period; that is, the time between the first exposure to asbestos and the diagnosis of the disease is typically 20-50 or more years. Therefore, when considering potential sources of exposure to asbestos for an individual with mesothelioma, the most informative job histories are those that occurred at least 20 years prior to diagnosis. As shown in Table 3, the length of time between initial employment and diagnosis was 30 or more years for all but one of the 58 cases. It is not known, however, whether that initial job (or any subsequent mining job) was a job in which exposure to asbestos or other fibers had occurred.

Table 3 also shows that three of the 58 cases had also worked for some period of time at the Conwed Corporation plant between 1958 and 1974 when large quantities of commercial asbestos were utilized in manufacturing ceiling tiles. Each of these three individuals thus had a very likely source of exposure outside the mining industry, although exposures within their mining history cannot be ruled out.

Table 4 provides a listing of all 58 mesothelioma cases among miners in the mining cohort database and indicates each mining company in which they had any work history (prior to 1984) according to the microfilmed personnel records used to create the cohort. Because the mining companies differed greatly in the number of employees who had ever worked in taconite operations prior to 1984, the number of employees for each company is shown to provide a very rough frame of reference. This number should be viewed cautiously since it does not take into account such factors as employee turnover, length of employment, period of employment, or job classification. (Such factors will be taken into account in future planned studies.) Many miners worked at more than one mining company and are included in the counts for each company for which they worked. Consequently, the sum of all the employee counts in this table greatly exceeds the number of individuals (72,000) in the cohort.

Several points can be made from Table 4: (a) while most of the cases (45) were employed at a single company, employment at multiple companies was not uncommon (13 cases); (b) cases have occurred among employees of all the mining companies, except for Inland (for which only 618 employees were listed in the available records); and (c) cases were associated with companies across the range.

Evaluation of miner work histories

As part of this preliminary examination of the expanded mesothelioma case series, microfilmed personnel records were examined to identify the job titles held by the 41 additional cases. A primary purpose was to determine to what extent these job titles appeared the same as or similar to job titles previously evaluated for potential exposure to commercial asbestos (MDH, 2003; Brunner et al, in press). However, this proved to be much more challenging than expected.

Some of the challenges in determining the mining jobs held by the 41 new cases and the proportion of these jobs previously evaluated for exposure to commercial asbestos are listed below:

- In some cases, the mineworker records show that the person was employed for a certain time period, but does not list the job title the person held.
- It is often difficult to tell whether a certain job title is equivalent to one that was assessed previously; e.g., mechanic versus auto mechanic
- Even when a job title held by one of the new cases (n=41) matches a job title that was evaluated for commercial asbestos exposure previously, that doesn't necessarily take into account the time period during which the job was held. It's possible that equivalent job titles may have had different exposures due to changes in technology or job responsibilities over time. The panel assessments conducted previously did take time period into account.
- Similarly, it is often difficult to tell whether a particular job was located at a hematite or taconite operation.
- We were not able to locate obituaries for all 41 new cases. Obituaries are a valuable source of information because they often contain an account of the deceased's work history, filling in gaps in the information provided by the University of Minnesota (U of M) mineworker records.
- In some cases, the mineworker database indicated that a case worked with a certain company, but the only information available in the microfilm/hardcopy records was an employment application. In at least one case, the obituary made it clear that the person had gone on to work at the company. For others, it's unclear whether the person went on to work at the company and if so, what job(s) they held.
- It is hard to know how to count the number of jobs a person held. For example, a person may have held jobs labeled "Mechanic A, Mechanic B, Mechanic C". The question is whether to count this as 1 job or 3 jobs. In this analysis, if it was clear that the person was moving through levels of the same position, we counted them as a single job.

Jobs held by the 41 cases

- According to the U of M mineworker records as well as obituaries (when available), the 41 cases are known to have held at least 122 different jobs in the mining industry from as early as 1942 through 1983 (when the U of M study ended) and into the 1990s (as reported in the obituaries).
- Among the 41, the length of employment in the mining industry ranged from less than a month to more than 30 years.
- Jobs held outside of the mining industry are not included in this summary.

Of the 122 mining jobs, 43 (35%) were previously assessed as to the likelihood and intensity of exposure to commercial asbestos in that job at a particular company during a certain time period. For 42 (34%) of the 122 jobs, a similar job title (not an exact match) at the same company, or the same job title at a different company was previously assessed. The remaining job titles (30%) have not yet been assessed in terms of potential for exposure to commercial asbestos.

Because of the above limitations, no further attempt was warranted to categorize exposures to commercial asbestos based on the previous assessments described in the 2003 MDH report. Further assessments of exposure by miners to commercial asbestos, other fibers, and taconite dust will be a critical component of future miner health studies currently under planning by University of Minnesota School of Public Health faculty and MDH staff.

Mesothelioma Among 5,200 former Conwed Corporation (Cloquet) Workers

The Conwed Corporation manufacturing plant in Cloquet (Carlton County) was in operation between 1921 and 1985. Prior to 1967, the company was named the Wood Conversion Company. The plant is currently owned and operated by USG.

The Conwed plant manufactured ceiling tiles (among other products) and was one of the largest mineral board plants in the U.S. Between 1958 and 1974, large quantities (50-120 tons/month) of commercial asbestos were used in the manufacturing of ceiling tiles.

A union-sponsored screening study of about 180 workers in 1986 (Robins and Green, 1988) and a much larger state-sponsored screening study in 1988 of 1,000 workers and 450 spouses (MDH, 1989; Kouris et al, 1991; Williams, 1994) identified high rates of asbestos-related respiratory abnormalities and asbestos-related cancer in these workers. These findings indicated that very high exposures to asbestos had occurred at that facility, particularly in certain departments/locations within the mill. Subsequent to these findings, with legislative support, MDH undertook a four-year effort (1989-1993) to identify all former Conwed workers employed at the Cloquet plant anytime between 1958 and 1974 and to notify them of their health risks (Bender et al, 1993). Approximately 5,700 former workers were identified.

Reports of mesothelioma among former Conwed workers were received by MDH prior to the medical screening program, during the medical screening, and subsequent to the screening. As MCSS accumulated several years of data, a number of these reports were able to be confirmed. Consequently, from the very first MCSS report on NE Minnesota cancer rates (MCSS, 1997) it has been noted that the excess of mesothelioma in NE Minnesota was at least partially attributable to asbestos exposures among the former employees of the Conwed Corporation (Wood Conversion Co.) plant in Cloquet.

As with the mining cohort, the first linkage of the Conwed cohort with MCSS data took place under the ORDIS investigation of excess mesothelioma in NE Minnesota. That linkage involved the 5,200 workers who were not deceased as of 1988 and it identified 11 former Conwed workers who had diagnosed with mesothelioma between 1988 and 1996. Nine of the 11 resided in NE Minnesota at the time of diagnosis, thus contributing to the excess in NE. Two of the

Conwed cases had also worked in the mining industry and were thus also included among the 17 cases in iron miners.

Mesothelioma incidence among Conwed workers was updated at approximately the same times that the incidence had been updated for the mining cohort (2006 and 2007). These linkages identified 14 additional mesotheliomas among Conwed employees that were diagnosed after 1996. As of June 27, 2007, MCSS records identified a total of 25 cases diagnosed since 1988. Figure 5 shows the years of diagnosis for each of the cases.

In addition to these 25 cases, there is reasonable documentation for an additional three cases among Conwed workers. One case was identified via MCSS but with an apparent initial diagnosis in 1980. Another case was identified through medical records from another state where the former employee lived at the time of diagnosis (1999). And a third case was identified only through a death certificate (1986).

Demographic characteristics of the 25 MCSS-identified mesothelioma cases are shown in Table 5. As with the miners, all the cases are males and 23 of the 25 resided in NE Minnesota at the time of diagnosis. While the age range is similar to that among miners and Minnesota males in general, the average age at diagnosis (64.6) is significantly younger than male mesothelioma cases elsewhere in the state (70.6). The interpretation of that age difference is not clear. Twenty of the 25 cases participated in the MDH-sponsored medical screening program in 1988.

The minimum latency (time between first exposure at Conwed and diagnosis) among the 25 cases was 28 years; all the other cases had 30 or more years of latency. Fourteen of the 25 had worked the entire 17-year period (1958-1974) that asbestos was used in the manufacturing of the ceiling tiles. The average duration of work during that period by the 25 cases was approximately 12 years with the shortest duration possibly less than 3 months.

Mesothelioma Among 450 Spouses of Former Conwed Workers

In June 2007, a linkage study was also conducted for the first time based on a roster of 450 spouses of Conwed workers who had participated in the MDH-sponsored medical screening program in 1988. No cases of mesothelioma were identified by MCSS records among the 450 spouses of Conwed workers as of the June 2007 study.

Future Updates

Future updates of mesothelioma occurrence among iron miners and additional information regarding work histories and exposures of cases will be conducted in conjunction with study protocols under development by University of Minnesota School of Public Health faculty and MDH staff. Information about the status of these studies will be available at both the MDH web page (below) and the University web page: http://www.sph.umn.edu/lunghealth/home.html.

Further information and updates about the health risks among former Conwed workers and their spouses will also be posted as it becomes available at the following MDH web site: http://www.health.state.mn.us/divs/hpcd/cdee/occhealth/index.html

FIGURES

Figure 1. Mesothelioma Rates by Region Compared to Statewide Average (1988-2002 data)

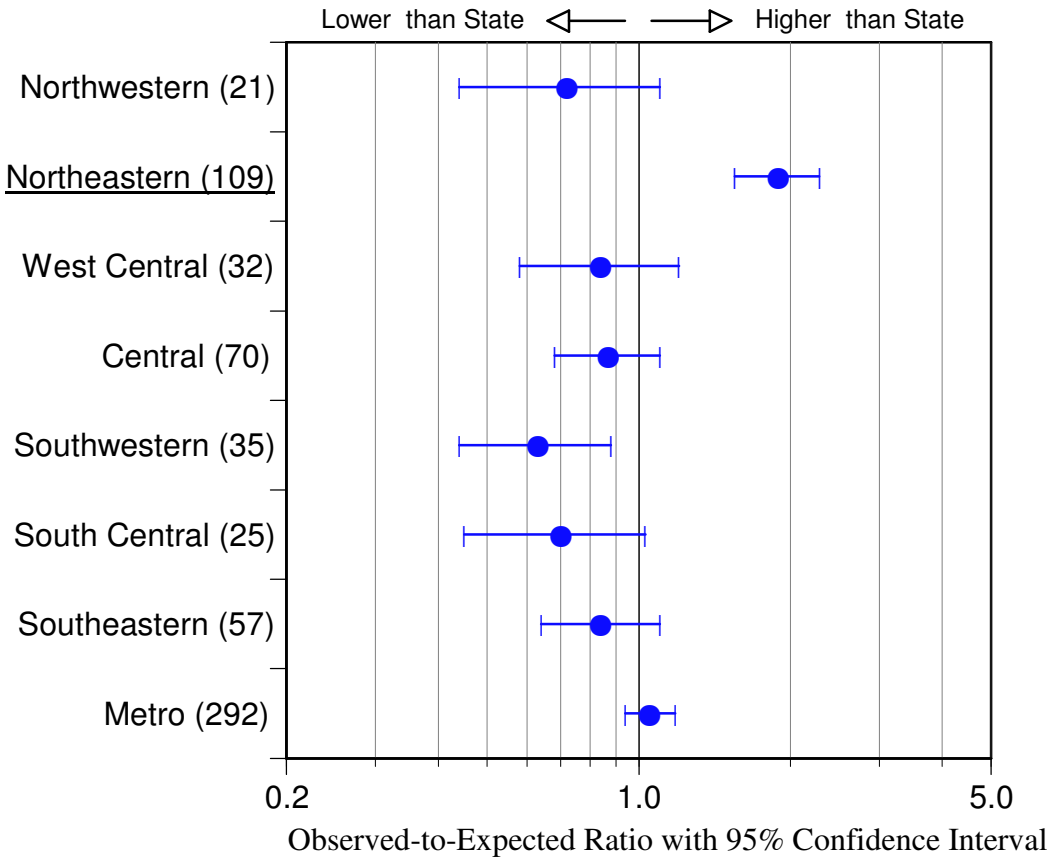


Figure 2. Annual Mesothelioma Incidence Rates Among Males: NE Minnesota vs. All Minnesota vs. 13 US Cancer Registries (NCI SEER Program)

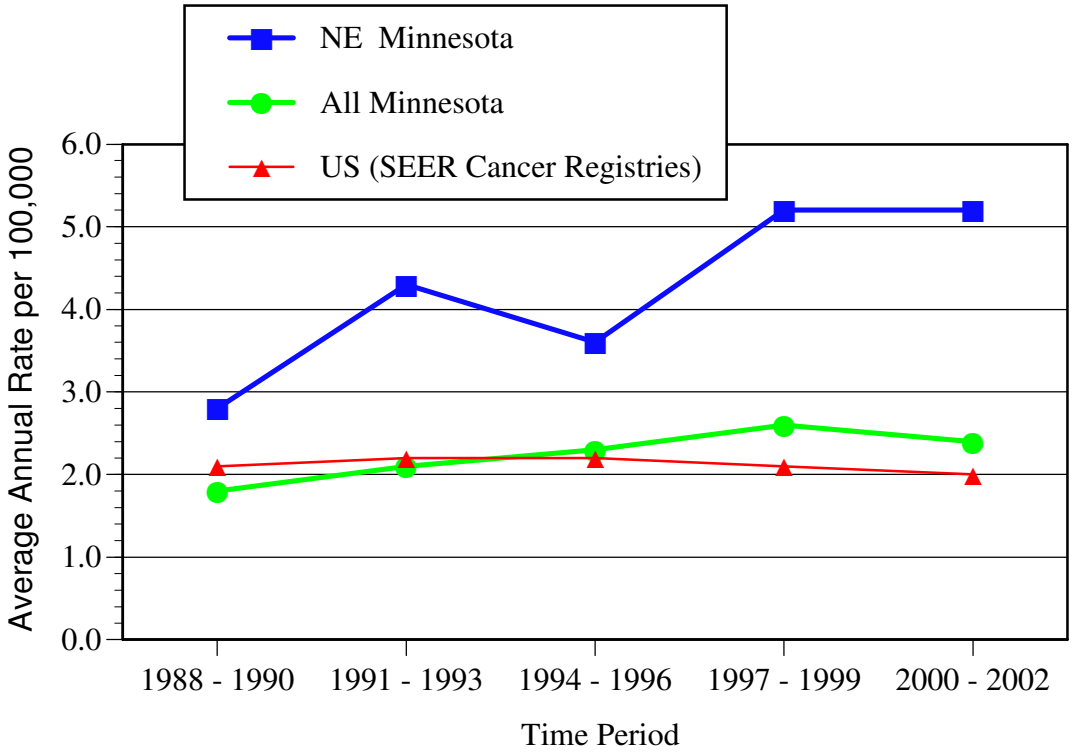


Figure 3. Age-Specific Rates of Mesothelioma, NE Males vs. Minnesota Males

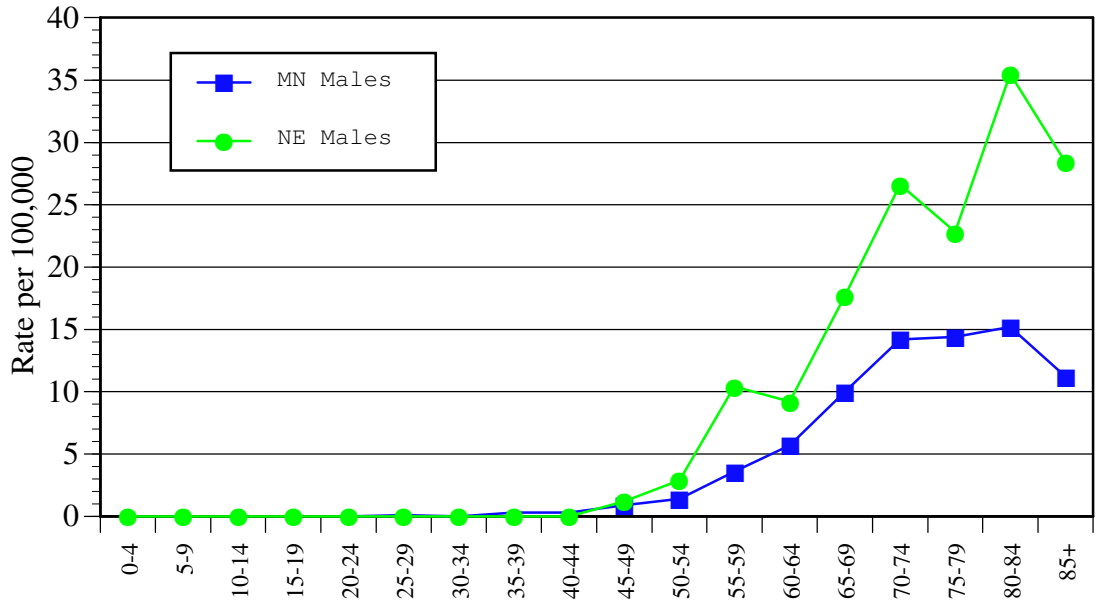
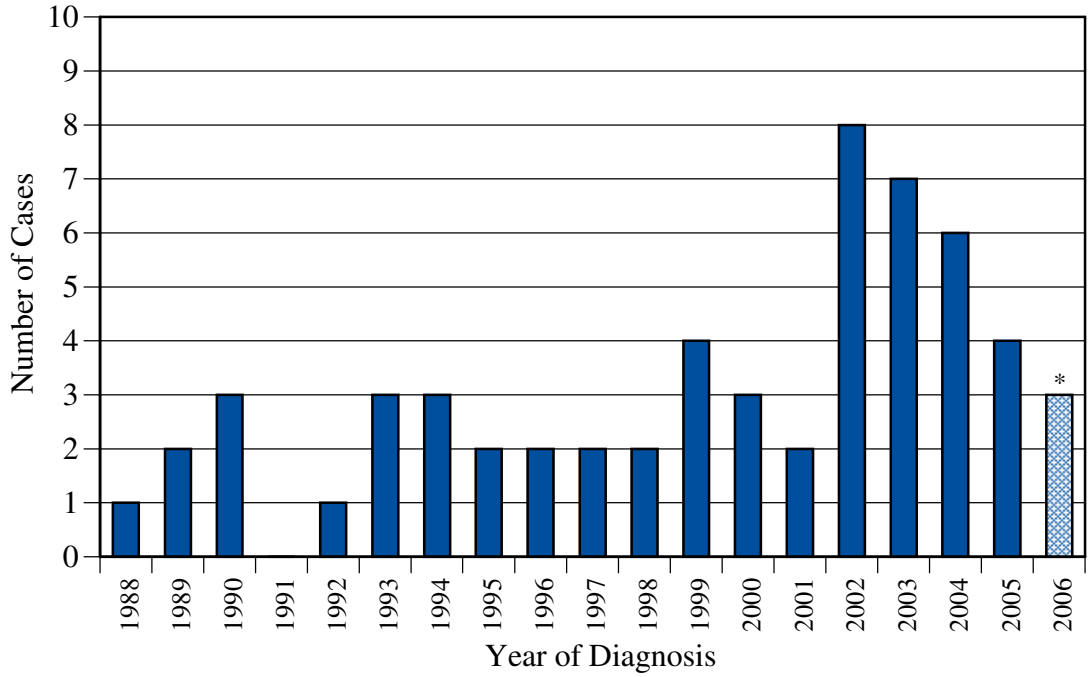
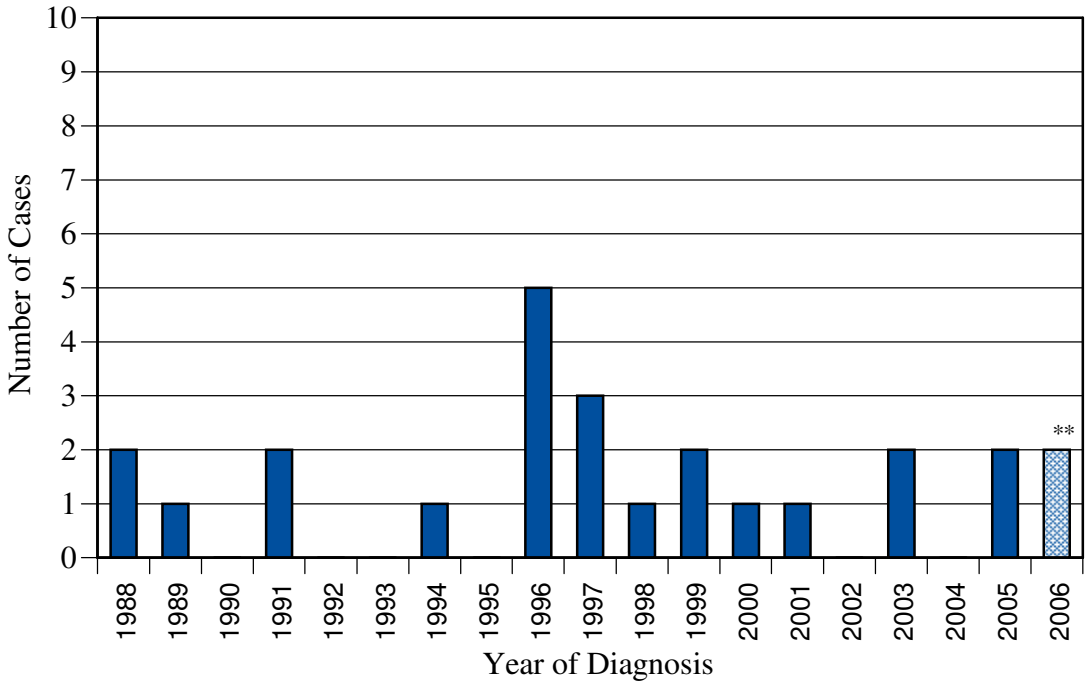


Figure 4. Mesothelioma Cases (N=58) Among 71,648 Minnesota Iron Miners by Year of Diagnosis, 1988-2006*



*Results from record linkage with MCSS performed on 06/18/07: 2006 data not complete at that time.

Figure 5. Mesothelioma Cases (N=25*) Identified by MCSS Record Linkage Among 5,200 Former Conwed Workers by Year of Diagnosis, 1988-2006**



*Documentation exists for three additional cases of mesothelioma, with dates of diagnosis or death of 1980, 1986, and 1999.

**Record linkage with MCSS performed June 2007; 2006 data not considered complete at that time

TABLES

Table 1. Previous and Current Findings of Mesothelioma Incidence in NE Minnesota

Source Report	Time Period Included	Males			Females		
		Actual	Expected	Ratio	Actual	Expected	Ratio
MCSS, 1997	1988-1994	39	23	1.7	2	7	0.3
MCSS, 1999	1988-1996	54	31	1.7	3	8	0.4
MCSS, 2003	1988-1999	81	45	1.8	10	11	0.9
MDH, 2003	1988-2001	99	50	2.0	10	12	0.8
Current report	1988-2006	146	69	2.1	13	18	0.7

Northeast Counties: Aitkin, Carlton, Cook, Itasca, Koochiching, Lake, St. Louis

Table 2. Demographic Characteristics of 58 Mesothelioma Cases Among Iron Miners

Characteristic	No.
Gender	
Male	58
Female	0
Geographic Residence at Time of Diagnosis	
Northeast MN	43
Other Minnesota	15
Age at Diagnosis	
<40	0
40-49	1
50-59	5
60-69	19
70-79	22
80+	11
Range = 47-90	
Ave. = 71.4	
Site of Mesothelioma	
Pleura	56
Peritoneum	2

Table 3. Employment Characteristics of 58 Mesothelioma Cases Among Miners

Characteristic	No.	%
Length of Employment in the Mining Industry (years)		
<1	14	24.1
1-5	16	27.6
6-9	2	3.4
10-29	9	15.5
≥30	17	29.3
Length of time between initial employment and diagnosis (years)		
<30	1	1.7
30-39	12	20.7
40-49	24	41.4
50-59	16	27.6
60-69	5	8.6
Also worked at Conwed Corp. in Cloquet 1958-74		
Yes	3	5.2
No	55	94.8
Number of Cases by Company (No. of employees**)*		
Reserve (10,813)	9	
Inland (618)	0	
US Steel (34,680)	24	
Jones & Laughlin (6,251)	3	
Hanna (15,826)	6	
Pickands Mather (Erie/Hibbing) (18,506)	28	
Eveleth (2,269)	3	

*Total here (73) is greater than 58 since 13 individuals worked for two or more companies

**Number of employees in database with any work history at this company regardless of work at other companies; roughly 11% of the 72,000 miners worked at more than one company and are thus listed in employee counts for more than one company.

Table 4. Mesothelioma Cases by Mining Company

	Company (number of employees*)						
Case	Reserve (10,813)	Inland (618)	US Steel (34,680)	Jones & Laughlin (6,251)	Hanna (15,826)	Pickands Mather (Erie/Hibbing) (18,506)	Eveleth (2,269)
1	X**						
2					X	X	
3			X				
4			X				
5			X				X
6			X		X	X	
7			X				
8						X	
9			X				
10						X	
11					X	X	
12						X	
13					X		
14				X		X	
15			X				
16			X				
17						X	
18	X		X				
19							X
20	X						
21						X	
22						X	
23						X	
24						X	
25						X	
26			X				
27			X				
28			X				
29			X				
30						X	
31			X				
32						X	
33						X	X
34			X				
35						X	
36						X	
37	X						
38	X		X				
39			X		X	X	
40						X	

	Company (number of employees*)						
Case	**Reserve (10,813)**	**Inland (618)**	**US Steel (34,680)**	**Jones & Laughlin (6,251)**	**Hanna (15,826)**	**Pickands Mather (Erie/Hibbing) (18,506)**	**Eveleth (2,269)**
41			X			X	
42			X				
43			X				
44						X	
45			X				
46						X	
47	X					X	
48						X	
49			X				
50			X		X		
51						X	
52	X			X			
53	X						
54	X						
55						X	
56						X	
57			X				
58				X			
Totals	***9***	***0***	***24***	***3***	***6***	***28***	***3***

*Number of employees in database with any work history at this company regardless of work at other mining companies; roughly 11% of 72,000 miners worked at more than one company and are thus included in the employee count for more than one company.

**An "X" indicates case name was listed in personnel records for that company, regardless of work duration.

Table 5. Demographic Characteristics of 25 Mesothelioma Cases Among Conwed Workers*

Characteristic	No.
Gender	
Male	25
Female	0
Geographic Residence at Time of Diagnosis	
Northeast MN	23
Other Minnesota	2
Age at Diagnosis	
<40	0
40-49	1
50-59	6
60-69	11
70-79	5
80+	2
Range = 46-81	
Ave. = 64.6	
Site of Mesothelioma	
Pleura	22
Peritoneum	3
Participated in 1988 Medical Screening Program	
Yes	20
No	5

*Linkage excluded approximately 500 of the 5,700 member cohort who were known to be deceased prior to 1988.

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Links to the following MDH reports are available at the MDH web page at:
http://www.health.state.mn.us/divs/hpcd/cdee/mcss/meso.html

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