CONTRACT RENEWAL
AND
PROGRESS REPORT

LONG-TERM MORTALITY STUDY
OF MINNESOTA IRON-ORE (HEMATITE) MINERS

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I. Introduction

This report documents the current status as of February 29, 1980 and
projected activities through June 30, 1981 for the University of Minnesota's
retrospective cohort mortality study of iron ore (hematite) miners. This epidemi-
ologic investigation, initiated August 1, 1979, is a study of a cohort of white, male,
hourly wage employees involved in mining of iron-ore since 1905 in St. Louis
County, Minnesota. The mortality experience of this cohort is being ascertained
and compared to the mortality experience of a demographically similar population.
Additional analyses will be made within sub-groups of the cohort (above and
below ground miners) to identify risks associated with specific kinds of
exposure. Based on the results of the initial mortality analysis, consideration
will also be given to the design and conduct of a case-control study to further
explore specific detailed work histories for any men found to be at significant
excess risk of death.

II. Specific Goals

A. to explore the relationship between involvement in the occupation of
iron-ore mining and human health
B. to explore the health effects of underground versus above ground
(open-pit) mining of natural iron-ore (Hematite)
C. to accumulate a data base for future studies contrasting natural iron-
ore mining exposures with taconite iron-ore mining exposures
D. to develop methodologies and strategies for use in future studies of
of the impact on human health of mining operations, such as copper-
nickel, peat, etc.

III. Progress Report

The ensuing report documents the progress achieved from the initiation
of the contract (August 1, 1979) through February 29, 1980. Table 1 provides
a summary of the projected starting and completion dates for each of the specific
study objectives and of the status of each of these activities through Feb-
uary 29, 1980. As is apparent from this summary, the study is well within
the projected time frame. Data on the 11,154 men have been abstracted, key-
punched and entered onto a computer edit. Both manual and machine edits have
been run and appropriate corrections made. A computer tape of the entire cohort
was made and sent to the Social Security Administration (SSA) in January, 1980.
From company records 2,073 deaths were ascertained. Death certificates for
these men are being requested from the appropriate state health department and
coded by a professional nosologist. All causes of death (immediate, underlying
and contributory) are being coded according to the eighth revision of the
International Classification of Diseases.

Concurrently the computer program developed by Monson for the analysis
of the data was obtained, converted for use on the University of Minnesota's
Cyber 172, debugged and tested.

More specific details of the various activities conducted during the
initial seven months of the study are given below.
Table 1 - Projected Starting And Completion Dates And Progress For Specific Objectives Relating To The University of Minnesota's Iron-Ore Miners Study (IOM)

February 29, 1980

<table>
<thead>
<tr>
<th>OBJECTIVE</th>
<th>PROJECTED STARTING DATE</th>
<th>PROJECTED COMPLETION DATE</th>
<th>DATE STARTED</th>
<th>DATE COMPLETED</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Retiree's List</td>
<td>September 15, 1979</td>
<td>October 1, 1979</td>
<td>September 10, 1979</td>
<td>October 15, 1979</td>
<td>Completed</td>
</tr>
<tr>
<td>Manual Edit of Data</td>
<td>September 1, 1979</td>
<td>October 1, 1979</td>
<td>September 1, 1979</td>
<td>October 19, 1979</td>
<td>Completed</td>
</tr>
<tr>
<td>Keypunch Data</td>
<td>October 1, 1979</td>
<td>November 1, 1979</td>
<td>September 17, 1979</td>
<td>October 24, 1979</td>
<td>Completed</td>
</tr>
<tr>
<td>Computerise &amp; Edit Data</td>
<td>November 1, 1979</td>
<td>January 1, 1980</td>
<td>October 29, 1979</td>
<td>February 1, 1980</td>
<td>Completed</td>
</tr>
<tr>
<td>Computerise Monson Computer Program on Cyber 74/172</td>
<td>September 1, 1979</td>
<td>October 1, 1979</td>
<td>August 6, 1979</td>
<td>October 5, 1979</td>
<td>Completed</td>
</tr>
<tr>
<td>Death Certificate Search 1 (phase #1)</td>
<td>September 1, 1979</td>
<td>July 1, 1980</td>
<td>September 15, 1979</td>
<td></td>
<td>on schedule</td>
</tr>
<tr>
<td>Social Security Number Matching</td>
<td>November 1, 1979</td>
<td>May 1, 1980</td>
<td>January 14, 1980</td>
<td></td>
<td>awaiting social security lists</td>
</tr>
<tr>
<td>Death Certificate Search 2 (phase #2)</td>
<td>April 1, 1980</td>
<td>January 15, 1981</td>
<td>After receipt of S.S. findings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-up of Cohort to Determine Status-Drivers license Directories</td>
<td>July 15, 1980</td>
<td>March 15, 1981</td>
<td>After receipt of S.S. findings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Analysis</td>
<td>March 15, 1981</td>
<td>May 15, 1981</td>
<td>After completion of follow-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare Report</td>
<td>May 15, 1981</td>
<td>July 15, 1981</td>
<td>After completion of data analysis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Identify and obtain death certificates for those individuals noted as deceased on employee records
2 Identify and obtain copy of death certificates for those individuals identified as deceased by Social Security Administration
A. Development of the Study Cohort

1. Study Population

The study population consists of white, male, hourly-wage employees exposed for at least one year prior to 1966 to iron-ore (hematite) dust in a mining operation in St. Louis County, Minnesota. White males were selected since only an estimated 40–50 females and 20 non-whites were ever employed by this company in the hematite ore mining operation. A cut off date of 1965 is utilized due to the fact that underground hematite mining ceased in early 1967 in St. Louis county.

2. Employee Records

Records are kept in the Minnesota Ore Operations offices of the U.S. Steel Corporation at Mt. Iron, Minnesota which is 180 miles north of Minneapolis. Personnel cards, known as permanent records, are kept for every employee back to 1905. Cards are kept in metal file drawers and are filed alphabetically and separated into active or inactive categories. Cards are moved from one category to the other but otherwise are never removed from this office. Other personnel records kept in these offices are the active workers file folders, retired workers card file, and death benefit file and these records are removed for storage to a nearby company warehouse or to the company archives in Pittsburgh when space is needed for current records. Active workers information has been key-punched and/or computerized since the 1940's but only current information is retained.

3. Abstracting

Abstracting of employee records was done at the company during 1978 and 1979 by two abstractors who resided in the area. Abstractors were trained and monitored by the project director who spent from four to six days a month at the company offices while the abstracting was being done and was otherwise available by telephone. The procedures for abstracting (Appendix A and B) were developed by the investigators and project director.

The time involved in reviewing and abstracting the 38,000 personnel cards was 130 person-days or 26 person-weeks. The abstractors worked a five day week, eight hour per day shift for approximately four months. The average number of records per person which were culled and abstracted was 37 per hour and the average for abstracting alone was 10 per hour. Results of abstracting are in Table 2.

Rosterizing was done from approximately 38,000 permanent personnel cards which were all reviewed and from which 11,154 men were found eligible for the study. The relevant data for each eligible man was recorded directly onto coding sheets to facilitate keypunching (Appendix C). The following information was abstracted: full name, last known address, social security number, birthdate, country of birth, spouse's name (when several persons abstracted with same name), date first employed, date last employed, unemployed periods of 12 or more months, underground mining experience, experimental taconite-plant experience and date of death if available. An identification number
was assigned to each member of the cohort. The cohort identification number identified the worker, the company, the abstractor and active or inactive status.

If an individual worked both an hourly wage and salaried position, only his hourly-wage tenure was included if it was 12 months or more. If an individual worked in both hematite and taconite mining, only the hematite experience was counted if 12 months or more, but a notation on any taconite experience was made under miscellaneous information.

4. Death Benefit File

Death benefit files included death certificates or proof of death records on all employees to whom death benefits were paid. Files back to 1963 were at the company offices at Mt. Iron and the project director received permission to copy all death certificates or proofs of death in the file on the copying machine when it was not in use by office staff. Over the four month abstracting period 780 death certificates or proofs of death were copied. These were matched to the computer list of all study members.

5. Roster of Retirees

A list of current retirees was typed from the company retiree card file. The retiree card file is regularly updated and considered to be reasonably complete. Information abstracted from the retiree card included: full name, social security number and current residence (city and state). A total of 1800 names were listed from the retiree file and these were matched with the list of members of the study cohort.

6. Quality Control

A number of quality control measures were introduced to check on the accuracy of the data. All abstract sheets were reviewed by the project director to ascertain any errors in the alignment of the data fields. Errors were found on 175 of the 22,308 (0.8%) lines of abstracted data.

A computer edit program was developed to check for out-of-range codes and other data inconsistencies (e.g. date of first employment must precede date of last employment). A total of 83 such errors were detected.

In addition to the above measures, a 2% sample of all employee records were selected and reviewed by the Project Director. Fifty records were randomly selected from each of the 15 file drawers in which they were stored.

Using the results of the sampling the estimated number which could fit the criteria for abstracting would be 11,149, the actual number abstracted was 11,154. Estimate of error for not abstracting persons who did fit criteria would be 54 or a potential 0.48% of the cohort (table 3). This error estimate is not considered significant enough to interfere with the study objectives.
Criteria for acceptance into cohort

Includes 5,160 (66%) underground miners

<table>
<thead>
<tr>
<th>Date of Death</th>
<th>Retired &amp; Alive</th>
<th>Inactive Workers</th>
<th>Active Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,073 (19%)</td>
<td>1,485 (13%)</td>
<td>10,460 (94%)</td>
<td>694 (6%)</td>
</tr>
</tbody>
</table>

Results of Abstaining Employee Records

Table 2 - Iron-Ore Miners Study (IOM)
<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstracted (fit criteria)</td>
<td>206</td>
<td>29.1%</td>
</tr>
<tr>
<td>Not abstracted (fit criteria)</td>
<td>1</td>
<td>0.14%</td>
</tr>
<tr>
<td>Employed &lt; 1 year</td>
<td>97</td>
<td>13.7%</td>
</tr>
<tr>
<td>Michigan mines</td>
<td>40</td>
<td>5.7%</td>
</tr>
<tr>
<td>Western mines</td>
<td>16</td>
<td>2.3%</td>
</tr>
<tr>
<td>Salaried employees</td>
<td>46</td>
<td>6.5%</td>
</tr>
<tr>
<td>Female employees</td>
<td>5</td>
<td>0.7%</td>
</tr>
<tr>
<td>Hired after 1965</td>
<td>287</td>
<td>40.5%</td>
</tr>
<tr>
<td>Taconite employment (exclusive)</td>
<td>10</td>
<td>1.4%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>708</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
B. Data Processing

Key-punching was done directly from the abstract sheets (Appendix C) by the University of Minnesota Health Sciences Computer Service. All cards (22,308) were punched and verified i.e. cards were repunched from abstract sheets a second time by a different operator. Error rates for key-punching are estimated at 5% and key-punching with verification would lower that to a rate of 0.25%. All the data was entered onto a computer tape and edited.

After the corrections were made on the tape, a number of lists were generated. These included: alphabetized list of all members of the cohort, and of all members of the cohort with a date of death recorded, a list of the cohort by identification number and a list by social security number. All lists included all information on the tape for each member of the cohort.

C. Ascertainment of Mortality

1. Deceased Identified From Employee Records

Phase I of a death certificate search was initiated as soon as the alphabetical list by year of death was available. This list included all persons with a date of death recorded on their personnel record as well as all persons whose names and birthdates were matched with proof of death records copied from the death benefit file at the company office. Full name, age, and date of death were compared with indices kept at the Minnesota Department of Health (MDH) Vital Statistics Division unless the place of death was known to be out-of-state. From 1962-1979 deaths at the MDH are on cumulative microfiche indices with the number of the death certificate listed. Before 1962, matching was done by individual year in annual alphabetized ledgers. When a match was found, a copy of the death certificate was made at the MDH where permission was obtained to xerox death certificates from 6-8 a.m. before their office working day began. Results of the Phase I search are listed in Table 4. To date, for 1,961 of the 2,152 (91.1%) deaths, a death certificate has been located and copied.

Table 4 - Results of Initial Death Certificate Search For Individuals of Study Cohort Identified as Deceased in Employee Records

University of Minnesota IOM Study
February 29, 1980

<table>
<thead>
<tr>
<th>Description</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of deaths ascertained from employee records</td>
<td>2,152</td>
<td>100.0</td>
</tr>
<tr>
<td>Number of death certificates located and copied</td>
<td>1,961</td>
<td>91.1</td>
</tr>
<tr>
<td>Number of death certificates located but not yet copied</td>
<td>43</td>
<td>2.0</td>
</tr>
<tr>
<td>Death certificates not located</td>
<td>148</td>
<td>6.9</td>
</tr>
<tr>
<td>Death occurred out of state-certificate requested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death occurred out of country-certificate requested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date of death recorded on employee record-no certificate found in initial search</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Social Security Administration

Phase II follow-up was initiated by contracting with the Social Security Administration to provide mortality information from social security records. The social security number and name of each study subject of the entire cohort was put on magnetic tape as per specifications of the Office of Enumeration and Earnings Records of the SSA and sent on January 15, 1980. The entire roster was sent so that there will be another check on the information we have on vital status from other sources. When the information is received from the SSA, matching will be done with the roster by social security number and persons receiving benefits or having earnings recorded will be assumed alive. A death certificate will be obtained for those individuals identified as being deceased.

Persons not identified as alive or dead by the death certificate search, SSA matching, or on active workers or retiree lists, will be followed using other techniques such as drivers license registration, union membership lists, and telephone contacts during Phase II of follow-up.

D. Coding

All death certificates are coded by a professional nosologist according to the eighth revision of the International Classification of Diseases. All causes of death (underlying, immediate and associated conditions) are coded. The underlying cause of death is noted in the margin of the death certificate and underlined twice.

As a check on the consistency of coding, a 1% sample of all the death certificates will be coded a second time. These, of course, will not be identified as duplicates.

The data from the death certificates are abstracted onto coding sheets according to the format outlined in Appendix D. The data will be keypunched, put on computer tape and edited.

E. Analysis

The Monson USDR computer program* has been obtained, converted to the Cyber 172 and tested using both the test data that accompanies the program and the data collected from our pilot study. The program is now available for use.

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IV. Proposed Work Scope for Period March 1, 1980 to July 31, 1981

During this period we anticipate receiving the results of the Social Security Administration's review of our data file. Death certificates will be obtained for those decedents not previously identified through employee records. These will be coded and added to the existing mortality data file.

Tracing procedures will be initiated for those members of the cohort whose status was not provided by SSA.

V. Proposed Work Scope for Period August 1, 1980 to July 31, 1981

The status of all study members will be determined. Efforts to trace the members of the cohort whose status is unknown will continue. Any outstanding death certificates will be obtained, coded and added to the file.

Initially, the analysis will compare the observed cause-specific mortality rates to those expected. The expected rates for U.S. white males are available as part of the Monson program.

If available, comparisons will also be made using expected obtained from mortality rates for St. Louis County and for Minnesota. Discussions are currently underway with Minnesota Department of Health to determine the feasibility of reconstructing mortality tapes prior to 1960. One option under consideration is to request the data from the National Center for Health Statistics. Deliberations on this issue will continue during this period.

Additional analyses will include a comparison between above and below ground miners and an examination of the relationship between mortality and years of exposure and place of birth.
APPENDIX A

IRON ORE (HEMATITE) MINERS STUDY
RULES FOR ABSTRACTING EMPLOYEES FROM EMPLOYEE PERSONNEL CARD

1. LIST IF EMPLOYED MORE THAN 12 MONTHS AND
2. IF HIRED BEFORE JANUARY 1, 1966 AND
3. IF WORKED IN ST. LOUIS COUNTY HEMATITE MINES AND
   a. no Michigan mines (Gogebic, Bessamer, Geneva, Geneva-Davis and Ishpeming)
   b. no Itasca County mines (Cannistero District, Coleraine, etc.)
4. IF EMPLOYED ON HOURLY-WAGE TIME
   a. If employment is split between salary and hourly wage use only hourly wage years. (Enter in miscellaneous columns (#77-80) the number of salaried years if at the end of hourly wage employment. Enter the number of salaried years in time-lapse column if in-between periods of hourly wage employment).
5. DO NOT LIST SALARIED EMPLOYEES UNLESS THEY WORKED MORE THAN 12 MONTHS AS HOURLY WAGE
6. DO NOT LIST ANY WOMEN EMPLOYEES OR MALES OF OTHER THAN WHITE RACE
7. DO NOT LIST UNLESS WORKED AT LEAST 12 MONTHS AT HEMATITE MINE. IF MIXED HEMATITE AND TAONITE EXPERIENCE, ENTER NUMBER YEARS OF TAONITE EXPERIENCE IN MISC. COLUMNS (#77-80) AND ADD THE FOLLOWING CODE FOR SPECIFIC PLANT.
   Code     Plant
   EXTA     EXTACA
   MT       MINNTAC
   PT       PILOT TAC
8. ENTER NUMBER OF YEARS OF TIME-LAPSE IF MORE THAN ONE YEAR (COLUMN 72-73)
9. IF WORKED AT LEAST 12 MONTHS AT UNDERGROUND MINE, CODE UG IN ROW # 1, COLUMN 75-76 AND ENTER TOTAL NUMBER OF UNDERGROUND MINE YEARS IN ROW # 2, COLUMN 74-76.
   Row # 1 = UG (code)
   Row # 2 = 000 (number of years)
10. NOTE SOUDAN UNDERGROUND MINE IN ROW # 1, COLUMN #74 IF WORKED THERE AT LEAST ONE YEAR
    ROW # 1 = S (code) followed by UG
APPENDIX B

IRON-ORE MINERS STUDY
INFORMATION ABSTRACTED

I. From employee job cards, active and inactive:
   Social Security number
   Full name
   Last known address
   Place of birth
   Date of birth (m-d-y)
   First date (m-d-y) of employment
   Last date (m-d-y) of employment (inactives) or date of
   abstracting for active employees
   Date of death (if recorded) (m-d-y)
   Gaps in employment, in years, if over 12 months
   Underground mining experience, in years, if over 12 months
   Miscellaneous information
      Taconite-ore experience
      Salaried employment
      If only employed 12-24 months, whether employment was
      intermittent or steady

II. From retiree's file:
   Name of retiree
   Social Security number
   Town and state of current residence

III. From file of deceased, insured employees:
   Copies of all death certificates available
   Copies of all proof of death insurance records