17. CONCLUDING REMARKS

The initial mortality analyses revealed excess risks among Rönnskär smelter workers, especially for lung cancer. About one third of the workers accounted for most of these excess risks (roasters and arsenic workers, nickel smelters and workers at the machine shop). These results were later confirmed by the analysis of cancer incidence, which also pointed at an obvious and encouraging decreasing lung cancer trend in the cohort (Sandström et al. 1989). During the course of finalizing this book, continued surveillance of the cohort revealed further declining mortality as well as incidence rates (Sandström and Wall, 1991). The analysis of different employment cohorts also confirmed lowered risks for those later employed. Despite these positive developments, however, lung cancer risks were not yet numerically in parity with those of the reference populations.

The observed mortality and morbidity figures as well as decreasing trends should, of course, be interpreted in view of early notifications of health problems and hazards and also consider technical and hygienic measures taken at the smelter. Changing smoking habits, subject to a separate study, may also, in view of the smoking-arsenic synergism (Pershagen et al. 1981), have accelerated these trends.

In 1932 the first joint Safety and Health Committee was appointed at Rönnskärsverken and an industrial physician and a safety engineer were also employed. Preventive work at the smelter was mainly directed towards the 'Rönnskär disease'. The recruitment of workers was mainly from forestry and agriculture and among unskilled workers. They were unaware of environmental problems and risks associated with modern industry (Nygren, 1980).

In view of the results from the study, it may also be warranted to analyse the changing environment of some of the risk locations within the smelter. The roaster departments including the gas purifier had an environment where most problems prevailed. The raw material was rich in arsenic, sulphur and heavy metals. The process lacked ventilation, the handling of calcine was manual and the work was heavy. Trucks were introduced by the end of the thirties, ventilation was gradually improved during the forties, and in 1953 a new gas purification system was introduced. In 1975 a further improvement eliminated the previous transport of crude arsenic and since 1978 a vacuum system was used. In 1978, overtime work at the roasters was also forbidden by the safety committee. After having been in operation for almost 50 years, the roasters were replaced in 1980 by a single fluidized bed furnace. This meant that the roasters could be operated mainly from the control room.

The nickel smelter was causing great hygienic problems. Fine-grained nickel fume, infiltrating the protective masks, was released during the reduction process. Thus, during January-February 1943, 13 workers were poisoned and one died. This department, however, was only in operation during the mid forties.

In arsenic departments, workers at the arsenic refining and arsenic metal works were most exposed. During refinement, the raw arsenic is freed from pollutants such as sulphuric acid and heavy metals, and the white arsenic trioxide powder is produced. This may also be further reduced into metallic arsenic. Originally, a dry refinement method was used, which caused many septum perforations and etching injuries. After 1935, a wet method brought considerable improvements but unsatisfactory methods (dry flotation etc) remained until 1957. The packing of refined arsenic was deficient, however, until the present refinery was built in 1962. Contents as high as 0.64 mg/m^3 were recorded. A new arsenic metal plant was erected in 1972 and later rebuilt in 1976. Previously, the old plant had had an environment that forced workers to spend some 2–3 h a day on hygienic measures.

Workers at the machine shop often had service functions throughout the smelter. Repair works inside the shop were sometimes associated with asbestos and other toxic materials. Furthermore, welding fumes often contained chromium and nickel.

In view of the analyses of mortality and cancer incidence and of the above description of work environmental

changes, we conclude that the heavy excess lung cancer risks are mainly due to the environmental conditions of the thirties and forties. This is also a consequence of the long latency periods preceding the occurrence of lung cancer. Improved technical and hygienic conditions at the smelter have obviously contributed to the declining trends in lung cancer relative to external populations. This is also supported by the observations that excess risks among those employed after 1950 are less pronounced. This must, however, be interpreted taking latency into account. When comparing employment cohorts and restricting follow-up to between 15–33 years (to increase validity in comparisons) small numbers will make the analysis less stable. The pattern remains, however, that excess risks are mainly to be found among those earlier employed.

Finally, it must be emphasized that the basic conditions for performing this study have been:

- For each worker, information was available concerning his assignments to various work sites within the industry.
- For each worker, it was possible to find out whether he was alive or not when the study was closed.
- For each worker, there was information concerning his cause of death and/or diagnosis of cancer.
- There were possibilities to combine all the above information on an individual level.
- Collective rather than individual informed consent through the trade union initiating the study.
- The Swedish statistics system could offer good reference data on mortality and cancer incidence.

Since there are no regulations to the effect that exposure data like those used here must be kept for future scientific use, similar future studies may be difficult to perform in Sweden. In this study it was a happy coincidence that the data were still available. The present trend is to sort out materials from the archives if it is not relevant for the day to day activities.

A lot of information which was previously written down on paper is now stored in various registers. There are now regulations which stipulate that individuals registered as, say, employees in a special firm, must be sorted out from the register when they leave their employment. Data in a register must not be utilized for other purposes than those stated in advance when a register was initiated.

Today, it would probably not have been possible to perform this investigation without obtaining informed consent from all, live, individuals (Smedby et al. 1991). It is also highly questionable whether it will be possible in the future to combine information from various sources through the use of the unique civic registration number as was done here.

Swedish epidemiologic research of the kind illustrated in this book is therefore at stake. At present the public attitudes and the political trends demonstrate a complete ignorance about the fact that it was the environment of yesterday which causes the health problems of today.

The observed trends however, strongly motivate further follow-up, especially of cancer incidence. The analyses so far have comprised workers first employed at the smelter during the period 1928–1966 with an employment of at least 3 months. An extension of the cohort with workers later employed (up to 1980) has recently been made for further analysis of different employment cohorts (Sandström and Wall, 1991).

Similarly, studies of the white-collar workers at the plant are under way. These workers constitute a group in between the more heavy exposed workers and the surrounding population. Thus, studies incorporating also the salaried employees will contribute to the dose-response discussion. The white-collar workers also represent another social background, and plausibly a different pattern of health behaviour.

The importance of changes in smoking habits will be assessed, now for the extended cohort of both blue- and white-collar workers. These studies will enable a deeper analysis of the interaction between smoking and occupational exposure. Up-dating the whole cohort with smoking habits will also result in a database which could be used for further studies. The effect of both smoking habits and occupational exposure could now be analysed also for other cancer sites than lung cancer.

Data on smoking habits have been collected in a questionnaire study where also information on their experiences from and opinions on Rönnskärsverken as a work environment are collected. In combination with indepth interviews of a small number of persons, strategically chosen from the cohort, we also aim at elucidating the antagonism between the demands on safe working conditions and the wish to keep the (well-paid) employment.