From screening to population studies

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In Norway the transition implicated in the title of this essay may largely be told through the fifty-eight years history of the institution that in 1943 was established as the National Mass Radiography Service. The institution was renamed the National Health Screening Services in 1985, and ended in 2002, when the institution became part of the new Norwegian Institute of Public Health in a merger with the National Institute of Public Health and several health registries (1).

The first X-ray apparatus for mass use was developed in Brazil by a radiologist in cooperation with a Siemens factory representative and put into use in 1937. In a few years thousands were X-rayed and the technique became known internationally. In Germany a professor at the University of Frankfurt am Main, Hans Holfelder, together with Siemens-Reiniger-Werke made an improved version that could be mounted in an autobus and transported around. Holfelder was also a SS-officer, and founded and chaired SS-Röntgen-sturmbann. In the Mecklenburg region 650,000 persons were X-rayed and the experiences was published in 1939 (2).

In September 1940 the then SS-colonel was at the head of an effort where 12,000 school children and teachers in Bergen were X-rayed. The examination was approved by the Bergen Health Authorities and an X-ray machine was bought in 1941, the first one in Norway (2).

The National Mass Radiography Service had two heads, Otto Ulrik Galtung Hansen (1945-1974) and Kjell Bjartveit (1968-1997). Unlike some other institutions within the governing system of Norway, The National Mass Radiography Service never had its history professionally written, but both heads of the institution were very visible in the society, both verbally and in writing (3-6), and the account given here is built primarily on their contributions.

In a discourse in The Norwegian Medical Society in 1967, named a 40 years co-memorial, Galtung described the period from 1927 through the 1930s as a watershed in the knowledge of tuberculosis that paved the way for a new and active policy in the handling of tuberculosis (3). Galtung became the TB Inspector in the "Medicinaldirektoratet" in 1939 and started planning mass radiography screening of the whole population. But, shortly after attending the mass radiography examination in Bergen in September 1940 he was removed from office and fled shortly afterwards to Sweden and England. According to word of mouth, it was his plans that were realized when the National Mass Radiography Service was established in 1943. Two teams were trained and the first miniature X-ray pictures were shot on 11th of October 1943 of the staff in the Ministry. Two and three weeks later the two teams started the work in the municipalities Hobøl in Østfold and Skoger in Vestfold.

When Galtung returned to Norway after WW2, he was appointed as Chief Physician of the Central Office for National Mass Radiography Service with a duty to lead the national activities for combatting tuberculosis. In a few years the staff of the National Mass Radiography Service counted 130, and seven busses and four boats with modern equipment for mass miniature radiography toured the counties of Norway in a systematic way. In 1952 the whole country was covered by the program. Bergen first and later Oslo and a few other bigger cities had got equipment for miniature X-ray picturing and it was decided that they should themselves be responsible for the TB health activities. The health authorities in the rest of the country should be offered the services from the National Mass Radiography Service.

At the beginning of the twentieth century the mortality due to tuberculosis in Norway was slightly over 30 per 10,000 with a variation by a threefold factor among the counties. A steady reduction in the TB mortality then began at the century shift and lasted during the whole century (7). In the 5-year periods before, during and after WW2, the crude rates were 9, 7 and 5 deaths per 10,000 population and the threefold variation among the counties prevailed (8). In 1946 the number of new TB cases reported to Statistics Norway was 10,333 (8) and it was given high priority by the health authorities to put in place measures to handle the epidemic according to the best of knowledge.

The new knowledge Galtung described in his co-memorial lecture – TB infection was not primarily contracted during childhood, but more during adolescence and early adulthood – implied that effective prevention was possible (3). And the mass miniature chest radiography was looked upon as an important part of the armamentarium at hand to combat tuberculosis by early detection of infection in the lungs and, at best, be able to prevent the spread of the infection, first by the isolation of the patients in the sanatoriums and later by treatment with the tuberculostatica that came into public use from the late 1940s (4). In 1947 legislation was passed that made the miniature chest X-ray

examination obligatory for the whole population over 14 years of age, and soon after new legislation made Pirque-testing and BCG-vaccination for all Pirquet negatives younger than 40 years an option for the municipality to decide for their population, and most did so. During the development of the TB surveillance program, the local health services and county and municipality medical officers were heavily involved in the organization of the screenings. The results of the X-ray readings were reported to the local health authorities who were responsible for necessary follow-up which mostly took place at local polyclinics for pulmonary diagnostics; at a time there were more than 100 such in the country. Actually, the northernmost counties of Norway with the highest frequency of TB, were the latest to be included in the program due to a lack of capacity for diagnostic follow-up and also sanatoriums. The intension was to run the screening every third year in each county, but the knowledge collected during the screening modified the procedures so that counties with the highest morbidity of TB was visited most frequently. The number of X-ray pictures evaluated yearly between 1950 and 1976 was fluctuating around 300,000 with a maximum of 437,783 in 1962 when the Oslo population was also examined for the first time by the National Mass Radiography Service (5).

As mentioned the results of the X-ray picture evaluation were reported to the local health authorities who then reported cases of TB to Statistics Norway. The National Mass Radiography Service did regularly publish data about their work but few scientific publications can be found. Figure 1 shows the reduction in number of reported cases of pulmonary tuberculosis from 1950 to 1968 in the two counties with the highest and lowest incidence of TB, respectively. On a logarithmic scale a linear reduction took place from 1950 and a leveling off is obvious during the early 1960s. It was also a close correlation between the county mortality of TB in the period 1946-50 and the rate of open pulmonary tuberculosis found during the second round of examinations in 18 counties. Again, the incidence varied a lot, from 5 to 35 per 10,000, taken as an indication that the finding by the mass screening did estimate the dissemination of tuberculosis as well as the mortality did (3).

As mentioned, the intensity of examinations already early in the 1950s were adapted according to the actual TB morbidity in the counties. Thus Finnmark was screened every second year from 1952 thru the sixties while two examinations in Oppland took place 10 years apart. This fact was the starting point for an important development taking into account the concept of risk. The establishment of a Central Tuberculosis Registry in 1962 paved the grounds for calculating an individual risk for becoming infected. With the system with a number for personal identity in place, a mathematical model including TB history, miniature X-ray results, Pirquet and BCG vaccination status, height, weight and demographic data was developed (11-13). It was decided to do a final total population screening that was finished in 1976 and, under way, a system for inviting those with high risk was piloted in Oslo. At the beginning of the selective screening program, 30% of the adult population were invited to the screening, which gradually decreased to 6% in the late eighties. The miniature mass X-ray screening program in Norway was closed in 1999.

During the time that the main work of the National Mass Radiography Service took place, several factors influencing the general course of the TB epidemic and developments affecting the possibilities to medical treatment interacted, and all together resulted in a steady decrease in both the morbidity and mortality of this infectious disease that during at least a century was a main killer of adolescents and young adults. During the first half of the twentieth century the improvement in general living and sanitary conditions evidently was important. There were also some medical efforts to prevent the spread of bacteria from sick to healthy individuals, but for a long time one supposed the majority of the population became infected during childhood. As knowledge about the immunity was gained, the BCG vaccination was tried in Norway during the 1930s. No research was done to clarify the possible impact of the multiple influencing factors in action.

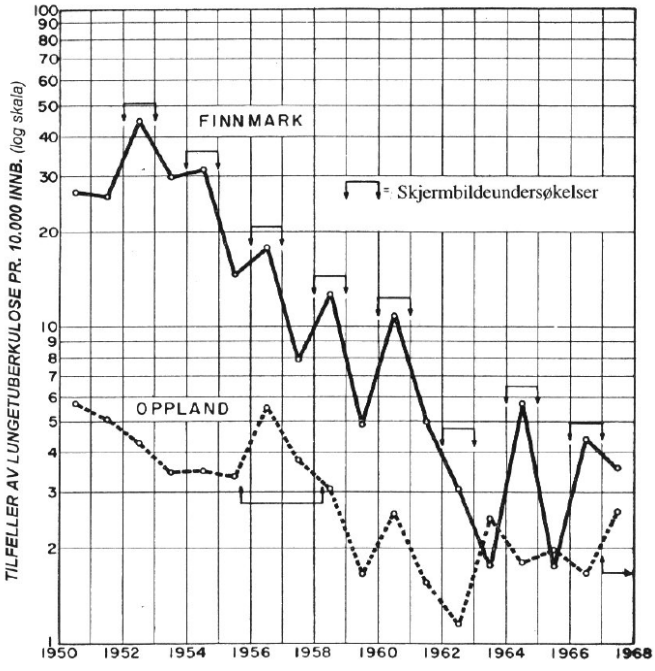

Figure 1. Reported cases of pulmonary tuberculosis (contagious + not contagious) per 10,000 residents in Finnmark and Oppland counties, 1950-1967. Periods of visits by the National Mass Radiography Service marked with brackets. Reproduced with permission of the European Respiratory Society: *Scand J Resp Dis* 1972; Suppl. 80: 31-42 (9). This material has not been reviewed by European Respiratory Society prior to release; therefore the European Respiratory Society may not be responsible for any errors, omissions or inaccuracies, or for any consequences arising there from, in the content.

It is impressive to see the humbleness that those in charge of the TB screening have voiced regarding the impact of their own efforts (3,4). This was the first and a pioneering screening program in Norway. A first insight conveyed was that the modern concepts of prerequisites for a successful screening procedure definitely were not at hand. Bjartveit (4) in a note in a paper admits (translated from Norwegian by the author): "… there is basis for claiming that the miniature mass X-ray program contributed to the faster decline in TB-incidence that came about from the late 1940s. No one has dared to distribute the credit for the accelerated decline in TB morbidity and mortality between the continued improvement in prosperity in the Norwegian society, the BCG vaccination program legally formalized in 1948, the introduction of new and effective medication and the screening program that covered the whole country from 1952".

The National Mass Radiography Service over the years made some contributions not directly related to TB. When the inhabitants of Bergen aged over 14 years was mass X-ray screened in 1962-63, blood pressure and heart rate were registered together with height and weight measurements. Actually, this Bergen Hypertension Study (10) started 10 years earlier as part of a local mass X-ray screening. The height and weight measurements were included in the national mass X-ray screenings from 1963 up to 1989. Scientifically, the height and weight measurements are by far the most important. None of the information collected during the TB screening program has been used in such a multitude of scientific analyses as those data!

Among those entitled to have an opinion, the quality of the work done by the leaders and staff of the National Mass Radiography Service was very good in several aspects. From the very beginning, it was emphasized to keep close contact with local health and municipality authorities and this, together with the legislative basis, secured a trust in the population and obviously contributed to a high participation rate in the screening. Internally, a lot of effort was put into securing the quality of the work; detailed protocols were developed and standardization of procedures and methods with supervision were systematically implemented. This quality of the institution was probably among the important premises for the successful transition of the institution into a competent actor in the population based cardiovascular health studies that were launched in Norway from 1972 and onward. The field work capacity of the National Mass Radiography Service was not needed for the down-scaled TB surveillance program that was coming and the prospect of a closing down of the institution was at hand.

The establishment of the TB screening program was initiated by public health officers and presented as an effort directed towards improving the health of the population. Of course also the cardiovascular screening had a general goal of promoting the health of the population, but a definite scientific motivation was probably to a greater extent a driver for the population based studies in Oslo in 1972 and in Tromsø and Finnmark in 1974. The Oslo Study was initiated by clinical researchers at Ullevål Hospital and the examinations was conducted as part of a TB screening that took place at Oslo Helseråd. Many of the procedures developed for this study were later applied in the population based studies during the next decades in Norway. And different from when the TB screening started, while the morbidity was in decline, the simultaneously leveling off of coronary heart disease morbidity was not observed by then. The situation at hand was a markedly increased mortality of coronary heart disease since the WW2, especially among middle aged men, and the northernmost counties were again the worst off.

The formal initiative for bringing National Mass Radiography Service into the cardiovascular screening business was a request from the county chief medical officer of Finnmark that asked if it would be possible to include a survey of risk factors for cardiovascular disease as part of the TB screening that was to take place in the county in 1974. This idea was supported by the University of Tromsø, where a cardiovascular study was planned to take place at the same time. The necessary decisions were taken and funding raised, and in March 1974 the first cardiovascular screening examination took place in Masi, about a month after the start in a fishing village in Tromsø. And – happily – in the Finnmark study women were included, as had always been the case in the TB screenings. In the wake of what became named the Health examination in Finnmark, the chief county medical officers in two other counties asked for the same kind of examinations in their counties. Both Sogn og Fjordane and Oppland had markedly lower coronary heart disease mortality than Finnmark, but together these three screenings became the so-called County examinations and were all repeated three times with 3 to 5 years intervals. During this period the institution also changed name to the National Health Screening Service in 1985. Technically these efforts proved that the institution mastered the change from TB to cardiovascular risk factor screening. The evident capability of carrying through the relevant procedures and ability to raise funding for the enterprise impressed the research community and the researcher driven population studies in Tromsø and Nord-Trøndelag succeeded in having the National Mass Radiography Service/National Health Screening Service run the screenings done in those locations from 1979 until late 1990s.

During the planning phase of the county examinations Bjartveit (4) in a note mentions that those involved were aware that the knowledge basis invited to do a randomized controlled trial of a structured intervention, but it was decided not to do so given several circumstances. Some years later, the results from the intervention in the Oslo study justified the decision.

Another extension of the results of the Oslo study

was due to the chief medical officer in Oslo who started a program for cardiovascular screening of 40 years old citizens of Oslo. The National Health Screening Service was requested to do an equivalent screening in Østfold in 1985 and funding for a nationwide program was put on the budget in 1987. For practical purposes this was coordinated with the county-wise selective TB screenings and due to a three year cycle the cardiovascular screenings included 40 to 42 year olds and the whole country was covered in 1993, but were continued when the X-ray photographing was ended and went on till 1999. In three counties, also some other selected age groups were invited to the screening. During the last decennium this activity took most of the screening capacity of the institution and it also included a lot of additional projects often locally initiated. In (14) there is a list of more than 50 projects, often locally initiated, from all counties, with topics ranging from measuring Thyroxine via physical activity, spirometry, alcohol and drug use to nutrition among farmers and municipality health services and so forth.

The last enterprise that the National Health Screening Service made an important contribution to was CONOR – a short name for Cohort Norway – an idea that was advanced in a Research Council working group for epidemiology during the 1980s. The beginning in 1994 was linked to the 4th Tromsø Study and over the years a selective set of standardized data and blood samples from close to 200,000 individuals have been included in CONOR. Altogether 10 of the cardiovascular screenings, both county and selective age-group screenings, are included and cover several of the regions of Norway (15).

The National Health Screening Service was in 2002 merged into the Norwegian Institute of Public Health. The legal basis for surveillance of tuberculosis in Norway became part of the general Act relating to control of communicable diseases, and there is also a separate directive regarding TB. The last selective miniature X-ray examination took place in 1999. The cardiovascular screening activities were gradually reduced and the competences and equipment for doing this type of health examinations were removed. The continuation of some of the scientific valuables created by the The National Health Screening Service have taken place within the Biohealth Norway funded by the Norwegian Research Council. So National Health Screening Service produced a great part of the data basis that nowadays make up what has become to be described as one of Norway's comparative strengths in the international research society. But the continuing collection and analyses and development of population based epidemiologic data is in Norway pursued mostly in two university based research enterprises.

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