Four decades of nuclear testing: the legacy of Semipalatinsk

Not far from Semey (formerly Semipalatinsk), one of the main cities in the northeast of Kazakhstan, the vast steppe is interrupted by a big lake that resembles a natural pond, called Lake Chagan. The landscape looks peaceful, but it hides a curious story: that lake, with a crater depth of 100 m and a diameter of 400 m, is also known as the Atomic Lake and it was formed in 1965 as the result of a nuclear testing explosion. The Balapan area, where the lake lies, was part of the Semipalatinsk test site (STS), where the former Soviet Union, over a period of four decades, performed a total of 456 nuclear testing explosions, 111 of them in the atmosphere. The first test took place on Aug 29, 1949, and the programme was officially shut down in October, 1989. Four explosions were conducted between 1965 and 1968 within the framework of peaceful uses of the nuclear testing programme, such as construction of lakes or canals, one of which generated Lake Chagan. 30 years on, what legacy has the programme left the people of northeastern Kazakhstan?

Although the STS area was chosen because it was uninhabited and access for civilians was restricted, several villages were located on the outskirts of the site and over 1 million people were estimated to be residing in Semey, located less than 150 km away. The atmospheric events were the major source of radioactive contamination and the radioactive cloud reached areas within a radius of more than 300 km from the epicentre, even though these areas were not recognised as potentially at risk during the nuclear testing era and were not covered by dosimeters. The cloud brought about important exposure of the general population living in the area, both externally, due to the radioactive material deposited in the ground, and internally, due to the inhalation of radioactive particles and the ingestion of contaminated food. Studies carried out more recently estimated that the population of the areas under study absorbed a cumulative effective dose between 20 and 4000 millisieverts (mSv), with a mean of 634 mSv in the exposed group. As a reference, in the UK, Public Health England has calculated that on average people are exposed to about 2-7 mSv of radiation a year, mainly due to cosmic irradiation.

Despite this enormous public health problem, still an issue for the Kazakh people, until 1956 no studies were conducted on the effect of the nuclear testing on the population, not even on individuals living close to the test site, and therefore statistics regarding acute as well as long-term effects are not available. Investigations started retrospectively from 1960 when the Semipalatinsk historical cohort study was established. The Semipalatinsk cohort has been the main source of information until now and it includes dosimetry and health information for 19,545 inhabitants of exposed and comparison villages in the Semipalatinsk region, followed up between 1960 and 1999.

Unfavourable health consequences of exposure to radiation in proximity to the STS site described in the literature are varied and many. Congenital malformations were reported more often among children exposed to radiation or born to women exposed at reproductive age or during pregnancy. The problem of teratogenicity is so evident that the Semey Medical University hosts a museum of mutations. More than ten studies available online describe an increased risk of cancer. Two recent ones, based on the Semipalatinsk cohort, reported a higher incidence of lung, stomach, female breast, and oesophagus cancers among the exposed group. An ecological study spanning from 1981 to 1991 described a two times higher incidence of childhood cancer in those living 200 km from the epicentre compared to those living 400 km away. Another health-related issue is the prevalence of cytogenetic abnormalities among the exposed population. There is increasing evidence, with the first studies online available between 1999 and 2003, mainly in Russian, reporting genetic aberrations such as chromosomal translocations, satellites, and micronuclei in the descendants of those living close to the testing site.

A further important health issue deserving special attention is the risk perception of the Semey area’s population. Recent studies describe traumatic psychological effects, such as stress and anxiety due to uncertainty about the radiation’s effect on heath and witnessing nuclear explosions, and have warned of the need to introduce effective psychological protection.

Epidemiological studies carried out so far have not elucidated all the aspects deserving attention. Further research is warranted to assess whether the health of the next generation could be affected, and to what extent. Recent technologies such as next-generation sequencing might help future studies to map genetic variants and establish their significance. The recently available State Scientific Automated Medical Registry of Kazakhstan, including information and biological material for those living around the STS site at the time of the testing and their offspring, might be a useful resource for future research. A government support programme, providing monetary help and additional health care especially to pregnant women and children who suffered from activities at the STS site, was put in place in 1992. Over a million people have been recognised as negatively affected by nuclear testing, but the government has not been able to completely fulfil its obligations, given the economic conditions.

Lake Chagan remains a restricted contaminated area and while nuclear testing sites have been buried, the legacy of the nuclear explosions on the Kazakh population remains. Further support from governmental and non-governmental bodies is required to support those affected by the nuclear testing programme and to conduct broad epidemiological studies and medical follow up to investigate the health impact of the radiation on the population and assess current and future dangers. In 2009, Kazakhstan tabled a UN resolution to create an International Day against Nuclear Testing, which falls on August 29. EClinicalMedicine is taking this opportunity to remind that the STS disaster is not a problem of Kazakhstan alone, but a global public health problem and as such it requires the engagement of the whole global community.

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