Case study title:	**Cyanide spill in Kyrgyzstan**
Target group:	**Public health professionals, general target group**
Linked to modules:	**Heavy metals, water**
Source of case study:	**National Institute of Public Health and the Environment (RIVM), the Netherlands**
Case handling:	**Use powerpoint presentation and/or handouts based on the case description. Stepwise approach.**

ACCIDENT IN BARSKOON (KYRGYZSTAN)

Introduction

After a cyanide spill on May 20th 1998, in Barskoon (Kyrgyzstan), WHO-Europe in Copenhagen asked WHO-ECEH (European Centre of Environment and Health) in Bilthoven, for analytical-chemical, environmental and (later) medical assistance.
The spill was the result of a truck accident on a bridge over the Barskoon River where reportedly some 1700 - 1800 kg of sodium cyanide (NaCN) was released into the river. NaCN was being transported on a regular basis by the Kumtor Operating Company to their gold mine in the mountains. The place of the accident was located some 8 km upstream of the village of Barskoon. The water from the Barskoon River is used by the local population as drinking water and to irrigate home gardens and agricultural fields. The Kumtor Operating Company, a daughter of the Canadian company Cameco, reported the accident to the local officials some 6 - 8 hours after the accident took place. In the meantime Kumtor had started to clean up the place of the spill a.o. by using hypochlorite in the water of the river and in the irrigation channels, to decompose the cyanide.

From May, 26 - 30, 1998, an environmental chemist at the National Institute of Public Health and the Environment (RIVM) of The Netherlands, was sent to Kyrgyzstan to evaluate current exposure concentrations, and to make an inventarisation of the health and enviromental problems.
The number of patients that kept visiting the local and regional hospitals in the days and weeks following the accident and the need for an independent assessment of potential medium or long term consequences of the cyanide release, called for a second WHO mission. So from June, 5 - 10, 1998, the environmental physician from RIVM, was asked to join the emvironmental chemist on his second visit to Kyrgyzstan.

To understand the need for more assistance after the first mission, the following should be considered:

- After the recommendations to the Minister of Health of the Kyrgyz Republic, on May, 28, 1998, that meat and milk of healthy animals could safely be consumed and only agricultural products such as vegetables that had been in direct contact with the

polluted soil should not be consumed, most products of the region were said to be refused on markets.
Also, Kazachstan tourists were said to have cancelled their holidays reservations in the recreation area north of Lake Issyk Kul.
The highest total cyanide concentration measured by the Laboratory of Inorganic Analytical Chemistry of RIVM, 0.7 mg/kg in a garden in Gagarin Street in Barskoon, was considered very low by Kumtor and very high by the Kyrgyz Government;
The number of patients kept growing in spite of decreasing levels of cyanide in soil and water.
One of the recommendations, on May 28, 1998, 'Prevent children to play at or with the soil in the polluted area', seemed to have triggered a massive and costly evacuation (it was said: up to 4000 women and children were moved to resorts south of Lake Issyk Kul).
The following goals for the 2nd mission were set:

1. To assess the potential for current and future health and environmental risks of the accident.
2. To assess the medical situation in the Barskoon area, in relation to the accidental release of cyanide in the environment;

QUESTION 1: HOW TO ACHIEVE THOSE GOALS.

- PLEASE USE A STEPWISE APPROACH, IN WHICH YOU DEFINE OBJECTIVES AND STRATEGY

(PLEASE ASK QUESTIONS TO THE TRAINER, YOU ARE NOT A CYANIDE EXPERT)

ANSWER TO QUESTION 1

Objectives

1. To acquire information on the likelihood of exposure, during and after the release;
2. To confirm the expected decrease in environmental concentrations of free cyanide;
3. To form an opinion on the complaints that led the patients to seek medical care;
4. To collect information on the motives for identifying a patient as a cyanide victim;
5. To collect information on the motives for starting (and ending) treatment.

Strategy

1. Estimation of concentrations of cyanide in the environment, particularly in soil and in air during and after the accident (by measurements of the free CN-concentration in soil on suspected places, and in air, by RIVM portable field equipment)
2. Refining the initial 'worst-case' calculation of the extent of the environmental pollution by cyanide, through closer inspection of the area downstream of the place of the accident.
3. Consultation of the physicians, dealing with cyanide victims on:
   - individual symptoms
   - type of exposure and interval between exposure and symptoms
   - potential clinical picture of ‘the intoxicated patient’
   - treatment protocol and results
4. Interview of selected patients on:
   - moment, duration and type of exposure
   - interval between accident and exposure

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NEW INFORMATION

Exposure

The chemical properties of sodium cyanide (NaCN) are described elsewhere. Suffice it to say that NaCN is readily soluble in water where part of it will react with water to form gaseous hydrogen cyanide (HCN), the bulk of which is being emitted into the air. Immediately after the accident, large quantities of NaCN were dissolving in the Barskoon-river. Part of the CN was being transported downstream as CN^- (distributed over a main stream to Lake Issyk Kul and smaller streams to the irrigation fields and home gardens), part was being emitted to the air as HCN, and a small amount of HCN was dissolved in the water.

At the time of the accident a portion of the river water was being directed towards irrigation channels in use by the local population.

QUESTION 2 AND 3:

- WHICH POTENTIAL EXPOSURE PATHWAYS CAN YOU MENTION ?
- DO YOU NEED INFORMATION FROM / ABOUT THE PATIENTS ?

ANSWER TO QUESTIONS 2 AND 3

Immediately following the accident

1. drinking of river water
2. dermal contact with river water
3. being close to the place of accident or to the river (resp. irrigation channels) for a certain period of time, inhaling HCN

(Prolonged contact seemed unlikely because of pronounced taste and/or smell, either from cyanide or from hypochlorite).

First few days

1. drinking of riverwater
2. dermal contact with river water
3. dermal contact with (irrigated) soil
4. short contact with sequestrated 'pools' of heavily contaminated water, if any.
5. eating of vegetables polluted through direct contact with cyanide.
6. cleaning of contaminated site and/or taking samples

Later

1. prolonged dermal contact with polluted soil or water
2. eating of vegetables polluted through contact and/or uptake of cyanide

Patients

In speaking with the patients and the doctors, we tried to assess:

1. when the exposure had taken place and how long the contact had lasted;
2. how close the contact had been with the potentially polluted media (air, water, soil or vegetables);
3. the interval between the accident and the exposure;
4. the interval between exposure and symptoms/complaints.

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NEW INFORMATION

Physicians

More than 2,000 patients had sought medical care because of suspected cyanide poisoning. Routes of poisoning as described by the physicians were by air and/or through working in the irrigated fields or gardens. Drinking of cyanide-containing water was not described as a major reason for seeking medical attention. All in all some 400 - 500 patients were admitted to the hospital.

According to the doctors, the more common symptoms were: headache, eye-irritation, weakness, dizziness, epigastric pain, diarrhoea, skin problems and convulsions. These symptoms seem to have played a major role in establishing the diagnosis of intoxication. This can be concluded by the fact that people from another village (10 km away) who had similar complaints, were also regarded by some doctors as having been intoxicated.

Only the physicians in the better equipped and staffed hospital had in their anamnesis explicit attention for the interval between exposure and complaints respectively accident and complaints. As a consequence they decided that some patients, in spite of their symptoms, were not suffering from NaCN-intoxication.

Patients

In the restricted period of time, it was not possible to see more than a dozen patients at the different locations. Several patients reported exposure by air, in the first few days of the accident, some of them had smelled the typical odour (Either the typical almond odour of HCN or the smell of hypochlorite, due to CN neutralizing measures). Other patients were working in the fields and reported to have had contact with either the soil, the water or both. For some patients there was a considerable interval between the moment of contact and the reported symptoms or the moment they sought medical care. Other patients reported to have been exposed and fallen ill days after the accident.

Environment

From initial 'worst-case' calculations of the total cyanide concentration in the soil of a target area of 4 km^2, on the condition that the main stream of the Barskoon River had been diverted to the village center, a concentration of 7 mg/kg resulted. From a closer inspection of the situation during the second mission, it appeared that the area in the village that had been irrigated was much larger, it was said to be over 10 km^2. Moreover, only a fraction of the flow of the Barskoon River had been diverted into the channels, in our estimation not more than about 20%.

Analytical results

From measurements of the first series of samples, taken May 26-27, 1998, the highest result for total cyanide was 0. 7 mg/kg in a garden in Gagarin street. In the Netherlands, the soil ‘target’ value for free cyanide is 1 mg/kg. According to the Netherlands government this level represents negligible risks to all ecosystems.

In all the soil samples, also in a new sample taken in the previously visited garden in Gagarin Street in Barskoon, the free cyanide concentration was in the lowest measurement range of the portable apparatus, being in between 0 and 0. 1 mg/kg. No measurable concentrations in air were found. Due to lack of devices to cut vegetables and fruit into sufficiently small particles, these samples could not be measured. Alternatively, we provided some additional information from literature, on fruits and vegetables.

QUESTIONS 4 AND 5

- WHAT WOULD BE YOUR CONCLUSIONS?
- WHAT WOULD BE YOUR RECOMMENDATIONS?

ANSWERS TO QUESTIONS 4 AND 5

Conclusions

Immediately after the accident on the Barskoon River, on May 20, 1998, high concentrations of cyanide in the water flowed to the lake and to the irrigated fields and home gardens. When NaCN is in contact with water it is partly being transformed into hydrogen cyanide (HCN), with its typical odour. This must have taken place at the accident site, but most likely also along the river and its canals. Any people who were there and worked in the fields or had contact with the water at that moment, have most likely been exposed with a potentially serious outcome. This was however not reported and therefore unlikely to have occurred at a large scale.

There was insufficient attention for the interval between exposure and disease and for the interval between the time of the accident and the first complaints. This led to a gross over reporting of accident related disease and finally to a – toxicologically unwarranted – evacuation of up to 4000 people.
Better risk communication – not only to the population, but also to the doctors, e.g. on exposure concentrations – could have prevented much of the unnecessary concern. With respect to the absence of a risk communication strategy, the central (local) government could be held responsible. However, Kumtor operating company, being part of an international industry, could be blamed just as well, in view of their easy access to literature and state of the art risk management protocols.

In our mission, we have tried to handle this concern, and the corresponding questions of the authorities, by providing:
- facts on diminishing cyanide concentrations in soil, water (and agricultural products);
- facts on the relation between exposure (dose) and disease;
- facts on the chemical, toxicological and environmental behaviour of NaCN.

We have reason to believe that under the circumstances this strategy was practical and effective.

Recommendations

– To establish emergency plans in case of future calamitous events in Kyrgyzstan.
– To establish an independent and reliable system of monitoring concentrations of cyanide in water, soil, vegetables and fruit, by proper measurement devices (including an up-to-date spectrophotometer, and a sufficient amount of necessary reagents) in order to convince the local population as well as consumers of the agricultural products of the safety of local environment and food.
– To set up a risk communication strategy, in close cooperation with all the stakeholders.
– To make a plan to build and maintain a sufficient level of education in epidemiology and (eco)toxicology at ministerial and local WHO level. (*This recommendation must of course be considered with respect to other medical and/or training needs of Kyrgyzstan)*= = = = =