Possible mercury poisoning in alluvial gold miners in the Porgera Valley, Papua New Guinea

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Introduction

In 1938, alluvial gold was first reported at Porgera and local prospecting began. By 1975, Placer (PNG) Pty. Limited became the operator of a joint venture with Mount Isa Mines Ltd (MIM). The Porgera Joint Venture gold mine (PJV) is now 50% owned by Placer Pacific, an Australian company whose major partner is Placer Dome, Canada. Built at 2700 m above sea level in rugged mountains, the operation is one of the world's largest modern mines using the latest mining technology developed. The mine is located 200 km west of Mt. Hagen in the remote Enga Province in the Highlands of Papua New Guinea (Peak undated). During the exploration and construction in the 1980s and early production days in the early 1990s, the mine experienced a lot of national and international criticism for environmental damage. One of the most detailed reports done on Porgera as a notorious company responsible for environmental damage was 'The Porgera File: Adding to Australia's Legacy of Destruction' by Philip Shearman (1995), a consultant with ICRAF. After this embarrassing exposure and others that followed (Kennedy 1996; Apte 2001), the mine has come a long way and now uses the latest technologies that are more environmental friendly.

Alluvial gold is very common in PNG and it is mined throughout the country. Currently there are an estimated 50,000-90,000 rural 'grassroots' miners producing an estimated 4 tones/yr worth K100 mil (Susapu and Crispin 2001). Silent mercury poisoning among alluvial gold miners in the Porgera Valley, which is yet to be addressed, is causing more immediate serious human health effects than environmental degradation. Alluvial miners have been in the Porgera Valley long before PJV came into being. Their presence in the valley goes back to the mid 1900s when gold was first discovered. There has been a long history of extensive alluvial mining by prospectors using elemental mercury to extract gold from gold dust.

Gold dust, mercury amalgamation and cooking

Presently, alluvial mining focuses on waste rocks that are dumped at in a small creek that joins the main Pongema River, which flows into the Lagaip and Strickland rivers. The tailings from the mine are discharged into the same creek (Apte 2001). These waste rocks are actually low-grade ore bodies that are discarded since only moderate and high grade ores are fed into the mill. Alluvial miners, most of whom are local people, look for potential gold bearing rocks from among the waste rocks. They crush the rocks up into a dust that is washed in gold panning dishes. The heavy gold containing particles of rock are left behind and may be further crushed to dust to end up with gold dust.

Once gold dust has been created, the next process is mercury amalgamation involving the use of elemental mercury to extract gold from gold dust. This is the most popular method of gold extraction practised in the Porgera valley by the alluvial miners. The mercury is poured into the gold dust after most of the rock particles have been washed out. The mercury is mixed well into the gold dust for few minutes allowing the mercury to bind to gold particles leaving the rest of the debri behind. The mercury-gold mixture called the amalgam is recovered.

The amalgam then goes through the next process of cooking (heating) or retorting (Blowers 1988). Retorting is done using a retort, a special container with the lid end connected to a simple pipe to serve as a condenser. When the amalgam is heated in the container, the mercury vapour escapes through the pipe. The pipe can be cooled with running water which allows the mercury vapour to condense and liquid mercury is collected as it flows out which can be reused later. The local miners do not use this very simple and safe method. The common method used is heating the amalgam placed in a pan or aluminium foil directly over an open fire, thus called 'cooking'. The mercury vapour escapes into the air and can easily be inhaled by anyone present.

Sometimes, the mercury - gold mixture is placed in a cloth and the excess mercury is squeezed out before it can be cooked. This is often done at the panning site and makes it a potential source of letting mercury into river system.

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The problem

The method of heating amalgam exposes miners to elemental mercury vapour, which can be easily inhaled. Inhalation of mercury vapour is the commonest route of elemental mercury poisoning. Other routes such as the skin and gastrointestinal track are not so effective. There have been cases reported where miners have actually cooked their amalgam inside their houses thus putting them at even greater risk of mercury poisoning. There is also the potential for environmental pollution caused by alluvial mining by discharging elemental mercury straight into the river system (Schulz et al. 2001). To really understand the depth of the problem, below is a real case history of mercury poisoning that was almost overlooked.

This is a case of chronic mercury poisoning in a mine employee who had been stealing gold amalgam from the mill where he worked and was cooking it inside his house. He was a 24-year-old local young man and had been visiting the Mine Medical Centre for almost 5 months. He first came in November 2000 complaining of having weakness in his arms, trembling fingers, insomnia and inability to concentrate well at work. It was found that each time he went home for field break (8 days) and returned, his symptoms were a little less than before. When he was on duty (21 days) he would visit the medical centre at least every week complaining of the same symptoms. The only significant findings were fine tremors in his fingers and the inability to sustain small weights in his hands. Numerous investigations revealed nothing. He was put on anti-inflammatory drugs thinking he may have had a compressed cervical nerve root although x-ray of the cervical spine did not reveal anything.

Six months later he did not show any improvement and his symptoms were getting worse. He was referred to a physician at the Port Moresby General Hospital where investigation for heavy metals was undertaken besides other investigations. Results indicated that he had very high levels of mercury in his blood and urine.

It was later revealed by his older brother (also an employee) that the man had been smuggling mercury into the mill where he worked and as the gold in solution came through he would pour the mercury into the solution. The mercury mops up the gold particles and leaves a lump of solid gold and mercury, the amalgam, behind. This was what he was stealing most of the time he was working. He would heat up the amalgam inside his house for fear of being suspected, thus exposing himself to high levels of mercury. It is possible that many other unidentified gold thieves are exposed to high levels of mercury in addition to the alluvial miners who get their gold from the dumpsite and process incorrectly.

Mercury poisoning

The potential source of acute or chronic mercury poisoning is through the inhalation of mercury vapour during the cooking process. The risk is increased when the cooking process is done indoors where most of the vapour is inhaled or the vapour may condense inside the house leaving mercury droplets every where and the whole family may be chronically exposed.

Another possible source of mercury exposure is from the tailings from the mill. The tailings are discharged directly into the small creek at the dumpsite where alluvial miners pan for gold using the water. Mercury is a by-product of gold processing and is recovered but small amounts of inorganic mercury do escape in the tailings and can be a likely source of slow long-term exposure.

Health effects can be due to the 3 forms of mercury: elemental mercury, inorganic mercury (mercuric chloride) and organic mercury (methyl mercury) (OSU 2002; CPCS 2002). The greatest risk of elemental mercury poisoning is via inhalation. The lungs easily absorb particles in the vapour which are distributed through the body via the blood stream. Acute symptoms include cough, chest tightness, difficulty breathing, confusion, weakness, metallic taste, mouth sores, kidney damage and even severe pneumonia. Ingestion of organic and inorganic mercury may cause nausea, vomiting, diarrhoea and severe kidney damage.

Chronic poisoning occurs with all forms and has three main symptoms:

1. Gum problems - soft, spongy and easily bleeding gums, loose teeth, and mouth ulcers.
2. Psychiatric manifestations - wide swings of mood, hallucinations, memory loss, loss of concentration.
3. Central nervous manifestations - headaches, dizziness, fine tremors in the fingers, ringing in ears, weakness in the limps, loss of balance, tingling sensations.

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Other health effects of chronic mercury poisoning include skin allergies, burns, damage to the lens of the eye, birth defects in babies of mothers exposed to mercury and infertility.

Of great concern is the chemical's ability to bioaccumulate, in food chains in aquatic environments where it is magnified in higher life forms such as fish and humans. In this way, mercury stays in the environment for a long time.

How can the problem be solved?

Many organisations including non-governmental organisations have been concerned more about the possible environmental problems from the waste rock dumping and the tailings down the river system and the discharge of mercury from alluvial miners into the river system or the health effects they are likely to suffer from inhaling mercury vapour have not been considered.

Because the limitation of alluvial mining by local people would be an extremely contentious issue, the best way to solve this problem would be through local education programs to increase awareness of the dangers of mercury exposure. Unfortunately, not many people are aware of this serious problem as indicated by many individuals interviewed while developing this paper.

The first step would be to admit that there is a problem and to define the problem by conducting a baseline survey including medical examinations and baseline blood and urine mercury levels on possible exposed groups of people. This would enable identification of risk factors and would give some indication of where to start. The findings of the study could then be interpreted and the information used to run a major awareness campaign on the health effects as well as environmental effects of mercury. The campaign could also provide the opportunity to teach safer methods of extracting gold such as using retorts, or cooking amalgam in a well-ventilated area such as in open-air settings. Other safer methods could also be introduced including the use of screens, shakers and sluices. There are other methods using chemicals such as sodium hydroxide and cyanide together with mercury that decrease the loss of mercury during the amalgamation process, but these are dangerous and people should be discouraged from using them.

Because this is probably only the tip of the iceberg, mines should be required by law to screen all miners working in the mills and mine for heavy metals.

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