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# Mercury as a health hazard due to gold mining and mineral processing activities in Mindanao/Philippines

## Treatment project

## – Final report –

**Munich. 21st of March 2001**

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**UNIDO Project No. DP/PHI/98/005**

**Contract 2000/123- Assistance in reducing mercury emissions in highly contaminated areas in Mindanao "Analyzing Blood and Urine Samples"**

**Contract DP/PHI/98/005/ 11-06 - Environmental Health**

# 1. Introduction

The region of Diwalwal, dominated by Mt. Diwata, is a gold rush area on Mindanao (Philippines), where approximately 15,000 people live. The fertile plain of Monkayo is situated downstream, where approximately 100.000 people live. Crops such as rice and fruits such as bananas are grown; locally caught fish is eaten frequently. The ore is mined by small scale miners and ground to a powder by ball-mills whilst still in Diwalwal. The gold is extracted by adding liquid mercury (Hg), forming gold-amalgam. To separate the gold from the Hg, in most cases the amalgam is simply heated in the open by blow-torches. A high external Hg burden of the local population must be assumed. To evaluate the internal Hg burden of the population and the extent of possible negative health effects, a project was funded by the UNIDO in 1999 [1]. 323 volunteers from Mt. Diwalwal, Monkayo and a control group from Davao were examined by a questionnaire, neurological examination and neuro-psychological testing. Blood, urine and hair samples were taken from each participant and analyzed for total Hg. A statistical evaluation was possible for 102 workers (occupationally Hg burdened ball-millers and amalgam-smelters), 63 other inhabitants from Mt. Diwata ("only" exposed by the environment), 100 persons, living downstream in Monkayo, and 42 inhabitants of Davao (serving as controls). A "Hg intoxication", that should be treated, was not diagnosed by the Hg concentration in the bio-monitors alone, but by a balanced combination of these Hg values and a medical score sum including typical symptoms of a chronic Hg intoxication. In principle, this means the higher the Hg concentration in the bio-monitors, the lower the number of characteristic adverse effects are required for the diagnosis of a chronic mercury intoxication. By this method 128 persons (0% of the controls, 38% downstream, 27% from Mt. Diwata, non-occupational exposed, 71.6% of the workers) were classified as Hg intoxicated. An attempt to treat the intoxicated participants with the chelating agent dimercaptopropanesulfonic acid (DMPS) was proposed [2].

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1 UNIDO Project No. DP/PHI/98/005 final report 1999 from S. Böse-O´Reilly, S. Maydl, G. Roider and Prof. Gustav Drasch Institute of Forensic Medicine - Munich, Germany (8)

2 Drasch G., Böse-O'Reilly S., Beinhoff C., Roider G., Maydl S.: The Mt. Diwata study on the Philippines 1999 - assessing mercury intoxication of the population by small scale gold mining. The Science of the Total Environment 267, 151-168, 2001 (21)

# 2. Health status and environmental problems in the area of Monkayo

## 2.1. Health status

### 2.1.1. Morbidity and mortality

Tuberculosis is still a major health hazard in the area. In June 2000 67 out of the total population of 92.000 in the Monkayo and Mt. Diwata area were treated for tuberculosis (TB). Within 1999s participants we recommended due to clinical symptoms some patients to be tested for TB. Tuberculosis was mainly confirmed and treated in our small selection! 2000 once again we did recommend in a couple of patients TB diagnostic procedures. One of the patients had an open tuberculosis since four years. Tuberculosis is according to our checking of the death records of Monkayo and according to the statistics of the health office still a mayor reason of death. Pneumonia and other infectious diseases and heart/circulation diseases are further prominent causes of death (see Figure 2).

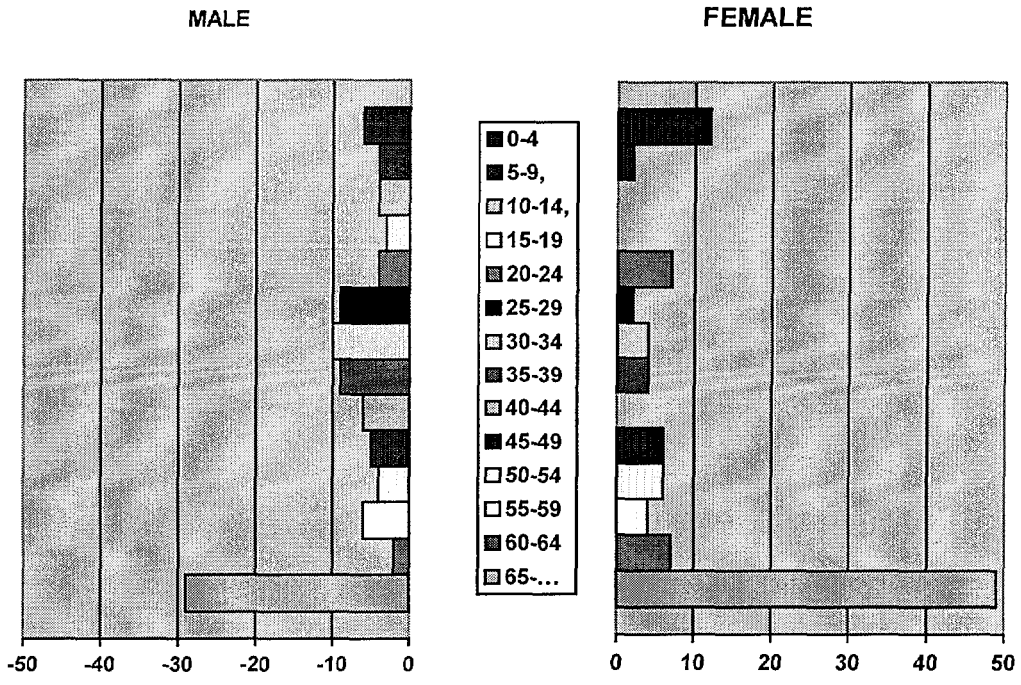



*Figure 1: Age distribution, given the total number, 1999 of the district of Monkayo, population size approx. 92.000. Data from Municipal Health Office.*

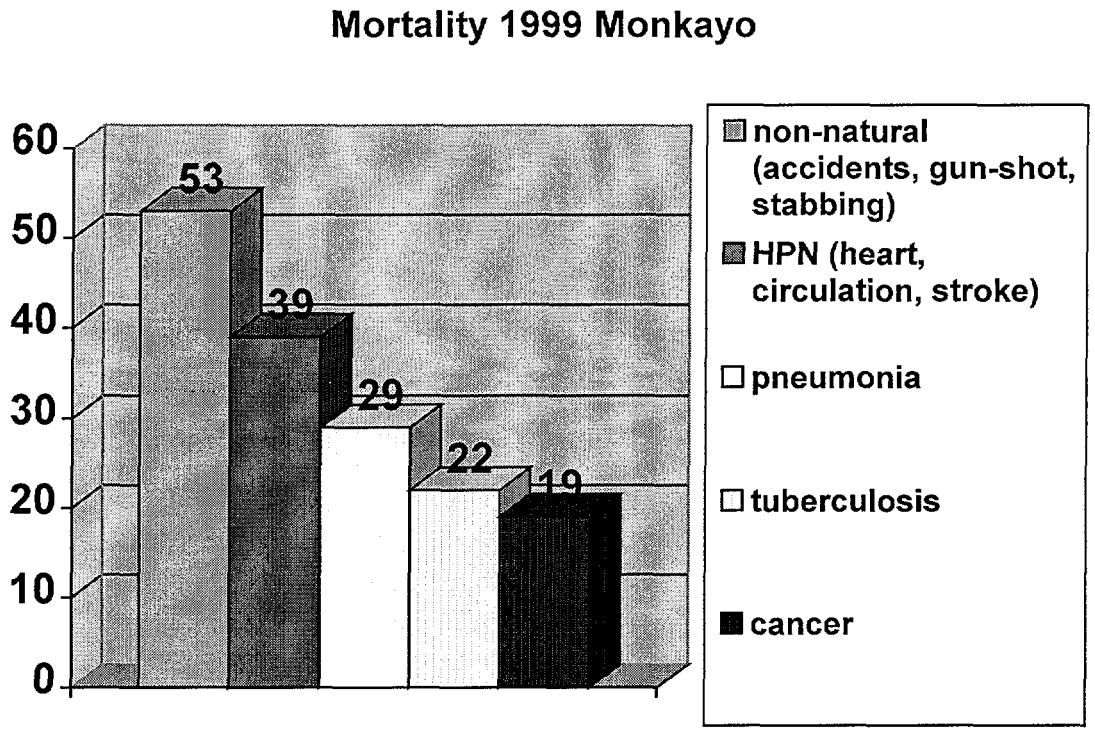



*Figure 2: Mortality in the district of Monkayo (given the total number, population size approx. 92.000). HPN is used for heart ischemia, stroke, heart failure etc. Data from Municipal Health Office.*

### 2.1.2. Criminal activities

Some participants reported about gun shot injuries, at least three of our 115 participants experienced gun shot injuries within the last 9 months! Security in Diwalwal seems not to have improved since 1999. Checking the death records 2000 of the Municipal Health Office revealed the enormous amount of non-natural causes of death in Diwalwal. Of approx. 50 casualties only few people died of "natural causes" such as tuberculosis and pneumonia. Some people died due to car accidents. A fair amount died due to landslide accidents and even more due to "accidents" in the tunnels. But mainly very young people in their twenties and thirties died due to criminal activities. Gun shot and stabbing injuries are most prominent. There are as well "peaks" when up to 10 young men died within 1-2 days within the tunnels, with suspected "poisoning". Some conflicts between tunnel corporations are handled with illegal methods such as letting poisonous gas into the rival tunnel, or even shoot-outs inside of the tunnels. It seems that not all casualties are included in the death records or brought to court.

### 2.1.3. Serious health risk for children in Diwalwal

Children in Diwalwal live within the houses where ball-milling or amalgam smelting is carried out, therefore they are also exposed to the mercury fumes. Some children start to help their parents with ball-milling at the age of seven. They are carrying sacks with rocks, ball-milling, hammering rocks to smaller pieces and many other activities. Nearly all the children in Diwalwal have access to fluid mercury, they play with their hands with mercury. Sanitary conditions are poor. The criminal activities in Diwalwal are threatening, dangerous and certainly make Diwalwal an inappropriate place to raise children.

## 2.2. Food and water

### 2.2.1. Pesticides

The farmers around Monkayo use pesticides in their rice fields and banana plantations. Many pesticides are possible neurotoxins, they can cause neurological symptoms including tremor, ataxia and polyneuropathy. But according to the interviews with the participants and the health experts in the area pesticide intoxication is unknown. In our study in 1999 we did not control for this possible confounder. To investigate this hypothesis we extended our questionnaire (see 11.5). We interviewed the participants from Monkayo regarding their living circumstances.

### 2.2.2. Mercury in Naboc river

Many participants from the Monkayo area do grow and eat their own food and own chicken, ducks and/or pigs. The fields are partly covered with gray Naboc river silt coming down from Diwalwal. Some of them still eat the local fish from Naboc River (tilapia, haluan, clamps). The special aspect of fish eating and mercury burden is mentioned later in this report (2.2.3). Some people use the water from Naboc river for drinking purposes or have only inappropriate ways of filtering the water as we saw during our inspection of the area.

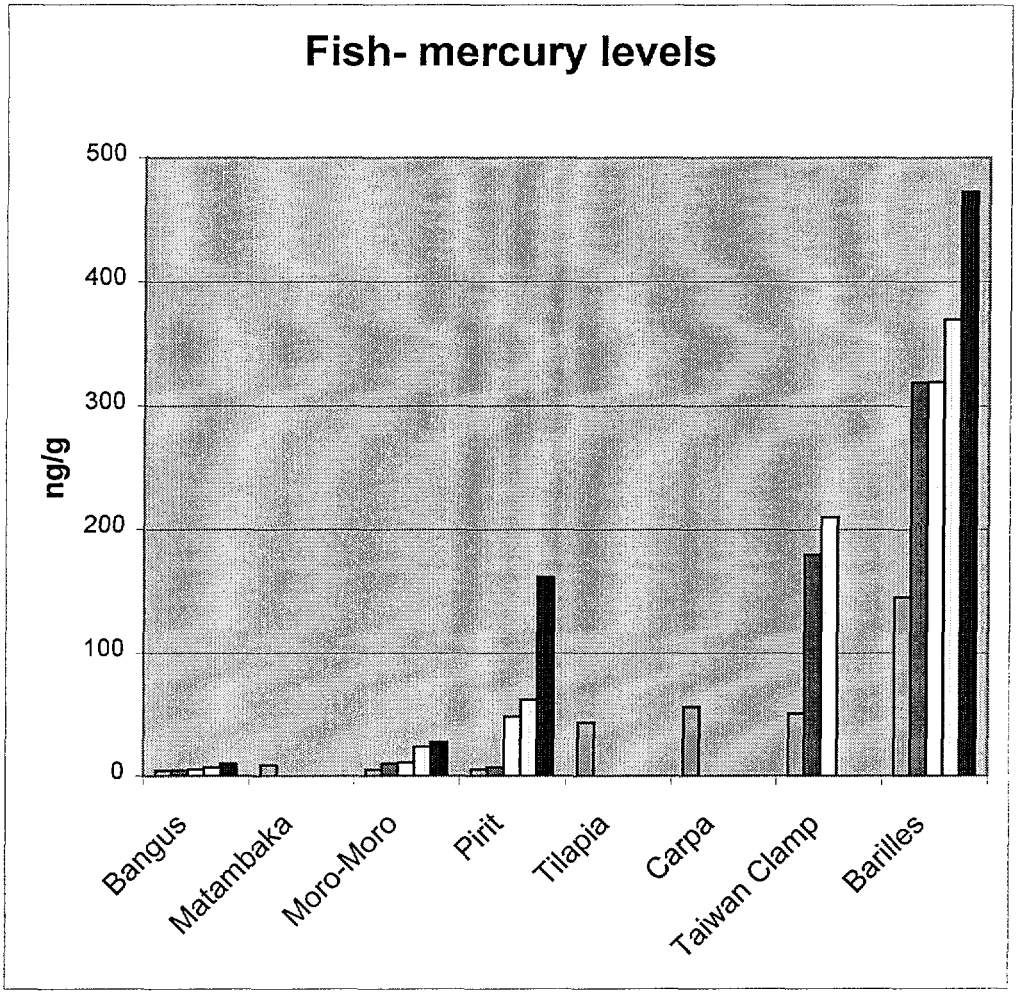
### 2.2.3. Mercury burden of fish

Fish is a mayor source of nutrition for Filipinos. The participants of the project in 1999 and 2000 all reported about an enormous consumption of fish, if not up to three times daily, then at least several times every week. In 1999 we analyzed a small, non randomised sample of fish. We bought the fish at the local markets of Davao and

Monkayo, some local fish from Naboc river was specially caught for us by participants. The results of the mercury analysis are shown in Figure 3. The mercury levels of tuna (barilles) ranged from 0,145-0,471 mg/kg, and were higher then of all the other fish. Tuna is a very much liked and eaten sea fish in the Philippines. Since tuna is a carnivorous fish the range of mercury burden is not surprising. The other fish were lower in their mercury burden. From Naboc river the fish "tilapia" and "carpa" and the Taiwan clamp mussels showed similar levels as reported by Weeks (36).

| Food type | Hg |
|---|---|
| Fish (Tilapia spp.) | |
| Agusan tributary | 0.125 |
| Naboc river | 0.2766 |
| Mussels (Taiwan clam) | |
| Naboc river | 0.3146 |
| Naboc pond off river | 0.8690 |

*Table 1 Results from Weeks (36): Mercury burden of fish in mg mercury / kg fish.*




- ✓ bangus (carnivorous fresh water fish)
- ✓ barilles is called as well tuna (carnivorous deep sea fish)
- ✓ carpa (carnivorous fresh water fish)
- ✓ matambaka (carnivorous sea fish)
- ✓ moro-moro (carnivorous sea fish)
- ✓ pirit (carnivorous sea fish)
- ✓ taiwan clamp (fresh water mussels)
- ✓ tilapia (carnivorous fresh water fish)

*Figure 3: Total mercury levels in ng/ g fish. Fish from shops in Davao and Monkayo, except for the locally caught fish from Naboc river (tilapia, carpa, Taiwan clamp). WHO limit 500 ng/g.*

Up to now there is no defined minimum dosage where adverse effects of mercury can be excluded. According to the WHO the PTWI (provisional tolerable weekly intake) level of mercury in food is 0,3 mg mercury per person and week. Not more then 0,2 mg of the PTWI should be methyl-mercury. Fish should not contribute to the whole amount of mercury per week for more then 0,1 mg mercury.

A tolerable daily intake (TDI or RfD) value was recommended by US EPA (US Environmental Protection Agency). It is 5 times lower than the WHO recommendation.

The WHO maximum permissible level of mercury in fish is 0,5 mg mercury / kg fish, in other food the maximum is 0,05 mg mercury / kg food.

In Table 2 different kinds of fish consuming habits and the thereby resulting PTWI levels are estimated. Parameters were: 1-3-5-7 times fish a week, with an estimated amount of 200 g fish per meal, and an estimated medium mercury burden of 0,150 or as high burden 0,500 mg mercury/ kg fish. PTWI levels range the from 0,03 to 0,7 mg mercury uptake per week. Since most of the total mercury in fish is methyl-mercury and the WHO suggests that not more then 0,1 mg methyl-mercury in fish should be taken up per person and week, the estimated mercury burden through fish is enormous in a country, where fish eating is of such mayor importance.

The median mercury levels of our report in 1999 are summarized in Table 3. Human bio-monitoring level I and II is given as well as HBM I and HBM II for comparison. The median mercury level in blood is well above HBM I in Monkayo but even higher in the control area in Davao. The median mercury level in urine is below HBM I in the control area of Davao, but higher and above HBM I in Monkayo. This difference might show the mainly methyl-mercury burden of the participants in Davao, a town situated at the sea with a high consume of fish like tuna whereas in Monkayo the fish consume might be less and the inorganic mercury burden higher.

| days of fish eating per week | kg fish per day with a medium burden (0,150 mg/kg) | weekly intake of mercury (in mg) due to medium burdened fish | kg fish per day with a high burden (0,500 mg/kg) | weekly intake of mercury (in mg) due to high burdened fish | weekly intake of mercury (in mg) (PTWI) |
|---|---|---|---|---|---|
| 1 | 0,2 | 0,03 | 0 | 0 | 0,03 |
| 1 | 0 | 0 | 0,2 | 0,1 | 0,1 |
| 3 | 0,2 | 0,09 | 0 | 0 | 0,09 |
| 3 | 0 | 0 | 0,2 | 0,3 | 0,3 |
| 5 | 0,2 | 0,15 | 0 | 0 | 0,15 |
| 5 | 0 | 0 | 0,2 | 0,5 | 0,5 |
| 7 | 0,2 | 0,21 | 0 | 0 | 0,21 |
| 7 | 0 | 0 | 0,2 | 0,7 | 0,7 |

*Table 2: Calculation of PTWI values*

| | Germany | Davao (control) | Down-stream | Ball-millers | Smelters | HBM I | HBM II |
|---|---|---|---|---|---|---|---|
| HG-B | 0,6 | 9,0 | 6,8 | 11,5 | 11,4 | 5 | 15 |
| HG-U | 0,5 | 1,0 | 5,6 | 17,6 | 13,1 | 7 | 25 |
| HG-H | 0,25 | 2,65 | 2,77 | 3,62 | 3,92 | | 5 |

*Table 3: Median mercury levels in blood (HG-B in µg/l), urine (HG-U in µg/l) and hair (HG-H in µg/g), reference values from a representative study in Germany versus median mercury levels in the control group in Davao, the participants 1999 in Monkayo and Mt. Diwata. The human bio-monitoring (HBM) values I and II are listed as well.*

## 2.3. Environmental mercury exposure

### 2.3.1. High exposure to mercury in Diwalwal

Mercury is still used by small scale miners, ball-milling and amalgam smelting is still done without any precautions. Most of the retorts delivered by the MGB / UNIDO project do not work any more due to improper use of the retorts. The smelters heated the retorts on the spot with a blue-torch to fasten the procedure of amalgam smelting instead of heating the whole cylinder properly.

### 2.3.2. Mercury contamination in Monkayo?

Theoretically there could be a still unknown local source for mercury contamination in Monkayo itself. But to our knowledge mercury was never used in industrial processes in Monkayo (no ball-mills, no gold-smelting, no tailings from Diwalwal, no mercury dealers). The UNIDO project No. DP/PHI/98/00511 by Appleton (6) and the UNIDO project No. DP/PHI/005-11-03 by Jason Weeks (36) examined mercury levels in drinking water, rice, fish and bananas. These projects did not show any excessive mercury burden for the population of Monkayo.

Our participants in the study 1999 came mainly from the barangays Tubo-Tubo, Naboc, Babag and Mamunga. These barangays are situated just beside the rivers coming down from Mt. Diwata, see Figure 4. These rivers like the Naboc river and Mamunga river are gray because they contain a lot of tailing material. These tailings are contaminated with mercury and a high amount of organic compounds due to insufficient hygienic conditions in Diwalwal (for details see UNIDO report of Appleton 2000 (6).

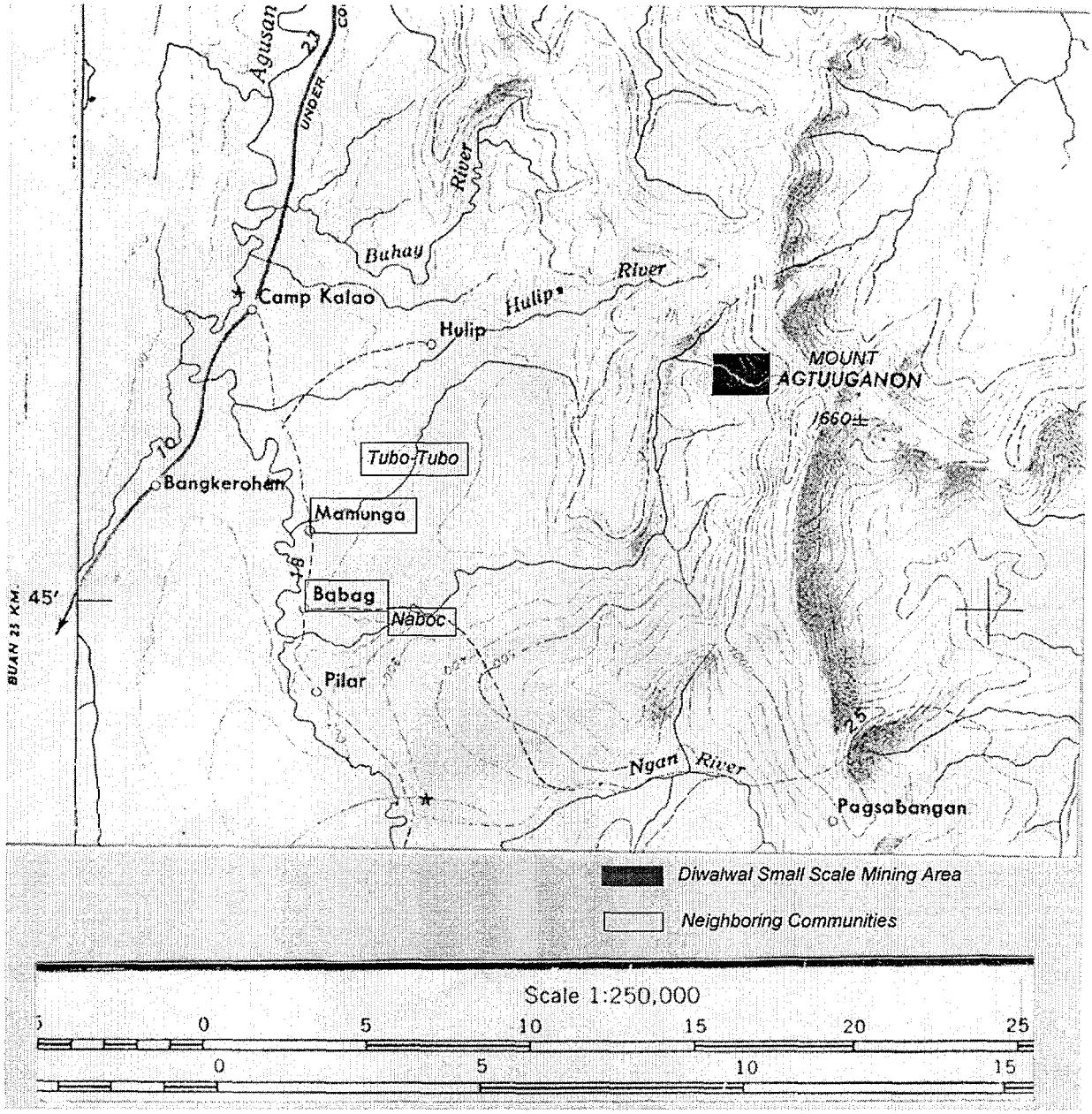



*Figure 4: Map of the area of Monkayo and Mt. Diwata*

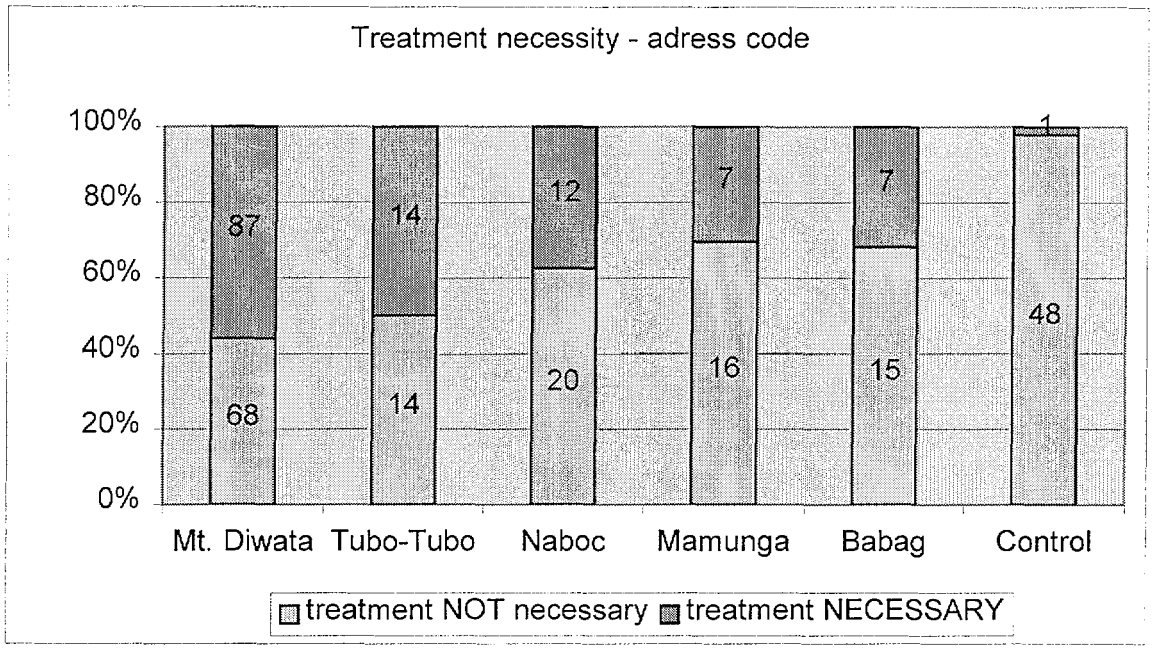



*Figure 5: Treatment necessity versus address code.*

The comparison of the four barangays (figure 5) showed, that the medical necessity of treatment was in the following order:

Diwalwal >> Tubo-Tubo > Naboc > Mamunga > Babag > control area.

Appleton's result of the mercury contamination of the soil and water in the same area shows a similar distribution. Tubo-Tubo has the highest Hg-burden of all the four barangays (Figure 6). These four mentioned barangays have higher mercury concentration in soil and water than the other areas in the plain of Monkayo.

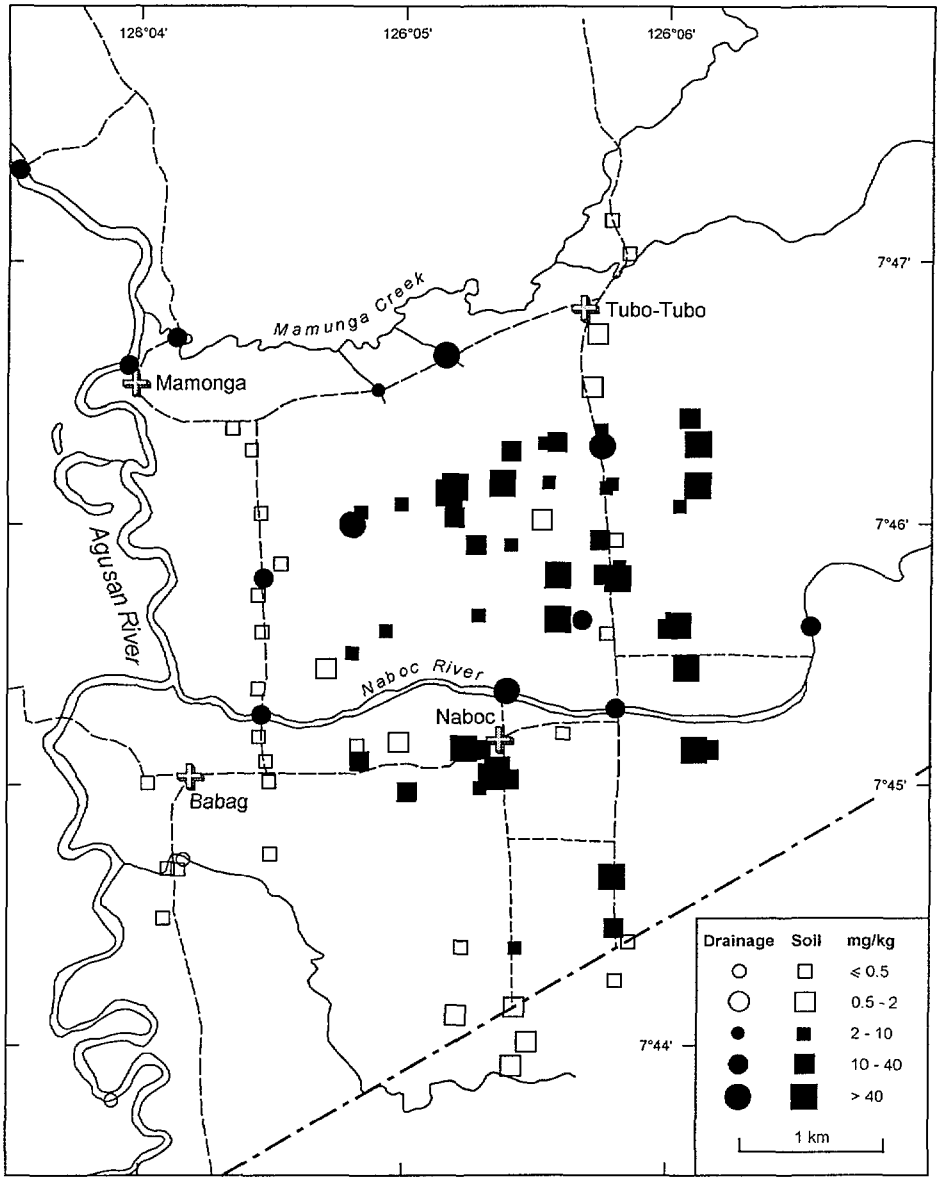



*Figure 6: Mercury in soil and water (from Appleton, figure 26; Hg in bottom sediment, canal silt and soil; Naboc River area (6)*

If only the adults from the four barangays and the necessity of medical treatment were compared, two subgroups can be formed: farmers and non-farmers. Within the group of farmers the percentage of treatment necessity is higher than in the sub-group of non-farmers, see Figure 7.

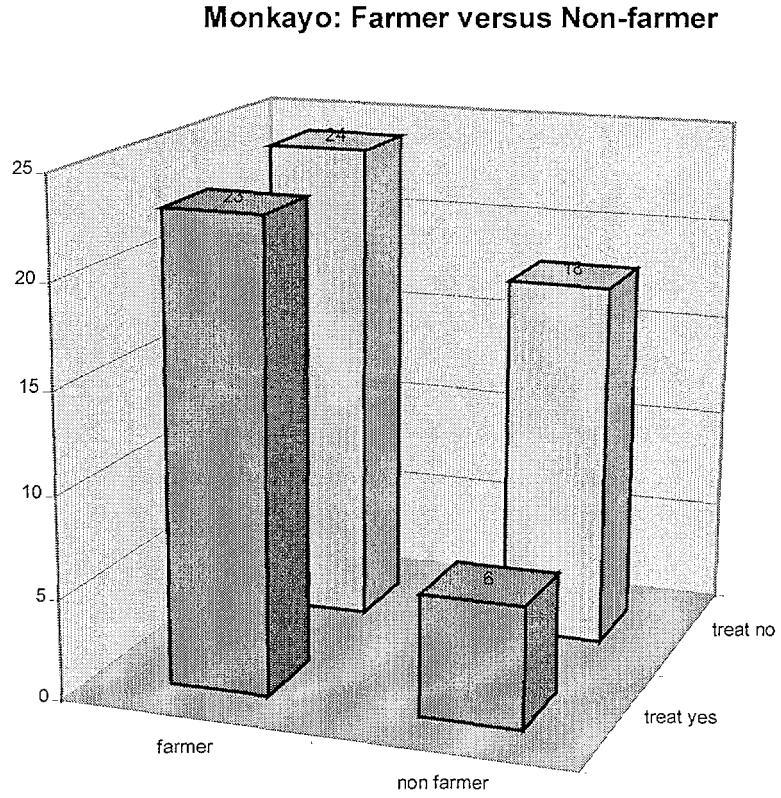
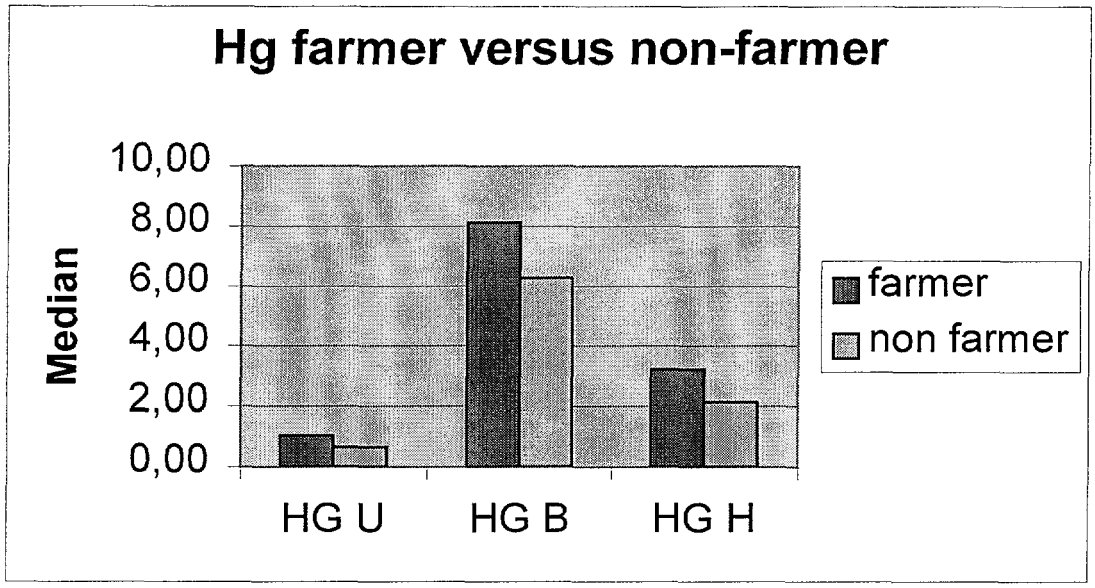



*Figure 7: necessity of treatment in downstream barangays Tubo-Tubo, Naboc, Babag, Mamunga, adults only, farmers versus non farmers*

Comparing the average and median mercury levels in blood, hair and urine of farmers and non-farmers there is a trend visible (see Figure 8). Mercury levels in urine are similar in both sub-groups, but mercury in blood and hair is higher in farmers, than in non-farmers.



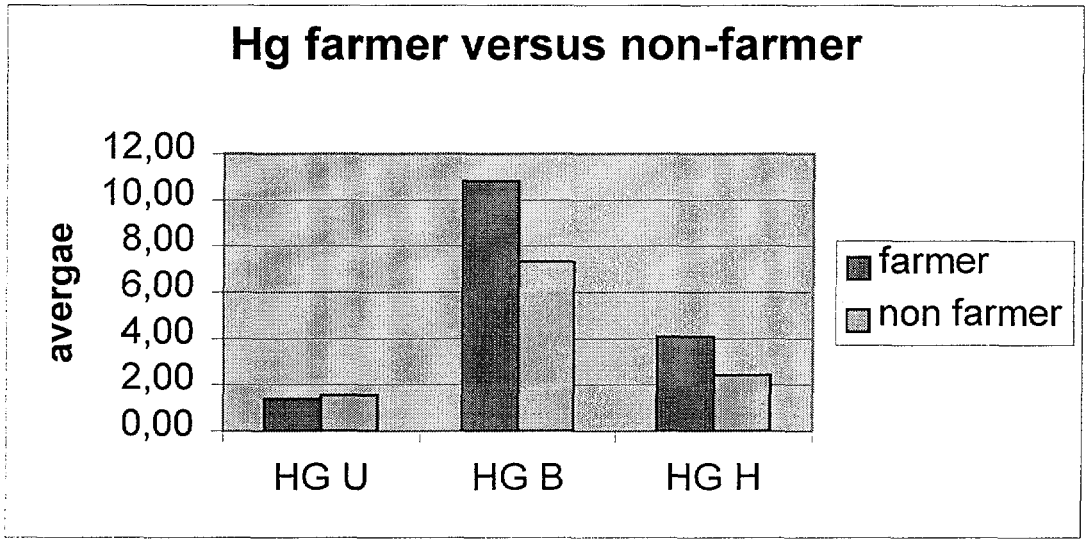




*Figure 8: Mercury levels in adults only from downstream barangays Tubo-Tubo, Naboc, Babag, Mamunga, farmers versus non farmers. HG U = mercury in urine in µg/l, HG B = mercury in blood in µg/l, HG H = mercury in hair in µg/g. Average and median.*

The comparison of the different barangays, their mercury burden and differences in the health status, as well as the comparison of farmers and non-farmers are only descriptive. The findings are not yet statistically properly evaluated. So these findings should not be over-interpreted. But for further projects it might be advisable to study the effects of possible local mercury contamination, influence of farming and confounding factors due to farming in more detail.

# 3. Project design

## 3.1. Pharmaceutical design

The medical treatment of the intoxicated participants should be performed with a newer chelating agent (detoxificant), like DMSA (Dimercaptosuccinic acid) or DMPS (Dimercaptopropanesulfonic acid). While DMSA is more common in Russia and Eastern European Countries, DMPS was notificated in Germany by the Federal Institute for Pharmaceuticals and Medicinal Products especially for the treatment of acute and chronic mercury intoxication. In humans, DMPS is an effective mobilizing agent for mercury. Compared to previously used antidotes such as BAL (Dimercaprol), DMPS has many advantages, such as less toxicity and (especially necessary for an application in field) the possibility of an oral application. More is known about the pharmacokinetetics of DMPS in human than about any other dimercapto chelating agent, including DMSA. An other possible antidote, D-Penicillamin, is much less effective.

The medical results from 1999 showed that the neurological symptoms like tremor were predominant. It had to be doubted to which extent the severe symptoms of the chronic mercury intoxication could be treated at all. It was necessary to take into consideration that, as in the case of stroke patients or severe brain damaged patients due to accidents, neuronal tissue, for example the brain, is the only tissue of the body, that can not be replaced after cell damage. Moreover it was questionable whether DMPS could transport mercury to a relevant extent out of the neuronal tissues through the lipophilic brain-blood-barrier. A better prognosis could be given for the reversibility of a mercury induced damage of the kidney by a DMPS treatment. Therefore, it seemed to be possible to lower the mercury body burden of all intoxicated persons by a treatment with DMPS, but not with all cases this might result in a full recovery of symptoms.

The treatment duration of 14 days, as proposed for this project, was only arbitrarily estimated, as there are almost no reports on comparable cases of a treatment of a chronic mixed intoxication with different mercury species in literature. A treatment with DMPS is expensive and adverse side-effects are reported especially after a longer duration of treatment by sensitization. Moreover, the longer the treatment lasts, the lower is the compliance of the patients in a constant take of the medicine.

Therefore the duration of the treatment should be only as long as necessary and as short as possible. In the present project it was impossible to control the progress of the therapy by monitoring the urinary mercury excretion during the therapy "on-line", due to a lack of analytical equipment and experienced staff in field or even on the Philippines. To get more information on the duration of DMPS application, necessary for a treatment in comparable cases in the future, ten selected participants from Mt. Diwata and Monkayo were asked to deliver urine samples during the whole treatment period of 14 days once a day, taken again 3-5 hours after the intake of the DMPS capsules in the morning. From the (decreasing) mercury concentrations in these urine samples it should be calculated, how long a treatment is necessary in comparable cases.

Judging the possible benefits, risks and (even if not very ethically) costs of a treatment with a chelating agent, at least an attempt for such a medical treatment was to be recommended.

## 3.2. Medical design

All participants of the former project found to be mercury intoxicated (128, with the exception of few small children) were examined and treated by the following regime (for details see 11.5):

### 3.2.1. Questionnaire

The participants were interviewed by nurses and a questionnaire was completed. To standardize the procedure the health questions were asked by one nurse only.

- Personal data (name, date of birth, sex, address)
- Occupation (ball-miller, smelter, miner, farmer ...)
- Burning amalgam in the open
- Melting gold in the open or with inadequate fume hoods
- Storing mercury in flasks at home
- Amount of working years with mercury
- Nutrition in detail
- Acute or former health problems (weight loss, cough, malaria, accidents, kidney disease, skin problems, loss of hair, hepatitis, tuberculosis, asthma, pneumonia, neurological disorders)
- Drinking alcohol, smoking habits

- Social and financial situation
- Metallic taste
- Salivation
- Problems with tremor / shaking at work
- Sleeping problems
- Fatigue problems (tiredness, drowsiness, energy lacking, strength, weakness, concentration, thinking)
- Well-being (nervousness, appetite, sadness/depression, palpitations, nausea, headache, numbness)
- Use of pesticides
- Use of Naboc water for drinking or farming
- Exclusion criteria for DMPS treatment (pregnancy, breast-feeding, certain actual medication)

### 3.2.2. Neurological examination

A neurological examination before treatment was carried out by Dr. Milan Vosko. Results were mainly primarily scored according to „Skalen und Scores in der Neurologie" (34):

- Tremor: tongue, eye-lids, finger to nose, heel-to shin and hand writing sample
- Rigidity (walking)
- Ataxia (walking, heel-to-shin)
- Romberg test (unsteadiness)
- Dysdiadochokinesia (alternating movements), bradykinesia
- Nystagmus (irregular eye movements)
- Reflexes: biceps reflex (BSR), TSR, styloradial reflex, knee jerk reflex (PSR) and ASR
- Chvostek sign
- Pathological reflexes, pyramidal signs,
- Sensory examination

### 3.2.3. Further clinical symptoms

- Signs of stomatitis, gingivitis, bluish discoloration of gum
- Hypo-mimia
- Kayser-Fleischer ring (golden brown corneal-ring) or bluish colorized ring in cornea / iris

- Weight and height
- Blood pressure

### 3.2.4. Neuro-psychological testing

Some neuro-psychological tests were carried out by Stefan Maydl. The following tests were carried out (40, 30, 34)

- Memory disturbances: Digit span test (Part of Wechsler Memory Scale) to test the short term memory
- Match Box Test (from MOT) to test co-ordination, intentional tremor and concentration
- Analogous "Frostig Score" to test tremor and visual-motoric capacities
- Pencil Tapping Test (from MOT) to test intentional tremor and co-ordination

According to the statistical evaluation in 1999 (anamnestic data, the neurological, clinical and neuro-psychological examinations(8)), a medical score sum was established (21). As higher this medical score is, as more typical symptoms of a chronic mercury intoxication were found (see Appendix, clinical score in 11.3). From the results in 2000 again the same medical score sum was calculated for each participant.

### 3.2.5. Specimens

Specimens were taken before treatment.

- Blood (EDTA-blood 10 ml)
- Urine (spontaneous urine sample 10 ml with 0,1 ml 96% acetic acid)
- Urine test for proteinuria was carried out with Bayer Albustix ®.
- Hair

Urine and blood specimens were kept under continuous cooling until they where analyzed. Treatment was started immediately after the examinations. The participants received the first 200 mg DMPS (Dimaval ®) in the health office. The participants were obliged to stay in the examination area and were asked to retain urine for 2-3 hours. Then a further urine sample was taken (mercury peak after the first DMPS dosage).

### 3.2.6. Treatment regime

DMPS was continued for 14 days twice daily 200 mg for adults. Children received a lower dosage according to their weight (5 mg / kg body-weight / day). DMPS was administered according to a "directly observed treatment" regime by the medical staff of the Municipal Health Office either in Monkayo or in Diwalwal. The patients had to go to the local health station and received their medication every morning and evening. If they did not turn up, the health officer went to the home of the patient and gave the medication.

## 3.3. Post-treatment examinations

After treatment every participant was examined again in Monkayo. Clinical, mainly neurological symptoms after treatment (questionnaire, neurological examination and neuro-psychological testing) and possible side effects were assessed. Urine and blood samples were taken after the last dosage.

Special assessment of:

- Possible side effects: chills, fever, skin reactions like itching or rashes, vomiting
- Compliance
- Improvement of actual health during treatment

Video and photo documentation was carried out.

# 4. Laboratory and statistical methods

## 4.1. Material and sample storage

From 161 persons a total of 270 blood samples, 505 urine samples and 150 hair samples were taken. The blood was sampled in EDTA-coated vials. The urine samples were acidified with acetic acid. To avoid degradation, all samples were stored permanently and flown back to Germany in an electric cooling box. Until the analysis the samples were stored continuously at 4 °C.

## 4.2. Sample preparation

### 4.2.1. Hair

In all cases the scalp near part from 0 – 3 cm of the hair was selected. 150 – 250 mg of these hair segments were treated with 1.0 ml nitric acid (min 65%, suprapur grade, E. Merck, Darmstadt, Germany) in polypropylene test tubes, locked with screw caps for approximately 12 hours at 50 °C in a heating block. After cooling, the clear solutions were filled up to 5.0 ml with redistilled water and vortexed. Aliquots of these solutions were analyzed. Intentionally washing steps with water, detergents or organic solvents like acetone were not performed before the solution. Washing procedures with different solvents are frequently applied before hair analyses with the aim to remove air-borne heavy metal pollution from the surface of the hair. But as shown in literature, a distinct differentiation between air-borne and interior mercury cannot be achieved which such washing procedures (27). Orientating pre-experiments with washing the hair samples from the Philippines supported this assumption. After washing some samples from the same strain totally irreproducible results were obtained. Therefore the hair samples were dissolved without any further pretreatment.

### 4.2.2. Blood and urine

Aliquots of up to 1.0 ml were measured directly without further pretreatment. This was possible, because sodium-borohydride was applied for the mercury reduction and all nascent mercury vapor was inter-collected on a gold-platinum-net (method see below).

### 4.2.3. Mercury determination and quality control

The (total) amount of mercury in the samples was determined by means of so-called cold-vapor atomic absorption spectrometry (CV-AAS), using a Perkin-Elmer 1100 B spectrometer with a MHS 20 and an amalgamation unit. The determination limit for Hg in blood or urine was 0.25 µg/l, for Hg in hair 0.01 µg/g.

All analyses were performed under strict internal and external quality control. The following standard reference materials served as matrix-matched control samples: human hair powder GBW No. 7601 (certified Hg 0.36 ± 0.05 µg/g) and Seronorm whole blood No. 203056 (certified Hg 8.5 – 11.5 µg/l).

## 4.3. Statistical methods

Statistics were calculated with the SPSS 9.0 program (SPSS-software, Munich, Germany). From each of the 161 participants 286 (!) parameters are in the data set. As expected, the mercury concentrations in the bio-monitors (blood, urine, hair) were not distributed normally but left-shifted. Therefore in addition to the arithmetic mean (only for comparison to other studies) the median (50% percentile) is given. For all statistical calculations distribution-free methods like the Mann-Whitney-U-test for comparing two independent groups or the Spearman rank test for correlation were used. "Statistically significant" means an error probability $p < 0.05$ (5%).

# 5. Non statistical results

## 5.1. Clinical medical results

The participants complained of skin problems, loss of hair, metallic taste, tremor at work, sleeping disturbances and fatigue, nervousness, memory problems, excessive salivation.

The neurological examination showed mainly intentional tremor, as well disturbances of alternating movements, pathological gait, altered reflexes. Hypo-mimia and bluish discoloration of the cornea / iris was found. Some participants showed a bluish discoloration of the gums, stomatitis and gingivitis. Dental status was bad in general.

The participants reported and showed the classical symptoms of mercury intoxication including erethismus mercurialis and tremor mercurialis.

The workers from Diwalwal are primarily healthy and strong young men (possible "healthy worker effect"). The people from Diwalwal had to come down to Monkayo for examination (2 hours journey).

Due to the lack of a highly developed social system in the Philippines, some very sick workers might have moved back to their original homes and families somewhere else in the Philippines, so that we might not yet have examined the worst cases of mercury intoxication in the area.

The children in general were fairly healthy, we did not find mayor neurological symptoms.

## 5.2. Migration as a risk factor for diagnosing mercury intoxication

A fair amount of the male adults have been working in Diwalwal within the former years of the gold-rush. A fair amount of them worked as ball-millers or amalgam smelters. It seems possible that these former ball-millers and smelters acquired their symptoms in those years when they had been living in Diwalwal and still suffer from the symptoms up to now. Therefore it is likely that a migration factor influenced the high incidence rate of mercury intoxication in the Monkayo barangays.

In our report from 1999 surprisingly not only the mercury exposed workers in Diwalwal, but also the people in the downstream area from Monkayo showed many typical symptoms of mercury intoxication (8). We discussed our report with MGB, UNIDO/UNDP and the Municipal Health Office. Summarizing these discussions there

are a few possible factors influencing our findings.

### 5.2.1. Sample size not at random

We did not have a randomized sample in 1999. The local health office choose the participants from Diwalwal as well as from Monkayo. Under the general circumstances in the area it does not seem to be possible to do a selection at random.

### 5.2.2. Migration effect

The population size was up to 100.000 people in Diwalwal at the peak of the gold rush (late 1980´s) and is now down to approx. 15.000-20.000 people. Workers from Mt. Diwata might have migrated from the mining areas down to the area of Monkayo. To investigate this hypothesis we extended our questionnaire.

38 of the patients live in the area of Monkayo (Tubo-Tubo, Babag, Naboc or Mamunga). Of these 38 patients 23 did never work in Diwalwal, but 15 of them did work formerly in Diwalwal (1-10 years) and do now live in Monkayo.

# 6. Statistical results

## 6.1. All persons, investigated in 2000

The blood concentrations before or without treatment reach from 2.9 µg/L to 110 µg/L (mean 17.34 µg/L; n = 161), the urine concentrations from 0.3 µg/L to 511 µg/L (mean 32.15 µg/L; n = 161), the hair concentrations from 0.8 µg/g to 42.2 µg/g (mean 5.61 µg/g; n = 150). These spans are extremely large. This shows that the internal Hg burden of the investigated population differs extremely.

In Table 4 a primarily classification of the total population by toxicological criteria is given by the so-called HBM-values (Human Biological Monitoring values) and by the BAT-values (biological working-place tolerance values) as proposed in Germany. The BAT limits are only applicable to healthy adult workers. The (much lower) HBMvalues are established to give a toxicological orientation for the Hg burden of the normal population. By these orientation values, the internal Hg burden is classified in the following categories:

- The "**reference values**" only describe the actual Hg-burden in Germany and do not have any toxicological relevance. In contrast to them, the HBM-values are assessed by toxicological considerations:
- The HBM I was set to be a "**check value**", this means an elevated mercury concentration in blood or urine, above which the source of the Hg-burden should be searched and, as far as possible, eliminated. But even by an exceeding of this HBM I the authors claimed that a health risk is not to be expected.

In contrast to this, the (higher) HBM II value is an "**intervention value**". This means, at blood or urine levels above HBM II, especially for a longer time, adverse health effects can not be excluded. Therefore interventions are necessary. On the one hand the source should be found and reduced urgently. On the other hand a medical check for possible symptoms should be performed.

| HBM | Blood | | | Urine | | |
|---|---|---|---|---|---|---|
| | Range (µg/L) | Number of cases | % of total cases | Range (µg/L) | Number of cases | % of total cases |
| Total | 2.8 - 110 | 161 | 100% | 0.3 - 511 | 161 | 100% |
| < HBM I | < 5 | 21 | 13.1% | < 7 | 67 | 41.6% |
| HBM I - II | 5 - 15 | 68 | 42.2% | 7 - 25 | 39 | 24.2% |
| > HBM II | > 15 | 72 | 44.7% | >25 | 55 | 34.2% |
| BAT | Blood | | | Urine | | |
| | Range (µg/L) | Number of cases | % of total cases | Range (µg/L) | Number of cases | % of total cases |
| > BAT | > 25 | 34 | 21.1% | >100 | 13 | 8.1% |

*Table 4: Mercury concentration in blood and urine samples from Mindanao*

55 out of 150 hair samples (36.7%) exceed 5 µg/g (limit analogous to HBM II) and 37 (24.7%) 7 µg/g, the threshold limit of the WHO.

For an interpretation of these frequencies it must be considered that predominantly two groups of persons were investigated:

During this project 45 participants came for the first time for the medical examination. They had not been examined in the previous project in 1999. From these persons one blood, one urine and one hair sample was taken and a medical and neurological examination was performed. As it could not be decided on field, whether these persons were mercury intoxicated, they were not treated. As after the project in 1999, all these persons will became individual information whether they were mercury intoxicated and received a treatment.

## 6.2. Patients, treated with DMPS

The main object of the project in summer 2000 on the Philippines was the treatment of all 128 persons, which were found to be mercury intoxicated by the project in summer 1999, with the chelating agent DMPS (sodium dimercaptopropane sulfonate).

The patients that were found to be intoxicated in 1999 (n=128) were informed individually about their results in 1999 in a written form and invited for the treatment, receiving an appointment. 116 patients accepted this offer and came to Monkayo to be treated. Some of the intoxicated patients of 1999 moved out of the area and were no longer detectable.

The participants were orally informed about their results in 1999. All participants gave a written consent to be examined and treated. They were informed of possible side effects and contra-indications of DMPS (Dimaval ®).

116 persons began the treatment program, 106 performed the treatment regularly for 14 days and could be medically examined before and after the treatment. From all these treated patients the following biological samples were taken and analyzed for total mercury:

- blood, urine and hair before the treatment
- urine after the first uptake of DMPS ("DMPS-urine")
- blood and urine after 14 days treatment

In the last project in summer 1999 criteria were established for the definition of a mercury intoxication (see Appendix 11.4 or final report (8)). Applying these criteria again to the 106 persons, regularly treated with DMPS, 95 out of them were again classified to be "mercury intoxicated" in summer 2000 before the treatment (see 11.3 and 11.4). It seems to be of interest, that by this classification (a balanced mix of the results of medical and neurological investigations, neuro-psychological tests and mercury concentrations in the bio-monitors) approximately 90% were classified one year later again as intoxicated, though the mercury concentrations in blood, urine or hair from most participants differ widely from 1999 to 2000 (for example see Figure 9). This proofs again that the mercury concentration in the bio-monitors is only one necessary part of the diagnosis of a mercury intoxication.

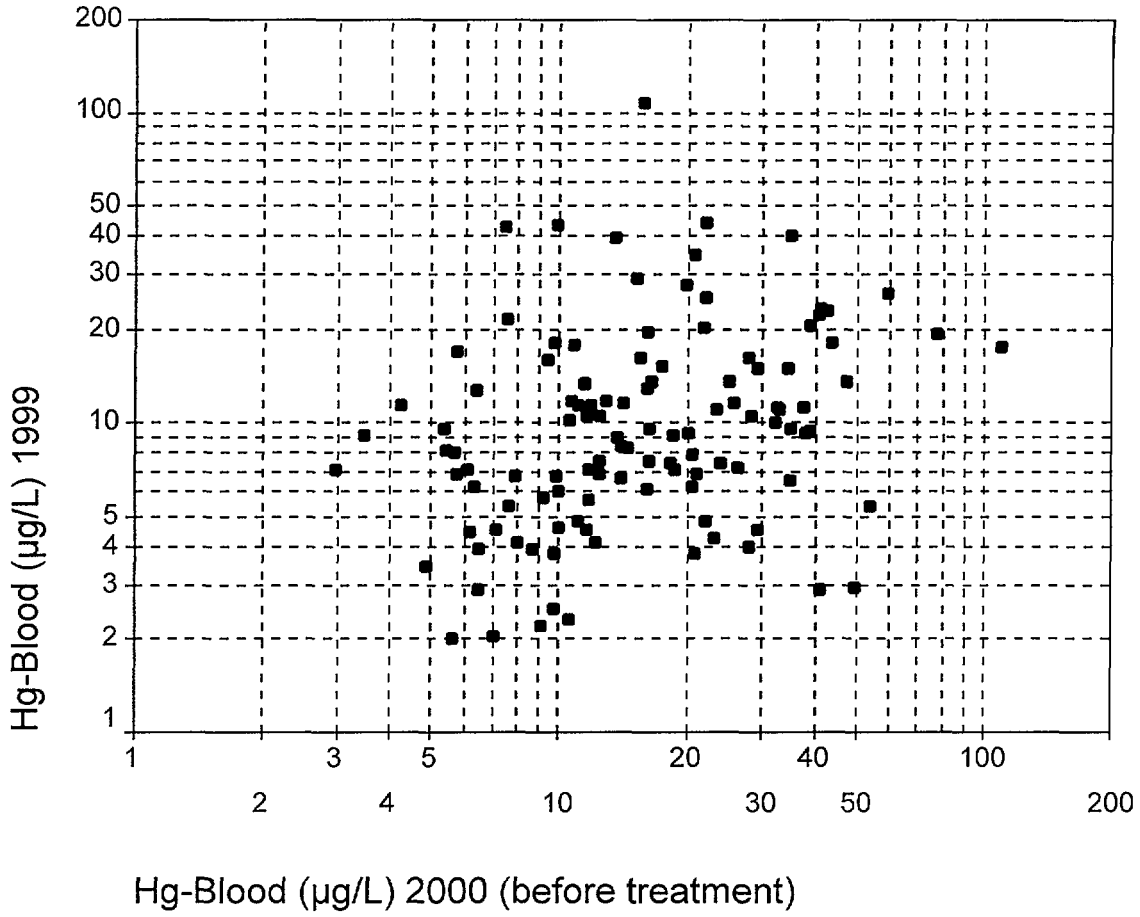



*Figure 9: comparison of the mercury concentration in blood-samples of the same persons, taken in summer 1999 and summer 2000.*

## 6.3. Effect of the Treatment with DMPS

The effect of the DMPS treatment was statistically tested with these 95 volunteers, who were classified to be mercury intoxicated in the actual project (summer 2000), too. (By this selection a slight difference appears to our draft report from Feb. 2nd, 2001, where all 106 treated persons were included in the statistics).

| | Number | Minimum | Maximum | Median | Mean | Standard-deviation |
|---|---|---|---|---|---|---|
| Hg-Hair (µg/g) | 91 | 1.00 | 42.20 | 4.2 | 6.59 | 7.01 |
| Hg-B1 (µg/L) | 95 | 4.9 | 110 | 16.0 | 21.06 | 16.21 |
| Hg-U1 (µg/L) | 95 | 0.4 | 511 | 16.7 | 41.17 | 71.86 |
| Hg-U1 (µg/g crea) | 95 | 1.3 | 388 | 16.5 | 35.41 | 58.96 |
| Hg-U2 (µg/L) | 95 | 4.3 | 17 800 | 134 | 1 056 | 2 551 |
| Hg-U2 (µg/g crea) | 95 | 2.3 | 9,244 | 162.3 | 690 | 1 450 |
| HG-B3 (µg/L) | 95 | 3.0 | 74 | 13.8 | 19.37 | 14.96 |
| HG-U3 (µg/L) | 95 | 0.6 | 1 852 | 21.9 | 108.69 | 251.61 |
| Hg-U3 (µg/g crea) | 95 | 0.9 | 681 | 25.9 | 65.25 | 97.82 |

*Table 5: Mercury concentration in bio-monitors of 95 mercury intoxicated persons before, during and after treatment for 14 day with DMPS (B1, U1 = before treatment; U2 approx. 4 h after first application of DMPS; B3, U3 = after 14 days treatment with DMPS)*

### 6.3.1. Increase of the urinary mercury excretion

The renal mercury excretion was increased by the first uptake of DMPS up to 160 fold. Concentrations as high as 17,800 µg/L (!) were found in the DMPS-urine samples. For comparison: the maximum mercury concentration in spontaneous urine before treatment was 511 µg/L. In the mean, there was an increase of the mercury concentration in urine (µg/L) after the first DMPS application by a factor of 26.7 (on the basis of Creatinin (µg/g crea) at least of 18.1).

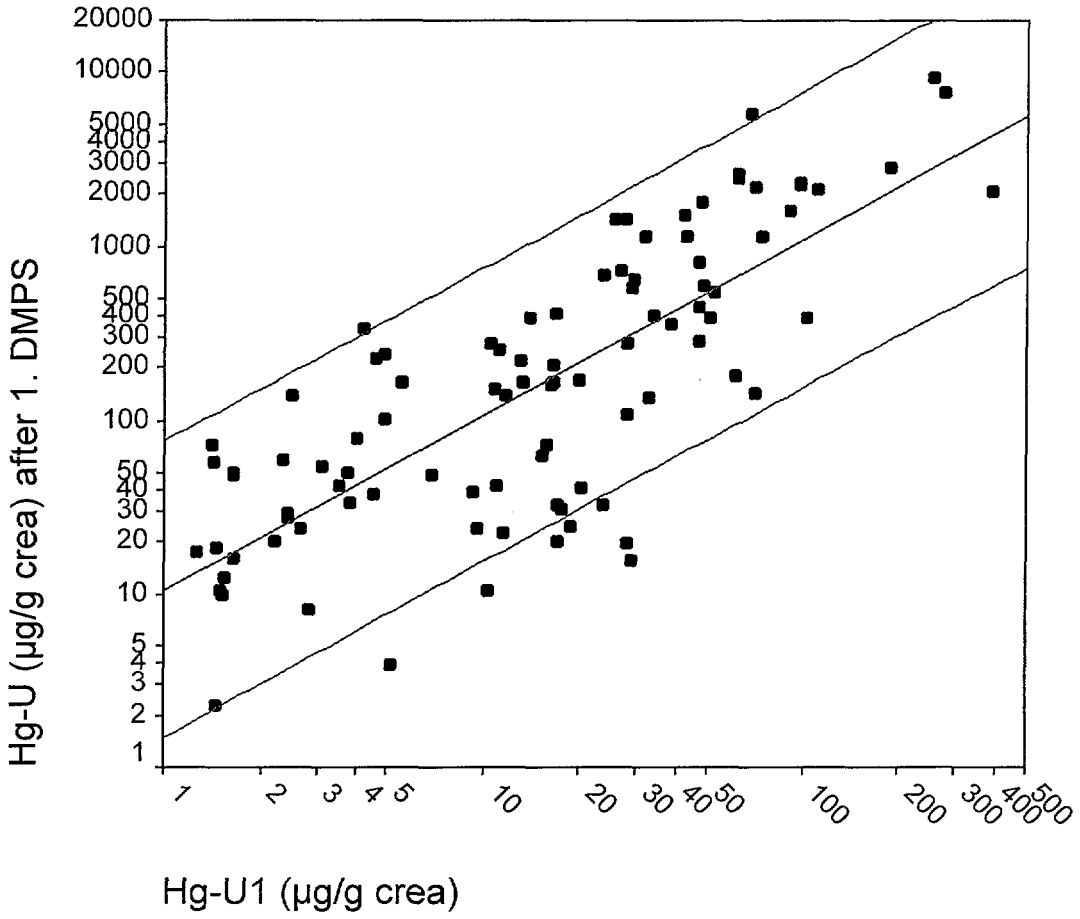



*Figure 10: Correlation of the Hg concentration in urine before and 4 hours after the first application of 200 mg DMPS orally (linear regression and 90% confidence interval for single values).*

Despite 14 days of treatment with a high dose of DMPS (2 x 200 mg per day for an adult) and the high excretion of mercury during this time, the mercury concentrations in blood had decreased only slightly (mean before treatment: 21.06 µg/L / after treatment:19.37 µg/L, max. values: 110 / 74). The mercury concentrations in urine were even higher after the 14 days' treatment (means: 41.17/ 108.69; max. values: 511/ 1852). This shows that in many patients of this project the mercury burden was so high that even a treatment for 14 days with 400 mg DMPS per day was not sufficient enough to sweep out all mercury which would be possible by DMPS.

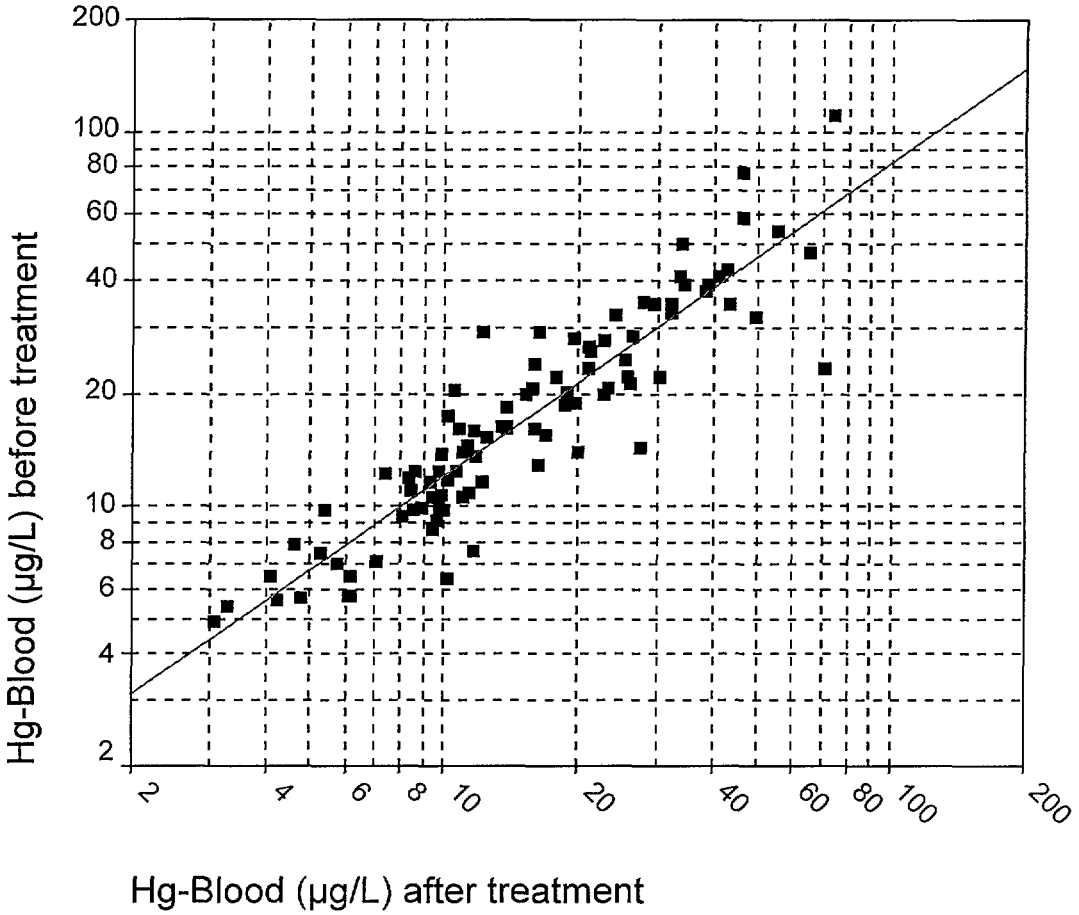



*Figure 11: Correlation of the Hg concentration in blood before and after 14 days' treatment with DMPS (linear regression).*

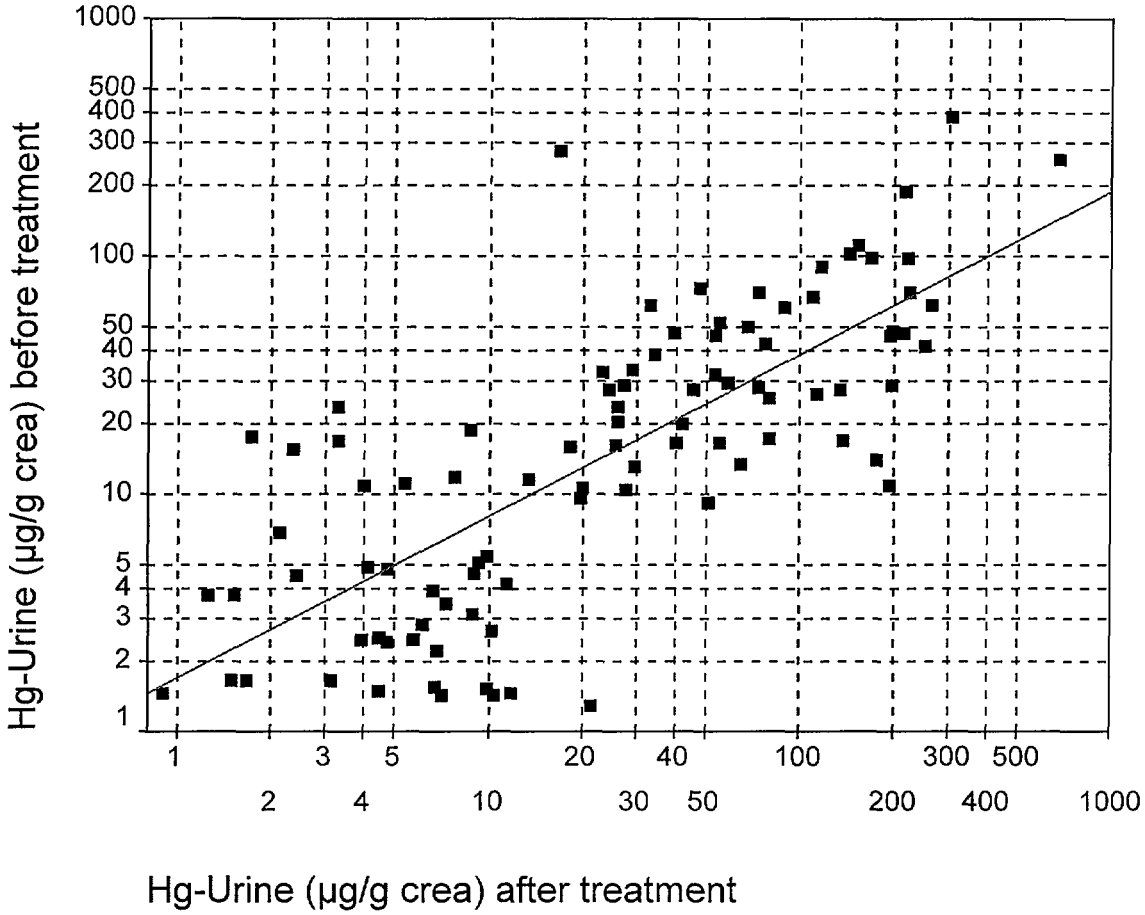



*Figure 12: Correlation of the Hg concentration in urine before and after 14 days' treatment with DMPS (linear regression).*

### 6.3.2. Half life of mercury excretion under DMPS treatment

In 10 cases under treatment it was tried to collect urine samples daily during the whole treatment. As the initial mercury concentration in urine was not known at that time, the cases were selected blindly. Unfortunately in six of the cases the mercury concentrations were much lower than the mean of all other cases under treatment. As they do not represent the mean situation at all, these results must be omitted. In one further case only a few samples were collected by the volunteer—a too low number for a sound statistical evaluation. For the remaining three cases pharmaco-kinetic elimination data were calculated, deriving from an exponential decrease of the mercury concentration. For the equation 1 the following values for –k were obtained for these three cases: - 0.25; - 0,18; -0,24. From this the elimination half life $t_{1/2}$ can be calculated to 2.77; 3.85 and 2.88 days, respectively. Figure 5 shows for example the calculation for one selected case (No. 4886): After the first treatment with DMPS

on day 1 the Hg-U was approx. $e^{8}$ = 3000 µg/L, after the last treatment on day 14 the Hg-U was below $e^{5}$ = 150 µg/L, the calculated mean half life was 2.88 days.

| $c = c_o e^{-k't}$ | $t_{1/2} = \ln 0.5 / k'$ |
|---|---|

*Equation 1: Calculation of the exponent of elimination k' and half life $t_{1/2}$*

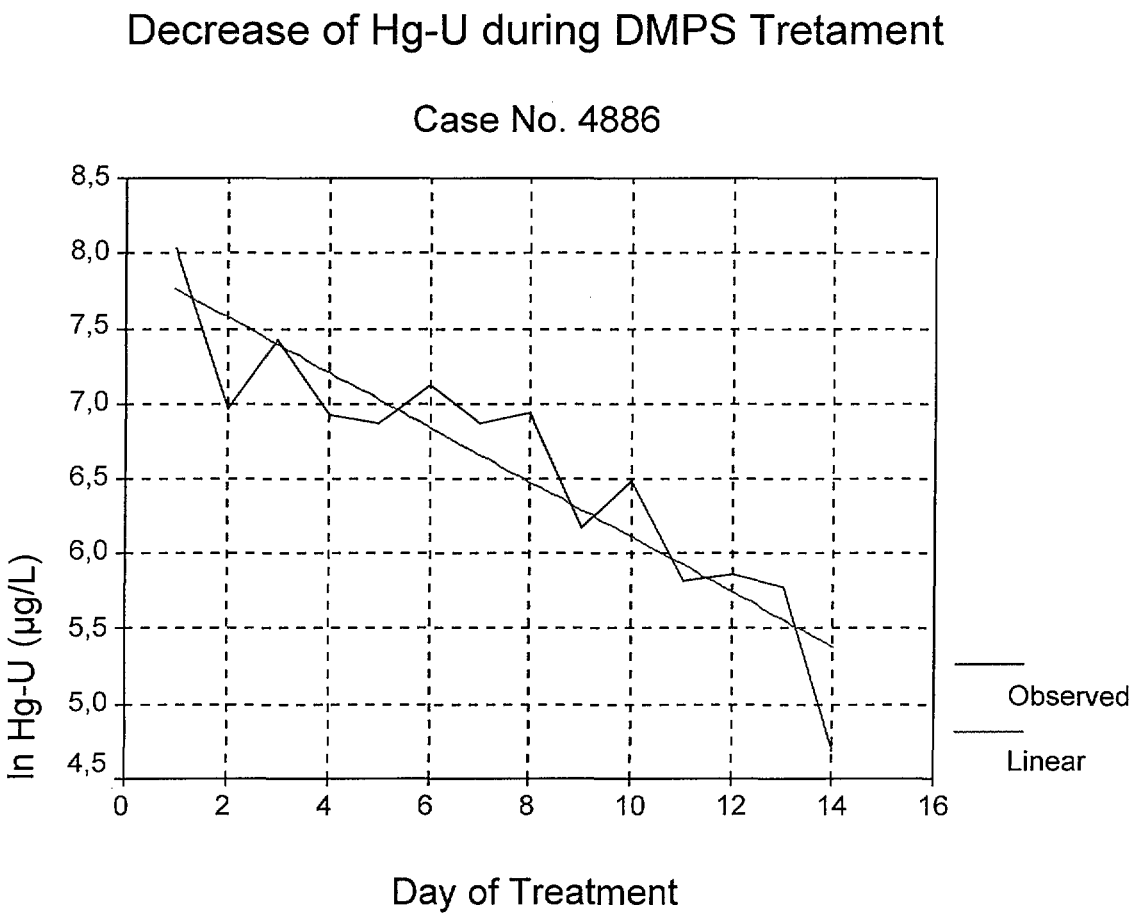



*Figure 13: Observed Hg-U's under DMPS treatment in a selected case and linear regression of the natural logarithm of Hg-U*

### 6.3.3. Effect of DMPS treatment on health status

The main question, which should be mainly answered by this project was, whether there is a positive effect of a treatment with DMPS on the health status of persons living under conditions as in the Mt. Diwata region.

For this the data of the 95 persons, which were found to be mercury intoxicated by the actual project in 2000, completely treated over 14 days with DMPS, and participated completely in the medical examinations at the beginning of the treatment and at the end. For each of these volunteers a complete data set exists.

According to the project design, the results can be grouped in

- anamnestic data
- medical and neurological investigations
- neuro- psychological tests

## 6.4. Anamnestic data results

It is striking, that most of the patients reported a marked improvement of the complaints, which were stated by them before the therapy (for details see Table 1). According to this, the physical as the mental fatigue sum scores (Figure 14 and Figure 15) indicated a throughout better feeling after the treatment. As well an improvement of subjective symptoms, statistically significant, were found (Table 7: Subjective symptoms of the patients (Wilcoxon-test and sign-test: * $p < 0.05$, *** $p < 0.001$)).

For ethical and financial reasons it was not possible to perform a double blind project with an untreated control group. Therefore, to some extent these subjective improvements may be explained by a "placebo-effect". On the other hand, in the sum, almost ¾ (!) of the volunteers reported an improvement, approx. ¼ an unchanged situation and only a negligible number (3.2%) a worsening (Figure 16). These results exceed by far the influence of an usual placebo-effect. It must be considered further that it is not possible to verify most of these complaints by objective medical tests.

| | Better than usual | Same as usual | Worse than usual | Statistical significance |
|---|---|---|---|---|
| During the treatment: | (case numbers) | | | |
| 8.2 Did you have a kind of a metallic taste? | 51 | 9 | 4 | *** |
| 8.3 Did you suffer from excessive salivation? | 45 | 11 | 3 | *** |
| 8.4 How was your appetite? | 49 | 40 | 6 | *** |
| 8.5 Did you have any problems with tremor (shaking) at work? | 40 | 14 | 0 | *** |
| 8.6.2 Estimate how tired you were and whether you had sleeping problems | 41 | 41 | 13 | *** |
| 8.7.1 Did you get tired easily? | 57 | 34 | 4 | *** |
| 8.7.2 Did you need to rest more? | 52 | 39 | 4 | *** |
| 8.7.3 Did you feel sleepy or drowsy? | 33 | 47 | 15 | *** |
| 8.7.4 Could you no longer start anything during the treatment? | 29 | 62 | 4 | *** |
| 8.7.5 Did you always lack energy? | 55 | 36 | 4 | *** |
| 8.7.6 Did you have less strength in your muscles? | 54 | 37 | 4 | *** |
| 8.7.7 Did you feel weak? | 50 | 33 | 12 | *** |
| 8.7.8 Could you start things without difficulties, but got weak as you went on? | 61 | 31 | 3 | *** |
| 8.7.10 Did you have problems concentrating during the treatment? | 40 | 52 | 3 | *** |
| 8.7.11 Did you have problems thinking clearly? | 42 | 52 | 1 | *** |
| 8.7.12 Do you make more slips of the tongue or have problems to find the correct word? | 41 | 52 | 2 | *** |
| 8.7.13 Did you have problems with eyestrain? | 33 | 59 | 3 | *** |
| 8.7.14 Do you have problems with memory? | 48 | 42 | 5 | *** |
| 8.11. Did your actual health change? | 68 | 23 | 3 | *** |

*Table 6: Self-reports of the patients (Wilcoxon-test and sign-test: *** p< 0.001)*

| | Less than usual | Same as usual | Worse than usual | Statistical significance |
|---|---|---|---|---|
| During the treatment: | (case numbers) | | | |
| 8.6.1. Have you sleeping disturbances? | 10 | 81 | 4 | - |
| 8.8.1. Did you feel nervous? | 54 | 38 | 3 | *** |
| 8.8.2 Did you feel sad? | 44 | 51 | 0 | *** |
| 8.8.3. Did you have palpitation? | 54 | 40 | 1 | *** |
| 8.8.4. Did you have headache? | 19 | 61 | 15 | - |
| 8.8.5. Did you have nausea? | 13 | 67 | 15 | - |
| 8.8.6. Were you irritable? | 13 | 76 | 6 | - |
| 8.8.7. Did you feel numbness, prickling or aching? | 29 | 50 | 16 | * |

*Table 7: Subjective symptoms of the patients (Wilcoxon-test and sign-test: * $p < 0.05$, *** $p < 0.001$)*

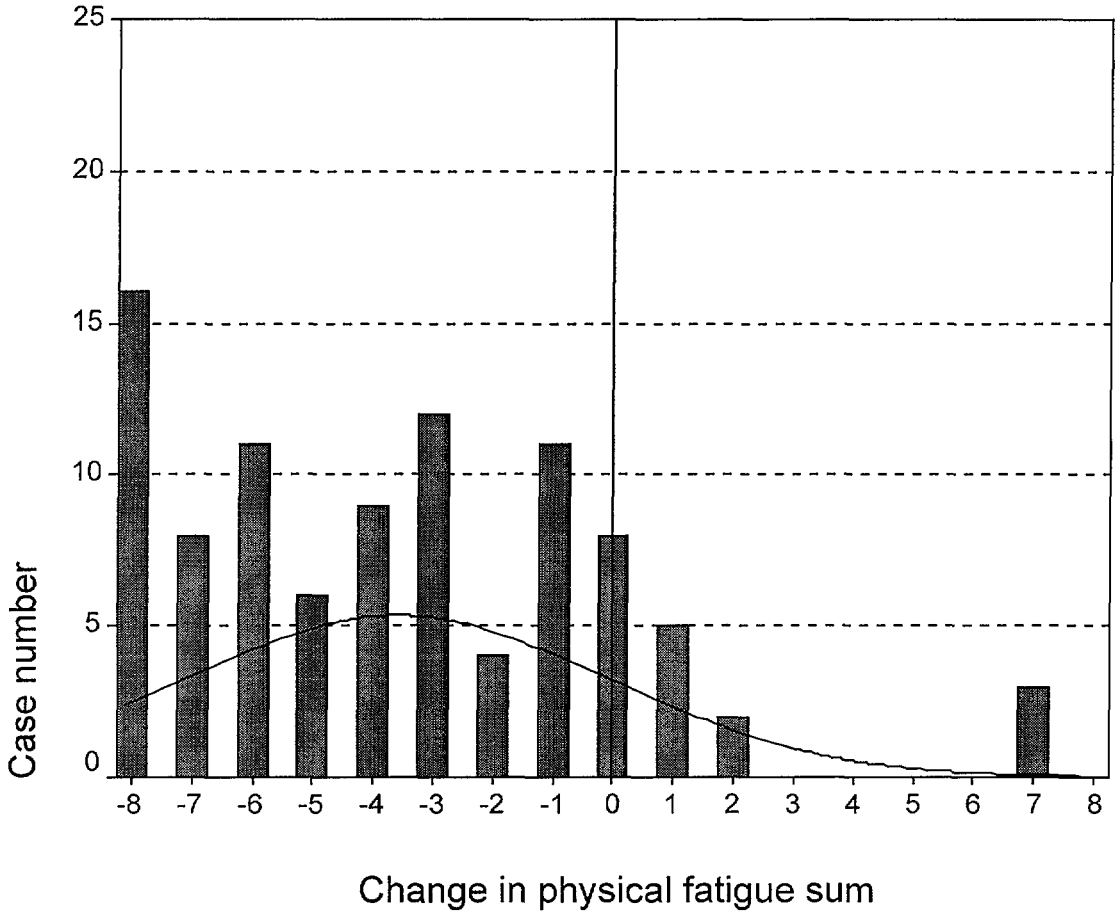



*Figure 14: Change in the physical fatigue sum score during treatment (negative values indicate a better feeling, positive values a worse one)*

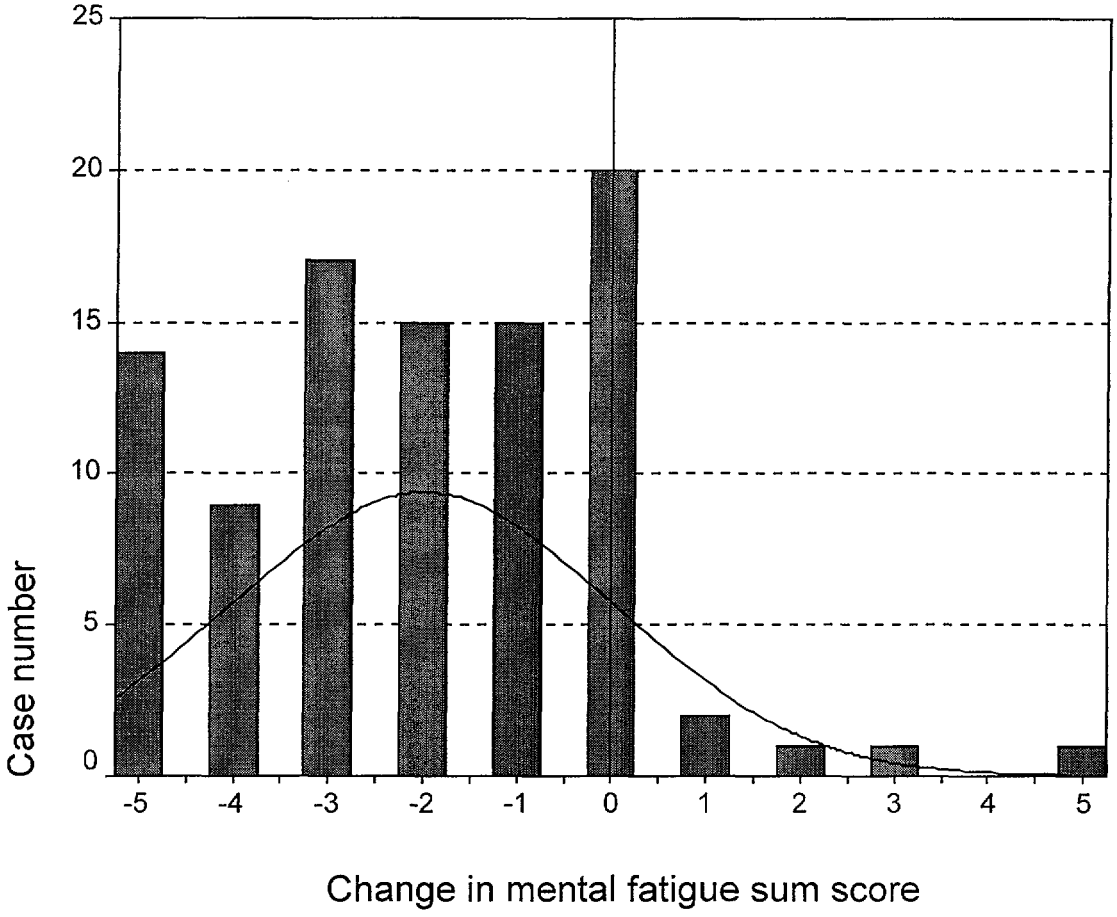



*Figure 15: Change in the mental fatigue sum score during treatment (negative values indicate a better feeling, positive values a worse one)*

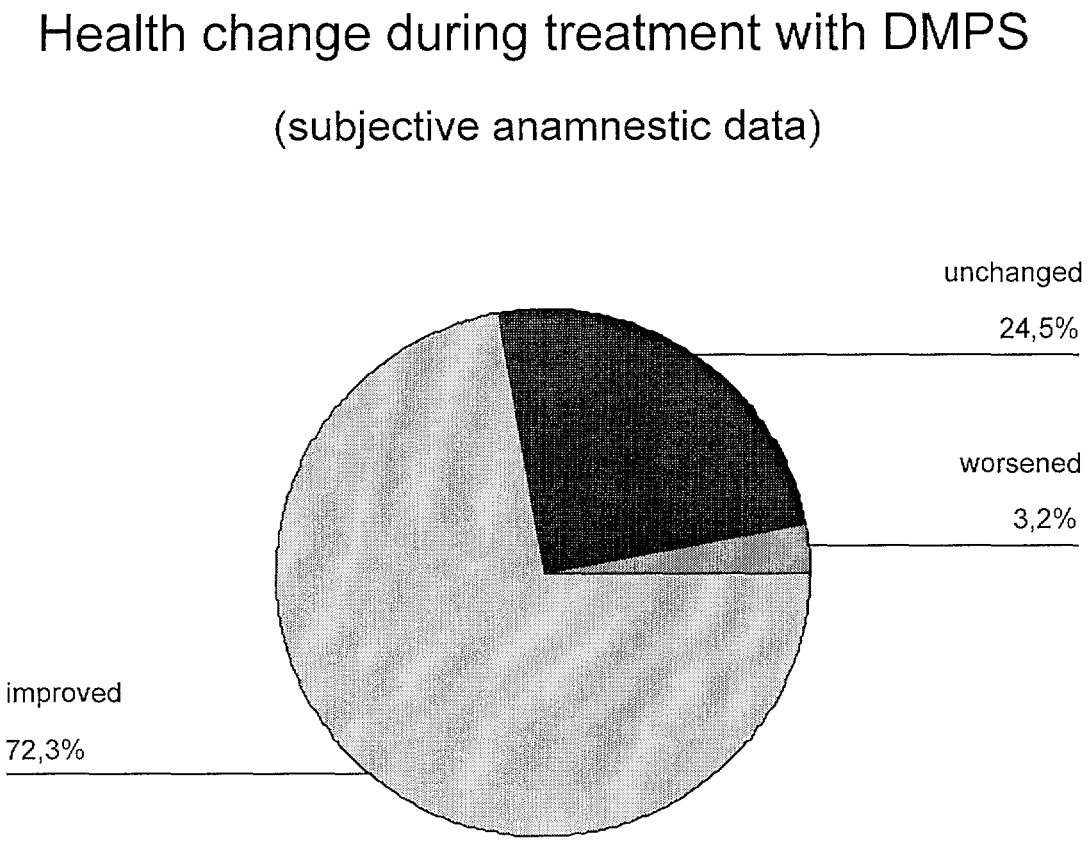



*Figure 16: Self report on health change during treatment with DMPS*

## 6.5. Adverse side effects

After the treatment, all volunteers were asked for possible adverse side effects during the treatment. All side effects of the drug which are indicated by the manufacturer to be possible were considered. The results are shown in the Table 8. There were no reports of the volunteers on further side effects. One 9 year old girl showed a rash (skin reaction) soon after the first application of DMPS. In this case the treatment was discontinued. In no other case the treatment was terminated due to adverse side effects.

Blood pressure did not change at all in the mean during treatment (before 123/75, after 124/74).

| | no | yes |
|---|---|---|
| During the treatment: | | |
| 8.10.1. Did you have chills? | 79 | 16 |
| 8.10.2. Did you have fever? | 83 | 12 |
| 8.10.3. Did you have any skin reaction? | 79 | 16 |
| 8.10.4. Did you have to vomit or die you feel sick? | 76 | 19 |
| 8.10.5. Were there any other health problems? | 69 | 26 |

*Table 8: Possible adverse side effects*

## 6.6. Neurological and medical examination results

Before and after 14 days treatment several medical – especially neurological - investigations were performed. In table 6 all cases are shown in which before and/or after the treatment a pathological result was obtained. For many of these parameters a trend to an improvement can be seen, in some cases the improvement is statistical significant. For the Chvostek sign a negative result was obtained[3]. Due to the limited case numbers for most parameters this statistical results should not be over interpreted. On the other hand it is striking that despite the limited number of cases showing the different pathological symptoms for many parameters an at least slight improvement could be found after a treatment of only 14 days. It cannot be expected that pathological neurological parameters change markedly in such a short space of time. A longer time period between the two neurological examinations, this means a neurological post-investigation some months after the treatment would be necessary to prove this trend.

[3] Chvostek is a sign of increased neuromuscular irritability. After treatment we found a higher rate of increased neuromuscular iiritability.

| | Better then before | Same as before | Worse then before | Statistical significance |
|---|---|---|---|---|
| After the treatment:: | (case numbers) | | | |
| 5/9.1.1 Rigidity of gait | 6 | 4 | 2 | - |
| 5/9.1.2. Ataxia of gait | 4 | 9 | 6 | - |
| 5/9.2.1. Romberg | 4 | 1 | 0 | * |
| 5/9.2.2. Dysmetria, finger to nose test | 9 | 30 | 10 | - |
| 5/9.2.3. Tremor, finger to nose test | 10 | 33 | 19 | - |
| 5/9.2.4. Dysdiadochokinesia | 10 | 33 | 10 | - |
| 5/9.2.5. Tremor eye lid | 16 | 19 | 13 | - |
| 5/9.2.6. Nystagmus | 1 | 0 | 0 | - |
| 5/9.2.8. Tremor tongue | 15 | 15 | 7 | * |
| 5/9.3.1. Chvostek sign | 3 | 79 | 13 | (*) |
| 5/9.3.2. Labial reflex | 4 | 1 | 1 | - |
| 5/9.3.3. Mento-labial reflex | 5 | 1 | 1 | * |
| 5/9.3.6. Intentional tremor heel to skin | 12 | 8 | 9 | - |
| 5/9.3.7. Ataxia heel to knee | 21 | 14 | 10 | * |
| 5/9.3.8. Pyramidal signs | 3 | 3 | 0 | * |
| 5/9.3.9. Sensory disturbances | 1 | 1 | 0 | - |
| 5/9.3.10. Bradykinesia | 4 | 4 | 2 | - |
| 5/9.3.11. Hypo-mimia | 14 | 51 | 7 | - |

*Table 9: Changes in medical, especially neurological parameters (Wilcoxon-test and sign-test:* $p < 0,05$, *** $p < 0,001$)*

| | | After Treatment | | |
|---|---|---|---|---|
| | | hypo-reflexia | normal | hyper-reflexia |
| Before treatment | hypo-reflexia | 38 | 6 | 0 |
| | normal | 15 | 28 | 2 |
| | hyper-reflexia | 1 | 1 | 3 |

*Table 10: Changes in the BSR (biceps brachialis reflex) during therapy*

| | | After Treatment | | |
|---|---|---|---|---|
| | | hypo-reflexia | normal | hyper-reflexia |
| Before treatment | hypo-reflexia | 30 | 3 | 0 |
| | normal | 15 | 36 | 2 |
| | hyper-reflexia | 1 | 3 | 4 |

*Table 11: Changes in the PSR (quadriceps brachialis reflex) during therapy*

The reflexes tend to go from pathological findings (hypo- or hyper-reflexia) to normal findings after treatment.

## 6.7. Neuro-psychological test results

Before and after the treatment simple neuro-psychological tests were performed. More sophisticated instrumental tests were not applicable under the complicated conditions in field.

| | Better than before | Same as before | Worse than before | Statistical significance |
|---|---|---|---|---|
| After the treatment:: | (case numbers) | | | |
| Handwriting (tremor) | 16 | 56 | 22 | - |
| Forward digit span test (score) | 32 | 39 | 24 | - |
| Backward digit span test | 24 | 56 | 15 | - |
| Match box test (from MOT) | 48 | 5 | 41 | - |
| Finger tapping | 64 | 6 | 25 | *** |
| Frostig test | 42 | 27 | 26 | * |

*Table 12: Changes in neuro-psychological test parameters (* $p < 0,05$, *** $p < 0,001$)*

Table 12 shows that the finger tapping test and the Frostig score have improved after the treatment. Figure 17 - Figure 20 are the result of a classifying these two tests. It can be seen from these figures that especially the percentage of slow/bad reactions have decreases markedly during the treatment. Similar to the discussion of the change of the neurological parameters (see above) it must considered that for an expectation of changes in neuro-psychological test parameters 14 days is an extreme short space of time. Nevertheless, the improvements in the finger tapping test and the Frostig test are striking.

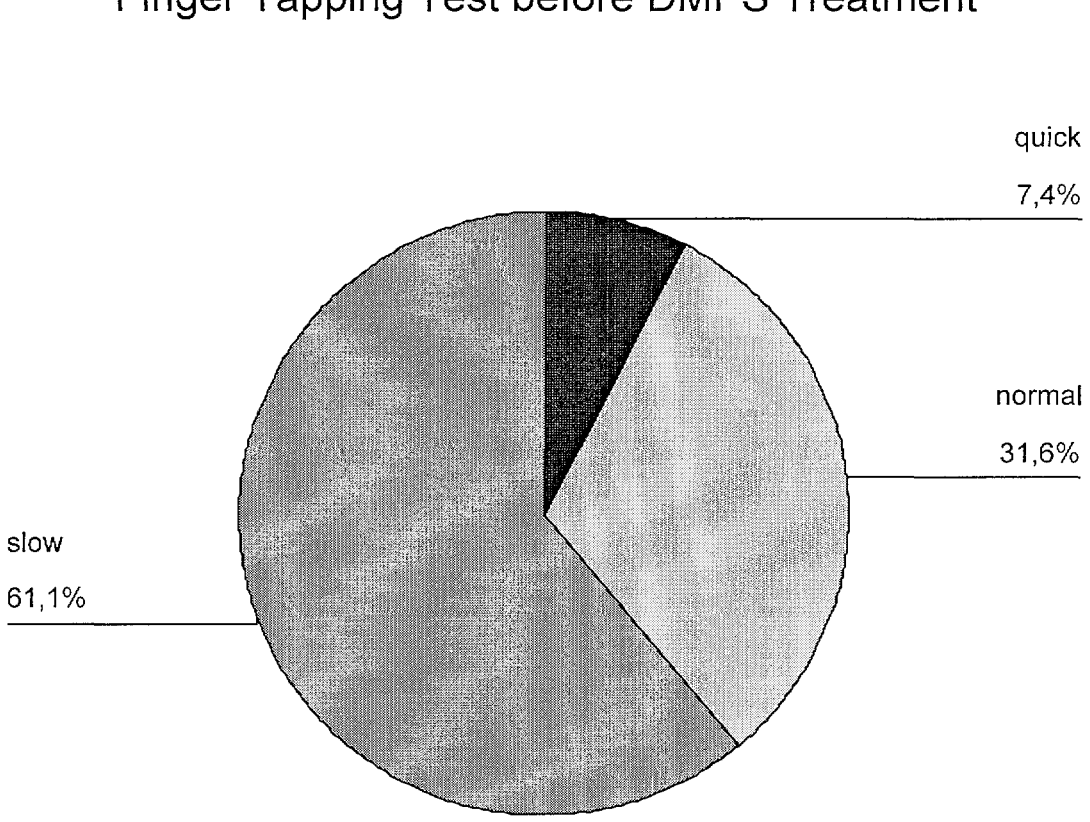



*Figure 17: Finger Tapping Test before DMPS Treatment*
*(n = 95; < 54 dots = slow, 54 – 64 dots = normal, > 64 dots = quick)*

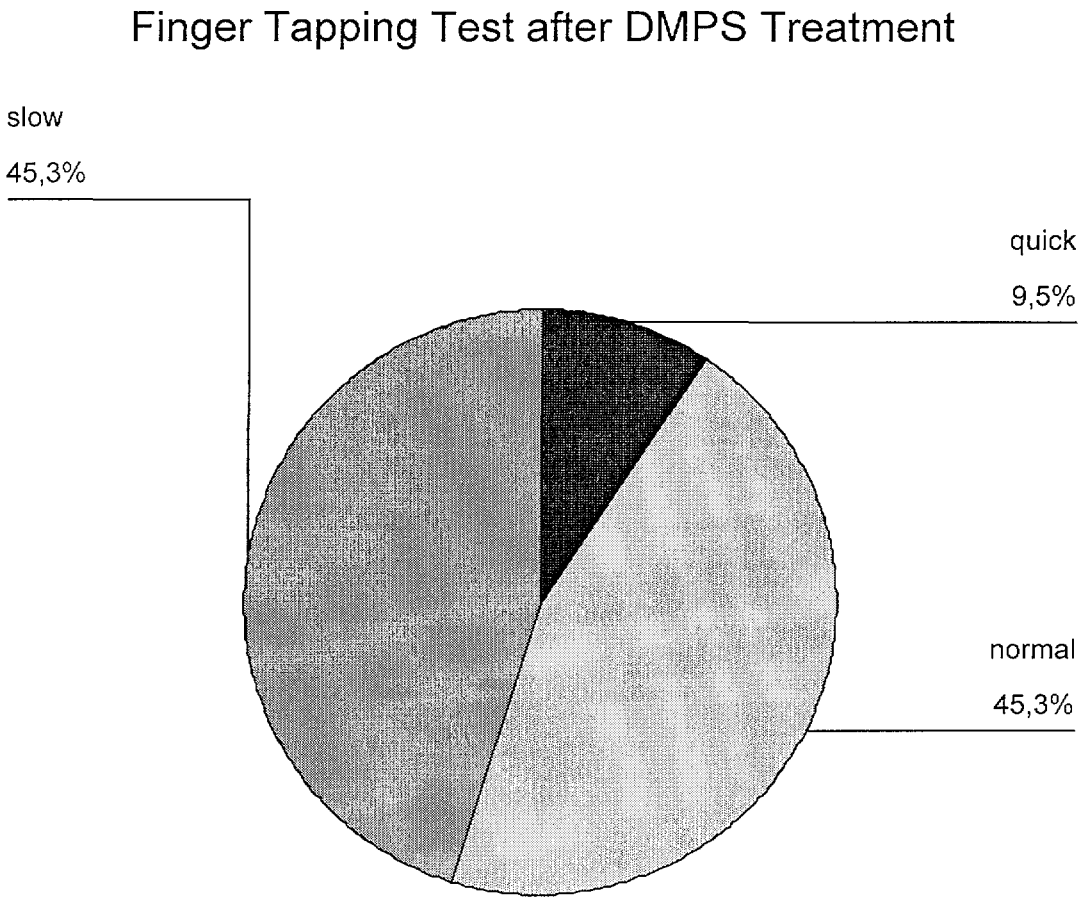



*Figure 18: Finger Tapping Test after DMPS Treatment*
*(n = 95; < 54 dots = slow, 54 – 64 dots = normal, > 64 dots = quick)*

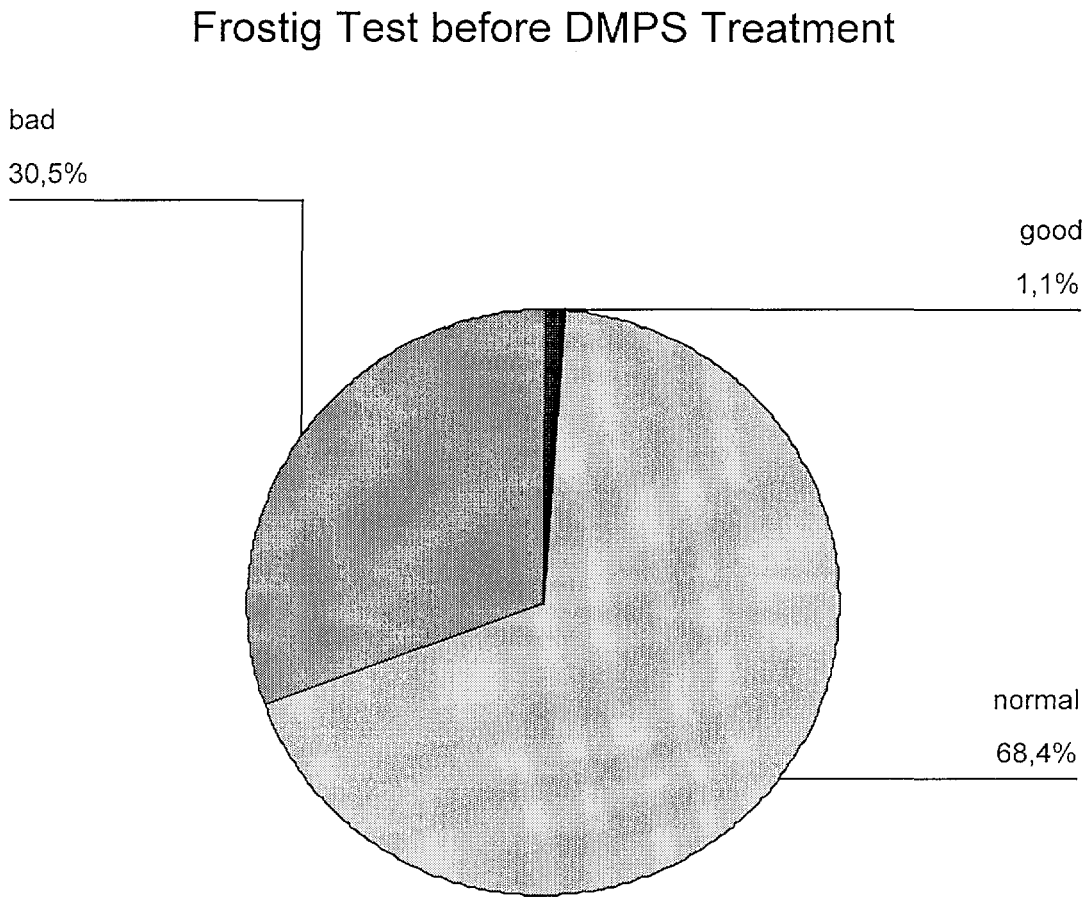



*Figure 19: Frostig Test before DMPS Treatment*
*(n = 95; score < 10 = bad, 10-12 normal, > 12 = good)*

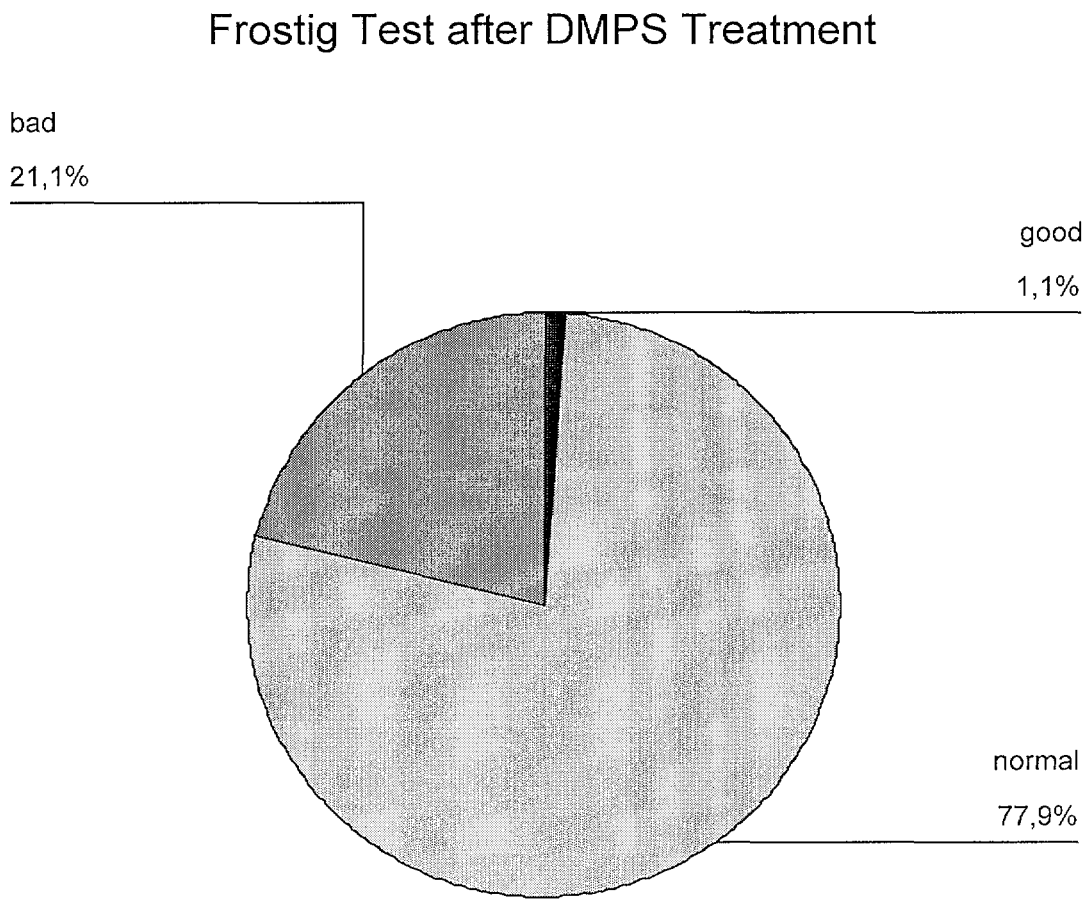



*Figure 20: Frostig Test after DMPS Treatment*
*(n = 95; score < 10 = bad, 10-12 normal, > 12 = good)*

# 7. Planned further Activities

## 7.1. Further chemical-analytical investigations

Exceeding the UNIDO contract, a speciation of the mercury (organic methyl-mercury/ inorganic mercury) in the bio-monitors (blood, urine, hair) is projected. The results will be again correlated to the neurological parameters to prove whether the concentrations of the different mercury species correlate better to the pathological signs of a mercury intoxication than the concentration of total mercury does. Moreover, by such a speciation the question can be answered, whether DMPS increases the renal excretion not only of inorganic mercury (as known), but of methyl-mercury, too.

## 7.2. Further statistical evaluation

As pointed out above, the criteria for the diagnosis of a mercury intoxication, as established from the investigation in 1999 have been proved by this project. But the collection of the complete data set is time consuming and requires a highly trained staff, the storage of the blood and urine samples need permanent cooling, and the mercury trace analysis in the bio-monitors requires a well equipped lab and an experienced staff. Therefore it is difficult to recommend this method for a routine selection of patients with a mercury intoxication, especially in countries of the third world. Statistical methods will be used to reduce the number of tests which are necessary for the diagnosis of a mercury intoxication to get a simpler screening method, which is applicable under adverse conditions in gold mining areas. The prediction value of the mercury concentration in the "DMPS-urine" (this means the urine taken 4hours after the first application of DMPS) will be proved further in this context. The results of this further statistical analysis will be presented later this year to UNIDO.

## 7.3. Training video

The medical team sampled many patients on video to be able to show the typical clinical symptoms of a chronic mercury intoxication. The result of 7.2 will be presented in an instructive video for training medical personnel (midwives and similar educated persons) in third world countries in an autonomous diagnose of a mercury intoxication, if necessary with the skillful sampling and storage of bio-monitors.

# 8. Discussion

The field conditions of the small scale gold mining area of Mt. Diwata are extremely adverse for a medical treatment. For safety reasons the medical experts from UNIDO were not allowed to the Mt. Diwata area. The inhabitants of the mining area had to be brought down by car in a two hour drive by midwives to the Health Center of Monkayo, where they could be medically examined.

- Even under these adverse conditions the acceptance of the affected people for an extensive medical examination, which lasts half a day, was very high (116 from 128 persons, addressed by local midwives, plus, in addition, 45 not addressed)
- All 116 medical examined patients accept, on a volunteer basis, the participation in the DMPS therapy. Under the precondition that the capsules were administered by highly motivated, local midwives, the compliance for an regular oral intake of two capsules twice a day for 14 days and a second medical examination after the treatment was very high (106 from 115).
- The criteria for the diagnosis of a mercury intoxication, as established from the investigation in 1999 (a balanced mix of the results of medical and neurological investigations, neuro-psychological tests and mercury concentrations in the bio-monitors) have been proved. More than 90% (104 from 116) of the persons, which had been diagnosed 1999 to be mercury intoxicated, were classified one year later as being again intoxicated, though the mercury concentrations in blood, urine or hair from most participants differ widely from 1999 to 2000.
- Under the given conditions in most of 10 selected cases it was not possible to get urine samples day by day from the volunteers. Therefore the planned pharmaco-kinetic evaluation (especially how long a treatment with DMPS is necessary) was complicated. But the time, necessary for a treatment, can be derived in an other manner: In most cases even the forced mercury excretion with a high dose of 400 mg DMPS daily for 14 days did not result in a markedly reduction the mercury concentration in blood. In the mean, the urine concentration after the treatment was even higher than before. From this it can be concluded that 14 days is a minimum time necessary for an effective treatment of persons, intoxicated with mercury to a similar extent like the volunteers, investigated in this project.

- Side effects were either negligible or, as in one of 116 cases, so obvious (allergic skin rash after the first application) that even a medical lay would terminate a further intake (an essential precondition for a recommendation for a further application under comparable field conditions).
- In all cases, the chelating agent DMPS increases the renal mercury excretion markedly, in some cases extra-ordinarily up to 160 fold.
- Almost ¾ of the treated patients reported an improvement of their health status during treatment, only 3% a worsening.
- Out of the objective tested neurological parameters at least signs for a tremor (*tongue tremor*) and *ataxia* (*heel to knee ataxia*) improve statistically significant. Tremor and ataxia are both characteristic consequences of a chronic mercury intoxication. The quick success of the DMPS therapy on these parameters was surprising. The problem with most other parameters was that, in spite of a sufficient total number of cases (95), for some of the neurological parameters the number of pathological cases were too low for a sound interpretation.
- From the applied neuro-psychological tests the finger tapping test and the Frostig test showed a statistically relevant improve during the treatment. Here, too, the quick effect within only 14 days was surprising.

In **summary** this project proves that a DMPS treatment of mercury intoxicated people, living in a gold rush area of the third world under conditions such as on Mt. Diwata, is accepted by the population (precondition are motivated local health officers) and effective.

# 9. Proposals

Prior to any other steps it is **necessary to reduce** drastically and quickly the improper **use of mercury in Diwalwal**. Without the reduction of exposure as primary preventive measurement no other measure seems to be advisable.

## 9.1. Environmental problems

The UNIDO projects of phase I which took environmental aspects into consideration (6, 36) should be discussed in a meeting with all the contributors. Perhaps the UNIDO could propose a meeting of all European teams prior to the final report of the UNIDO project to UNDP. Some synergy effects could be expected. To estimate the pathways of mercury in the ecosphere of Monkayo we would suggest:

- Detailed assessment of the mercury burden of local fish and all the fish along the Agusan river system down the bay of Butuan
- Assessment of mercury in the local chickens and pigs
- Detailed assessment of the amount of mercury already existing in the biosphere

## 9.2. Medical suggestions

Mercury is a mayor health hazard in Diwalwal and to some extent in Monkayo. It is necessary to implement a diagnostic and treatment unit for mercury intoxication in the area as soon as possible. Necessary components of such a unit are:

### 9.2.1. Diagnostic procedures

- Standardised questionnaire
- Standardised clinical tests
- Laboratory for mercury analysis in urine and blood

The results of the two projects in 1999 and 2000 would enable us to develop a shorter version of a questionnaire and examination protocol (7.2). A clinical-medical laboratory on Mindanao equipped with AAS is a necessary component, but not necessarily in Monkayo, the laboratory could as well be in Davao.

### 9.2.2. Treatment

- Available medication
- Follow-up

DMPS proved to be effective. But it is not regularly available in the Philippines. Possible legal implementations have to be sorted out. Since the optimal length of a treatment with DMPS for a chronic mercury intoxication is not known yet, it would be necessary to follow up all patients carefully and re-examine all patients in certain intervals.

### 9.2.3. Necessary facilities

- Location
- Staff
- Laboratory
- Funding
- Evaluation
- External supervision

The diagnostic and treatment unit for mercury intoxication would be best located at the local health center in Monkayo (1-2 rooms). It is essential that for a certain time (approx. 2 years) the local staff (doctors, nurses, midwifes) are supported by a team of specialists (neurologist, expert in environmental health). The laboratory could be established either at the MGB laboratory in Davao or the regional Health Center in Davao. For a period of 6-12 months a transfer of knowledge would be necessary to train local staff.

The funding of a diagnostic and treatment unit for mercury intoxication might be not to easy, since environmental and medical aspects are touched at the same time. Funding would include the examination of approx 15.000 people in Diwalwal and approx. treatment of 5.000 patients. Another group of people that migrated from Diwalwal to Monkayo should be examined as well , the extent of that group is very difficult to estimate (possible 10.000-20.000), but the rate of Hg intoxicated patients might be much less.

Scientific evaluation of such a project is essential: Quality control of all medical procedures, optimizing length of treatment, laboratory quality control. External super-

vision might be after the first 2 years a possibility to implement a sustainable development and quality control at the some time.

### 9.2.4. Necessary preparations

To be able to establish such a mercury diagnostic and treatment unit some more parts are necessary

- Development of a short version of the questionnaire and
- Translation of the questionnaire into Cebuano
- Preparation of a video as training material
- Training of medical staff into examination techniques in more detail
- Using more parameters to test for kidney function such as N-Acetyl-β-D-Glucosaminidase (NAG)
- Laboratory equipment within the area to be able to test for mercury in human specimens (urine, blood). Atomic absorption spectometry (AAS) is suggested.
- Training medical technicians to use AAS for example in the Institute of Forensic Medicine
- Service facilities for AAS have to be identified before purchasing
- Standardised recommendation for treatment
- Financial aspect of treatment
- Legal problem of importing drugs (DMPS)

### 9.2.5. Summary medical proposals

It is proposed to extend the Monkayo Health Center for the diagnosis and treatment of a mercury intoxication, which can be consulted by all inhabitants of the mercury exposed area. For training of the local staff (which is available and highly motivated) in a competent and autonomous work, an experienced medical expert should guide them for a longer period of time (1-2 years) and should be available in the future for further requests.

Further, a laboratory, which is equipped for and experienced in trace analyses of total mercury in biological materials like blood, urine or hair should be established in the region, e.g. in Mindanao, with the regional health service. For this an intensive training by an expert and a further contact to an experienced foreign laboratory for control of the analytical quality seems to be urgently necessary. A speciation of organic and inorganic mercury seems to be to high sophisticated, at least for the beginning.

## 9.3. Further steps

### 9.3.1. Prenatal and postnatal exposure

In some studies mercury showed a negative influence during prenatal development. In Minamata the contamination of fish with methyl-mercury was responsible for congenital damages such as: microcephalia, spastic cerebral palsy, mental deficiency and malformations (ear, heart, bone, eye). Grandjean (25) published, that mercury in lower concentrations has still a negative influence on the neuro-development.

Our the study design in 1999 was not appropriate to detect any possible negative effects on the prenatal or postnatal development in the area. The participants of the study in 1999 had a high mercury burden. 40 participants had mercury levels in hair above 7,00 µg/g, a level above which negative effects on the prenatal development are discussed. It is known that during prenatal and postnatal development the organism is more susceptible to mercury. We would suggest to design a further study to examine the possibility of mercury as a pre- and postnatal risk factor in Monkayo:

- Mercury related birth defects
- Increased abortion/miscarriage rates
- Infertility problems
- Learning difficulties in childhood or other neuro-psychological problems related to mercury exposure
- Mercury levels in breast-milk

### 9.3.2. Immunology

Mercury is accused to weaken the immunological system. In our project in 1999 we did not find any case of acute malaria. But in future projects the aspect of mercury influencing the immune system should be studied. Mainly the possible relation between primary mercury exposure and secondary development of pulmonary tuberculosis seems of mayor importance in the area. At least a compulsory sputum examination should be done.

### 9.3.3. Lead and Cadmium

J. Weeks (36) reports about a considerable high amount of lead (Pb) and Cadmium (Cd) in the food from the Monkayo area:

"regular consumption of the rice by the residents in the study area poses some hazard as a potential health problem from long-term metal exposure especially for Cd and Pb but to a lesser extent for Hg. The residents living near the study area regularly consume the rice grown on soils contaminated by the mine. The average metal intake from the rice by these residents was estimated to be 4.5 µg Hg /day; 87.2 µg Cd/d; 14.4 µg/Pb/d, respectively. Only for Cd do these values exceed the tolerable daily intakes recommended by FAO and WHO. Thus it is possible that long-term regular consumption of locally grown/collected vegetables and rice poses some potential health problems in view of the limited data presented from this study"

Lead and Cadmium as heavy metals can cause serious health damages. Lead is a neurotoxin. Cadmium can mainly cause kidney damages. In further medical projects it might be advisable to control for these possible confounders in human specimens and the design of a clinical study.

# 10. Conclusions

It is not acceptable that **children** live in Diwalwal. Crime and accidents related to illegal mining activities; and missing law and order in the area; as well as child work in physically and environmentally health threatening jobs are not suitable for the healthy development of a child. Missing sanitary standards and high exposure to mercury are further reasons for children not to live in the area of Mt. Diwata.

The **occupational related health risk** of mining has to be properly assessed (tuberculosis, ventilation in tunnels, accidents). An important step to reduce the health hazards in Diwalwal would be a proper mining technique and **zoning** into industrial, commercial and housing areas.

The criminal activities in Diwalwal could be called "**Wild East**". The loss of life in young men is absolutely unacceptable and political measures, law enforcement and the implementation of some basic rules of social behavior are priorities to secondary medical measures such as a detoxification with chelating agents. The acute "lead" problem has to be solved prior to the chronic mercury intoxication!

The use of mercury in the processing of gold ore has to be immediately reduced by the immediate use of **retorts**. As soon as possible the by UNIDO project of Mendoza suggested mineral processing plants have to be established. Then any use of mercury has to be discontinued. Both the use of retorts and later the **total ban of mercury** have to be carefully monitored and consequently prosecuted.

The housing area in Diwalwal is polluted with mercury since over a decade. To stop further exposure of the inhabitants housing has to be discontinued in the area and relocated to for example the valley of Monkayo. **Environmental rehabilitation programs** need to be planned and established as suggested by the UNIDO projects of Mendoza.

Finally a **medical unit to diagnose and treat mercury intoxication** should be established as mentioned in detail above.

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Finally we would like to thank all patients and participants of the medical examinations.

## 11.3. Clinical Score

With the project in 1999 an algorithm for the diagnosis of a chronic mercury intoxication was developed. To make this report easier to read in the following this algorithm can be found:

| Test | Score Points |
|---|---|
| Anamnestic data | |
| metallic taste | 0/1 |
| excessive salivation | 0/1 |
| tremor at work | 0/1 |
| sleeping problems at night | 0/1 |
| health problems worsened since Hg exposed | 0/1 |
| Clinical data | |
| bluish coloration of gingiva | 0/1 |
| ataxia of gait | 0/1 |
| finger to nose tremor | 0/1 |
| dysdiadochokinesis | 0/1 |
| heel to knee ataxia | 0/1 |
| heel to knee tremor | 0/1 |
| labial reflex | 0/1 |
| proteinuria | 0/1 |
| Neuropsychological tests | |
| memory test | 0/1/2 |
| matchbox test | 0/1/2 |
| Frostig test | 0/1/2 |
| tapping test | 0/1/2 |
| Maximum | 21 |

*Table 13: Anamnestic, clinical, neurological and neuro-psychological scoring scale (8)*

## 11.4. Decision for the diagnosis "chronic mercury intoxication"

In the previous study in 1999 for the different Hg burdened groups (< HBM I; HBM I - HBM II; HBM II - BAT; > BAT) no striking differences in the results of the medical and neuro-psychological tests could be seen. Therefore at least a chronic mercury intoxication could not be diagnosed on the basis of the blood, urine and/or hair concentration alone, to what values ever the threshold limits are set (see above). An "intoxication" is defined by the presence of the toxin in the body and typical adverse health effects.

| | | Medical Score Sum | | |
|---|---|---|---|---|
| | | 0 – 4 | 5 – 9 | 10 – 19 |
| Hg in all bio-monitors | < HBM I | – | – | – |
| Hg at least in one bio-monitor | > HBM I | – | – | + |
| | > HBM II | – | + | + |
| | > BAT | + | + | + |

*Table 14: Decision for the diagnosis "chronic mercury intoxication"*

Deriving from this interpretation we tried to find a balanced result by the combination of mercury concentration in blood, urine and hair and the negative health effects, as summarised in the medical score sum. The medical test scores were divided in three groups, according to the quartiles (0-25%, 25-75%, 75-100%). Table 14 shows this combination. In principle this means, that the higher the mercury concentration in at least one of the bio-monitors was, the lower the number of adverse effects for a positive diagnosis of a mercury intoxication must be and vice versa.

## 11.5. Questionnaire and examination protocol

# Project of DENR-MGB, UNIDO-UNDP, Institute of Forensic Medicine

# Assistance in Reducing Mercury Emissions in Highly Contaminated Gold Mining Areas in Mindanao - Phase I

# Treatment Project of Mercury Intoxication

## Dear patient!

Please read this information and direction for use carefully, since it contains important information about the use of this drug. In case of uncertainty, ask the doctors of the project for advice.

### Information and direction for use

---

# Dimaval® (DMPS)

**Active Substance: Sodium-(RS)-2,3-dimercapto-1-propane sulfonate (DMPS), monohydrate**

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### Composition

1 capsule contains:

108,56 mg sodium-(RS)-2,3-dimercapto-1-propane sulfonate (DMPS), monohydrate corresponding to 100 mg DMPS sodium

Inactive ingredients: Gelatin, corn starch, sodium dodecyl sulphate, colloidal anhydrous silica, titanium dioxide (E 171), water

### Chemical and pharmacological group

*Antidote for the treatment of heavy metal intoxication*

**Pharmaceutical Company**

**Heyl**

Chem.-pharm. Fabrik

GmbH & Co. KG

Goerzallee 253 Phone: 030 / 816 96-0

D-14167 Berlin Fax: 030 / 817 40 49

## Indications

- Clinically manifested chronic and acute poisoning with mercury (inorganic and organic compounds, vapor, metallic mercury),
- chronic poisoning with lead.

## Contraindications

***When should Dimaval (DMPS) not be administered ?***

Dimaval (DMPS) must not be used in cases of hypersensitivity to DMPS or its salts.

***What is to be observed during pregnancy and lactation ?***

DMPS did not show any teratogenic effects in animal experiments. Although adequate experience is not available in humans, pregnant women must not be automatically excluded from DMPS therapy. The risk of poisoning versus the risk of drug treatment should be carefully evaluated. In the case of treatment of pregnant women with DMPS, the mineral balance, especially of zinc, should be carefully monitored. It is known that zinc deficiency caused by chelating agents can have a teratogenic effect.

Advantages of breast feeding might outline possible disadvantages if there is heavy metal intoxication.

## Precautions for use and warnings

***Which precaution is to be considered ?***

In long-term DMPS treatment, the urinary excretion of the toxic metal, in addition to essential trace elements, should be checked regularly.

***What is to be considered on the road, in working with machines, and in working without safe hold ?***

Up to now, no effects are known on the ability to drive a car or on operating heavy machinery.

## Interactions

***What other drugs may influence the effect of Dimaval (DMPS) ?***

Dimaval (DMPS) should not be taken together with mineral preparations, since DMPS/mineral chelate formation could take place in the intestines. This could lead to a reduction in the effectiveness of DMPS. For the same reason DMPS should be taken at least 1 hour before meals.

Simultaneous ingestion of Dimaval (DMPS) and activated charcoal (medical carbon) should be avoided.

***Please note, that these statements may be valid also for drugs used a short time ago.***

## Dosage, type and duration of administration

The Institute of Forensic Medicine (Prof. Drasch) advised the following dosage for treatment:) for you. Please observe the rules of application, since otherwise Dimaval (DMPS) may not be effective properly !

- In chronic poisoning:

The dosage is 2 capsules of Dimaval (DMPS) in the morning and 2 capsules in the evening for 14 consecutive days.

***How and when should you take Dimaval (DMPS) ?***

Capsules should be taken at least 1 hour before meals with some fluids.

## Mistake in administration and overdose

***What is to be done in the case of administration of too many capsules of Dimaval (DMPS) (intentional or inadvertent overdose) ?***

Overdose of orally administered DMPS is not known at this time. DMPS can be removed by dialysis.

***What is to be observed when too little of Dimaval (DMPS) has been taken or one application has been forgotten ?***

If you have taken less than the prescribed partial dose or if you have forgotten one application of Dimaval (DMPS) completely, take not more than the prescribed dosage in the next application.

## Side Effects

***What side effects may occur during the application of Dimaval (DMPS) ?***

Occasionally, patients may develop chills, fever, or cutaneous reactions, presumably of an allergic nature such as itching or rashes (exanthema), which usually are reversible once treatment is stopped. Severe allergic dermatological reactions (e.g., erythema exsudativum multiforme, Stevens-Johnson's syndrome) have been described in a few isolated cases.

Particularly when used over a long period of time, DMPS may influence the body's mineral balance, especially that of the elements zinc and copper.

The administration of DMPS mobilizes the ingested mercury in the body. In a few cases this may trigger the clinical symptoms of mercury poisoning.

Sickness or vomiting rarely appear after ingestion of Dimaval (DMPS).

In some cases an increase in the level of transaminases (liver problems) may occur.

***If you notice adverse drug reactions, which are not described in this document, please inform the doctors of the project.***

***What procedures should be undertaken in case of side effects ?***

In cases of mineral deficiencies the adequate minerals have to be substituted. In all other cases of side effects Dimaval (DMPS) should be discontinued. In addition a symptomatic therapy may be necessary.

## Notes and information about the shelf life of the drug

This medicinal product should not be used after expiration date. The expiration date is printed on the package.

***How should Dimaval (DMPS) be stored ?***

Keep out of reach of children!

## Properties

Sodium-(RS)-2,3-***Di****m*ercapto-1-***p***ropane ***s***ulfonic acid (DMPS), the active ingredient of Dimaval (DMPS), is a chelating agent. By virtue of its two vicinal thiol-groups it can

form stable complexes (chelates) with a variety of heavy metals. These chelates are predominantly excreted through the urinary tract. In this way, DMPS enhances the excretion of heavy metals, especially of those present in the extracellular space.

The toxicity of heavy metals is diminished by chelation alone, because chelated heavy metal ions are no longer available to block the thiol-groups of essential enzymes.

## Information for the project doctor to inform patient

***Contra-indications:***

- **Dimaval (DMPS) should not be used where there is hypersensitivity to DMPS or its salts (Sodium salts).**
- **Use during pregnancy and lactation**

  DMPS did not show any teratogenic effects in animal experiments. Although adequate experience in not yet available in humans, pregnant women must not be automatically excluded from DMPS therapy. The risk of poisoning and the risk of drug treatment should be carefully considered. In the case of treatment of pregnant women with DMPS, the mineral balance, especially of zinc, should be carefully monitored. It is known that zinc deficiency caused by chelating agents can have a teratogenic effect. Breast-feeding should not be carried out if there is heavy metal intoxication.

***Adverse drug reactions***

- Occasionally shivering, fever or skin reactions, presumably of an allergic nature, such as itching or rash (exanthema, rash) which are generally reversible on withdrawal of the treatment. In isolated cases, severe allergic reactions (e.g. erythema exsudativa multiforme, Stevens-Johnson's syndrome) have been reported.
- Long-term use of Dimaval (DMPS) can influence the mineral balance, especially the elements zinc and copper.
- Administration of DMPS causes mobilization of mercury taken up in the body. In isolated cases therefore, clinical symptoms of mercury poisoning may be produced.
- Nausea may occur rarely after ingestion of Dimaval (DMPS).
- In individual cases there may be raised levels of transaminases.

***Interactions with other drugs***

- Dimaval (DMPS) should not be taken simultaneously with mineral preparations as a possible DMPS-mineral chelate formation can lead to loss of activity of DMPS already in the intestines. For the same reason DMPS should be taken at least 1 hour before meal.
- The simultaneous administration of charcoal (carbo medicinalis) and Dimaval (DMPS) should be avoided.

## 11.6. Recorded Data

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1.1 ID Number | ___ | | | | | | | |
| 1.2.1 Surname | Type name | | | | | | | |
| 1.2.2 First Name | Type surname | | | | | | | |
| 1.2.3 Date of Birth | dd.mm.yyyy | | | | | | | |
| 1.2.4 Age:. | __ in years | | | | | | | |
| 1.2.5 Sex: | 0 Female | 1 Male | | | | | | |
| Adresse | | | | | | | | |
| 1.2.6 Address Code | A Mamunga | B Babag | C Tubo-Tubo | D Naboc | E Diwalwal | F Tagum | G Davao<br>H Manila or other | I Other barangay of Monkayo |
| 1.3.1 Weight | __ kg | | | | | | | |
| 1.3.2 Height: | ___ cm | | | | | | | |
| 2 Specimens BEFORE TREATMENT | # | - | - | - | - | - | - | - |
| 2.1.1 Date of the specimen | dd.mm.yyyy | | | | | | | |
| 2.1.2 Time of the specimen | hh.mm | | | | | | | |
| Group | M = other individuals | V Monkayo Health Center Control group | Z Davao control test | X Divalval Control | U no treatment necessary according to 99 report | Y did not come for treatment | T Treatment<br><br>W excluded 99 from statistics<br><br>K Control Monkayo Health Centre | L = Diwalwal new |
| 2.2 Urine (spontaneous urine sample 10 ml) | 0 Yes | 1 No | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2.2.1 Proteinuria? | 0 Negative | 1 15-20 mg/dl | 2 30 | 3 100 | 4 300 | 5 > 2000 | | |
| 2.3 Blood (EDTA-blood 10 ml) | 0 Yes | 1 No | | | | | | |
| 2.4 Hair | 0 Yes | 1 No | | | | | | |
| 2.5.1 Are you pregnant? | 0 No | 1 Yes | | | | | | |
| 2.5.2 Do you breastfeed at the moment? | 0 No | 1 Yes | | | | | | |
| 2.5.3 Do you take any medication regularly? | 0 No | 1 Yes | if yes what kind of medication? | | | | | |
| 2.5.4 Did you ever take any chelating agent (mercury detoxificant)? | 0 No | 1 Yes | if yes: did you have any side effects (which)? | | | | | |
| 2.6 Exclusion criteria from medical treatment? | 0 No | 1 Yes, but patient either stops medication or wants to be treated after being informed about side effects and contraindi-cations | 2 Yes, and patient does not want to be treated. | | | | | |
| Remarks about exclusion criteria | | | | | | | | |
| 2.7 Written consent | 0 Yes | 1 No | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2.8 DMPS Intake | 0 Yes | 1 No | | | | | | |
| if medication different from 2-0-2 cps/d for 14 days | | | | | | | | |
| 3.2.1 How long do you live in this area? | __ year(s) | | | | | | | |
| 3.2.2 Occupation (Detailed description of the job) | a | B Smelter | C Worker at a cyanidation plant | D Miner (abantero) | E Farmer | F Office Job | G Driver<br><br>H School child (not working<br><br>I waitress/waiter | J Other job |
| Remarks *occupation* | | | | | | | | |
| 3.2.3 Do you burn amalgam in the open (for example in pans)? | 0 No | 1 Yes | | | | | | |
| 3.2.4 Do you melt gold in the open or with inadequate *fume hoods*? | 0 No | 1 Yes | | | | | | |
| 3.2.5 Do you store mercury containers or flasks? | 0 Never | 1 At work | 2 At home | | | | | |
| 3.2.6 Do you return with dirty working clothes to your home? | 0 No | 1 Yes | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3.2.7 Do you keep work clothes at home? | 0 No | 1 Yes | | | | | | |
| 3.2.8 For how many years did you work with mercury? | 0 No working with mercury | (n) Year(s) | | | | | | |
| 3.3.1 How frequently do you eat fish? | 0 Never | 1 At least once a month | 2 At least once a week | 3 At least once a day | | | | |
| 3.3.2 Name the fish you consume regularly | A Barilles (sea fish) | B Pirit (sea fish) | C Bangus (fresh water fish) | D Moro Moro (sea fish) | E Others | F Tilapia (local fresh water fish) | G Haluan, pantat, mudfish, taiwan (local fresh water fish) | |
| 3.3.3 Do you consume from local production chicken, ducks or eggs? | 0 Never | 1 At least once a month | 2 At least once a week | 3 At least once a day | | | | |
| 3.3.4 Do you consume from local production meat (beef etc.)? | 0 Never | 1 At least once a month | 2 At least once a week | 3 At least once a day | | | | |
| 3.3.5 Do you consume from local production vegetables, fruits? | 0 Never | 1 At least once a month | 2 At least once a week | 3 At least once a day | | | | |
| 3.3.6 Do you consume from local production milk or milk products? | 0 Never | 1 At least once a month | 2 At least once a week | 3 At least once a day | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3.3.7 How frequently do you eat barilles? | 0 Never | 1 At least once a month | 2 At least once a week | 3 At least once a day | | | | |
| 3.3.8 Do you have a headache after drinking beer or other alcohol? | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 3.3.9 Do you have nausea after drinking beer or other alcohol? | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 3.4.1 Did you loose weight within the last year | 0 No | 1 Yes | | | | | | |
| 3.4.2 Did you cough within the last year for more then for 3 month | 0 No | 1 Yes | | | | | | |
| 3.4.3 Did you ever have malaria? | 0 No | 1 Yes | 2 If yes, within the last year ? | | | | | |
| 3.4.4 Did you have any serious accidents (did you have to go to hospital)? | 0 No | 1 Yes, but not severe (less then 1 hour unconsciousnes s) | 2 Yes, and it was severe (more then 1 hour unconsciousnes s) | | | | | |
| 3.4.5 Did you ever have a kidney disease except urinary tract infection? | 0 No | 1 Yes | Which?. | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3.4.6 Did you ever have skin problems like allergies, loss of hair, eczema's? | 0 No | 1 Yes | Which?. | | | | | |
| 3.4.7 Did you ever have hepatitis or any other hepatic disorder? | 0 No | 1 Yes | Which?. | | | | | |
| 3.4.8 Did you ever have tuberculosis ? | 0 No | 1 Yes | when?. | | | | | |
| 3.4.9 Did you ever have any other major infectious disease? | 0 No | 1 Yes | Which?. | | | | | |
| 3.4.10 Did you ever have severe respiratory problems (asthma, pneumonia)? | 0 No | 1 Yes | Which?. | | | | | |
| 3.4.11 Did you ever have neurological disorders (epilepsy, stroke, Parkinson etc.) or mental disorders? | 0 No | 1 Yes | Which?. | | | | | |
| 3.4.12 Are you healthy now? | 0 Yes | 1 No | Why not?... | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3.4.13 Has the actual or former health problem worsened since exposure to mercury occurred? | 0 No mercury exposure | 1 Mercury exposure, but no worsening | 2 Yes, mercury exposure and worsening | | | | | |
| Remarks (Disease(s)) | | | | | | | | |
| 3.4.14 Exclusion criteria from statistical evaluation? | 0 No | 1 Yes | Why?. | | | | | |
| 3.5.1 Do you smoke? | 0 Never | 1 Rarely (0-10 cigarettes per day) | 2 Medium (10-20 cigarettes per day) | 3 Lots (more then 20 cigarettes per day) | | | | |
| 3.5.2 Do you drink alcohol? | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 3.5.3 How is your financial situation? | 0 Bad | 1 Normal | 2 Good | | | | | |
| 3.5.4 How is your social situation? | 0 Bad | 1 Normal | 2 Good | | | | | |
| 4 Health Questionnaire (day 0) before treatment? | # | | | | | | | |
| 4.1.2 Name of the interviewer - Code of the interviewer | A Ray | | | | | | | |
| 4.2 Do you have a kind of a metallic taste | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4.3 Do you suffer from excessive salivation | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 4.4 How is your appetite in the last time | 0 Better then usual | 1 Same as usual | 2 Worse then usual | | | | | |
| 4.5 Did you have any problems with tremor (shaking) at work? | 0 I have no tremor or tremor does not interfere with my job | 1 I am able to work, but I need to be more careful than the average person | 2 I am able to do everything, but with errors; poorer than usual | 3 I am unable to do a regular job, I may have changed to a different job due to tremor, | 4 I am unable to do any outside job; housework very limited | | | |
| 4.6.1 How do you feel after a usual night of sleep? | 0 Bad | 1 Normal | 2 Good | | | | | |
| 4.6.2 Estimate how tired you are and whether you have sleeping problems? | 0 Feeling active and vital, alert, wide awake | 1 Functioning at a high level, but not at peak, able to concentrate | 2 Relaxed, awake, not at full alertness, responsive | 3 A little foggy, not at peak, let down | 4 Fogginess, beginning to loose interest in remaining awake, slowed down | 5 Sleepiness, prefer to be lying down, fighting sleep 6 Almost in reverie, sleep onset soon, lost struggle to remain awake | | |
| 4.7.1 Do you get tired easily? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.2 Do you need to rest more? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.3 Do you feel sleepy or drowsy? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.4 Can you no longer start anything? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4.7.5 Do you always lack energy? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.6 Do you have less strength in your muscles? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.7 Do you feel weak? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.8 Can you start things without difficulties, but get weak as you go on? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.9 Physical fatigue sum; 4.7.1 to 4.7.8 | __ score sum (0-16) | | | | | | | |
| 4.7.10 Do you have problems concentrating? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.11 Do you have problems thinking clearly? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.12 Do you make more slips of the tongue or have problems to find the correct word? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.13 Do you have problems with eyestrain? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |
| 4.7.14 Do you have problems with memory? | 0 Same as usual | 1 Worse then usual | 2 Much worse than usual | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4.7.15 Mental fatigue sum: 4.7.10 to 4.7.14 | score sum (0-10) | | | | | | | |
| 4.8.1 Do you feel nervous? | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 4.8.2 Do you feel sad? | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 4.8.3 Do you have palpitations? | Feeling the heart beating | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | |
| 4.8.4 Do you have a headache? | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 4.8.5 Do you have nausea? | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 4.8.6 Are you irritable? | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 4.8.7 Do you feel numbness, prickling, aching at any location of your body? | 0 never | 1 at least once a month | 2 at least once a week | 3 at least once a day | | | | |
| 5 Examination (day 0) before treatment | # | | | | | | | |
| 5.1.2 Name of the neurological examiner - Code | A Milan Vosko | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5.2.2 Rigidity of gait (walking) | 0 Normal | 1 Mild diminution in swing while the patient is walking | 2 Obvious diminution in swing suggesting shoulder rigidity | 3 Stiff gait with little or no arm swinging noticeable | 4 Rigid gait with arms slightly pronated; this would also include stopped-shuffling gait with propulsion and retropulsion | | | |
| 5.2.3 Ataxia of gait (walking) | 0 Absent | 1 Slight (ataxia only visible when walking on tandem or without visual feedback) | 2 Moderate (ataxia visible in normal walking; difficulties, when walking on tandem) | 3 Marked (broad-based, staggering gait; unable to walk on tandem) | 4 Severe (unable to walk without support; wheelchair bound) | 5 Most severe (bedridden) | | |
| 5.3.1 Romberg | 0 Negative | 1 Positive | | | | | | |
| 5.3.2 Dysmetria - finger to nose test | 0 Normal | 1 Moderate pathologic | 2 Severe pathologic | | | | | |
| 5.3.3 Tremor - finger to nose test | 0 None | 1 Slight to moderate (amplitude < 0,5 cm – 1cm); may be intermittent, may be intermittent | 2 Marked amplitude (1-2 cm) | 3 Severe amplitude (> 2 cm) | | | | |
| 5.3.4 Dysdiadochokinesia | 0 Absent | 1 Slight (minimal slowness of alternating movements) | 2 Moderate (marked slowness of alternating movements) | 3 Severe (severe irregularity of alternating movements) | 4 Most severe (inability to perform alternating movements) | | | |
| 5.3.5 Tremor – eye lid | 0 None | 1 Slight | 2 Marked | | | | | |
| 5.3.6 Nystagmus | 0 No nystagmus | 1 Nystagmus present | Which?. | | | | | |
| 5.3.7 Kayser-Fleischer ring in the cornea | 0 Absent | 1 Present | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5.3.8 Tremor – tongue | 0 None | 1 Slight (amplitude < 0,5 cm); may be intermittent | 2 Moderate (amplitude 0,5-1,0 cm); may be intermittent | 3 Marked amplitude (1-2 cm) | 4 Severe amplitude (> 2 cm) | | | |
| 5.4.1 Chvostek sign | 0 Negative | 1 Positive | | | | | | |
| 5.4.2 Labial reflex | 0 Negative | 1 Positive | | | | | | |
| 5.4.3 Mentolabial reflex | 0 Negative | 1 Positive | | | | | | |
| 5.4.4 BSR (bizeps brachii reflex) | A No reflex | B Hyporeflexia | C Normal | D Hyperreflexia | E Clonus | | | |
| 5.4.5 PSR (quadrizeps reflex) | A No reflex | B Hyporeflexia | C Normal | D Hyperreflexia | E Clonus | | | |
| 5.4.6 Intentional tremor - heel-to-shin test | 0 Absent | 1 Slight (slight terminal tremor) | 2 Moderate (marked terminal tremor) | 3 Marked (kinetic tremor throughout intended movements) | 4 Severe (severe kinetic tremor heavily interfering with everyday life) | 5 Most severe (maximal form of kinetic tremor making intended movements impossible) | | |
| 5.4.7 Ataxia - heel-to-shin test | 0 Absent | 1 Slight (slight hypermetria in heel-to-shin test) | 2 Moderate (hypermetria and slight ataxic performance of heel-to-shin test) | 3 Marked (marked swaying: unable to stand with feet together) | 4 Severe (pronounced ataxia in performing heel-to-shin test) | 5 Most severe (unable to perform heel-to-shin test) | | |
| 5.4.8 Pyramidal signs | 0 Absent | 1 Present | | | | | | |
| 5.4.9 Sensory disturbances | 0 Absent | 1 Present | | | | | | |
| 5.4.10 Bradykinesia | 0 Absent | 1 Present | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5.4.11 Hypo-mimia | 0 Absent | 1 Present | | | | | | |
| 5.5 Blood pressure, systolic | _____/ | systolic | | | | | | |
| diastolic | /___ | diastolic | | | | | | |
| 6 Specific Tests (day 0) before treatment | # | | | | | | | |
| Side effects on the first day of treatment | | | | | | | | |
| 6.1.2 Name of the tester - Code | A Stefan Maydl | | | | | | | |
| 6.2.1 Clinical signs of stomatitis | 0 No | 1 Yes | | | | | | |
| 6.2.2 Clinical signs of gingivitis | 0 No | 1 Yes | | | | | | |
| 6.2.3 Bluish discoloration of the gums | 0 No | 1 Slight | 2 Yes, obvious | | | | | |
| 6.2.4 How many teeth with dental fillings (Amalgam)? | 0 None | (n) One or more à how many | | | | | | |
| 6.3 Handwriting example - tremor | 0 Normal | 1 Mildly abnormal; slightly untidy, tremulous | 2 Moderately abnormal; legible, but with considerable tremor | 3 Markedly abnormal; illegible | 4 Severely abnormal; unable to keep pencil or pen on paper without holding hand down with the other hand | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6.4.1 Forward digit span test (part of Wechsler Memory Scale) | Score | | | | | | | |
| 6.4.2 Backward digit span test (part of Wechsler Memory Scale) | Score | | | | | | | |
| 6.5 Match Box Test (from MOT) | seconds | | | | | | | |
| 6.6 Finger Tapping Test (from MOT) | points | | | | | | | |
| 6.7 Frostig Score | Score: | | | | | | | |
| 7 Specimens 2-3 Hours after the first intake of DMPS | # | | | | | | | |
| 7.1.2 Time of the specimen | hh.mm | | | | | | | |
| 7.2 Urine (spontaneous urine sample 10 ml) 2-3 hours after DMPS | 0 Yes | 1 No | | | | | | |
| 8 Health Questionnaire AFTER TREATMENT for 14 days | # | | | | | | | |
| 8.1.1 Date of interview | dd.mm.yyyy | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8.1.2 Name of the interviewer - Code of the interviewer | A Ray | | | | | | | |
| 8.2 Did you have a stronger kind of a metallic taste then usual during the treatment? | 0 Never any metallic taste | 1 Less | 2 Unchanged | 3 Stronger | | | | |
| 8.3 Did you suffer from excessive salivation during the treatment? | 0 Never any salivation | 1 Better then usual | 2 Same as usual | 3 Worse then usual | | | | |
| 8.4 How was your appetite during the treatment | 0 Better then usual | 1 Same as usual | 2 Worse then usual | | | | | |
| 8.5 Did you have any problems with tremor (shaking) at work during the treatment? | 0 Never any tremor | 1 Less | 2 Unchanged | 3 Stronger | | | | |
| 8.6.1 Sleep disturbances during the treatment | How did you feel after a usual night of sleep during the treatment? | 0 Bad | 1 Normal | 2 Good | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8.6.2 Estimate how tired you were and whether you had sleeping problems during the treatment? | 0 Feeling active and vital, alert, wide awake | 1 Functioning at a high level, but not at peak, able to concentrate | 2 Relaxed, awake, not at full alertness, responsive | 3 A little foggy, not at peak, let down | 4 Fogginess, beginning to loose interest in remaining awake, slowed down | 5 Sleepiness, prefer to be lying down, fighting sleep 6 Almost in reverie, sleep onset soon, lost struggle to remain awake | | |
| 8.7.1 Did you get tired easily during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.2 Did you need to rest more during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.3 Did you feel sleepy or drowsy during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.4 Could you no longer start anything during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.5 Did you always lack energy during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.6 Did you have less strength in your muscles during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.7 Did you feel weak during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8.7.8 Could you start things without difficulties, but got weak as you went on during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.9 Physical fatigue sum; 8.7.1to 8.7.8 | ___ score sum (0-16) | | | | | | | |
| 8.7.10 Did you have problems concentrating during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.11 Did you have problems thinking clearly during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.12 Do you make more slips of the tongue or have problems to find the correct word during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.13 Did you have problems with eyestrain during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8.7.14 Do you have problems with memory during the treatment? | 0 Better then before the treatment | 1 Same as usual | 2 Worse than before the treatment | | | | | |
| 8.7.15 Mental fatigue sum: 8.7.10 to 8.7.14 | ___ score sum (0-10) | | | | | | | |
| 8.8.1 Did you feel nervous during the treatment? | 0 Less | 1 Unchanged | 2 More | | | | | |
| 8.8.2 Did you feel sad during the treatment? | 0 Less | 1 Unchanged | 2 More | | | | | |
| 8.8.3 Did you have palpitations during the treatment? Feeling the heart beating | 0 Less | 1 Unchanged | 2 More | | | | | |
| 8.8.4 Did you have a headache during the treatment? | 0 Less | 1 Unchanged | 2 More | | | | | |
| 8.8.5 Did you have nausea during the treatment? | 0 Less | 1 Unchanged | 2 More | | | | | |
| 8.8.6 Were you irritable during the treatment? | 0 Less | 1 Unchanged | 2 More | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8.8.7 Did you feel numbness, prickling, aching at any location of your body during the treatment? | 0 Less | 1 Unchanged | 2 More | | | | | |
| 8.9.1 How many days have you followed the treatment regulations? | ___ days | | | | | | | |
| 8.9.2 How many tablets did you really take during the treatment period? | ___ tablets | | | | | | | |
| 8.10.1 Did you have chills during the treatment? | 0 No | 1 Yes | If yes: | | | | | |
| 8.10.2 Did you have fever during the treatment? | 0 No | 1 Yes | If yes: | | | | | |
| 8.10.3 Did you have any skin reaction during the treatment, like itching or rashes? | 0 No | 1 Yes | If yes: | | | | | |
| 8.10.4 Did you have to vomit or did you feel sick during the treatment? | 0 No | 1 Yes | If yes: | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8.10.5 Where there any other health problems during the treatment? | 0 No | 1 Yes | If yes: | | | | | |
| Remarks Side effects | | | | | | | | |
| 8.11 Did your actual health change during the treatment ? | A Improve | B Unchanged | C Worsen | | | | | |
| 9 Examination AFTER TREATMENT for 14 days | # | | | | | | | |
| 9.1.1 Rigidity of gait (walking) | 0 Normal | 1 Mild diminution in swing while the patient is walking | 2 Obvious diminution in swing suggesting shoulder rigidity | 3 Stiff gait with little or no arm swinging noticeable | 4 Rigid gait with arms slightly pronated; this would also include stopped-shuffling gait with propulsion and retropulsion | | | |
| 9.1.2 Ataxia of gait (walking) | 0 Absent | 1 Slight (ataxia only visible when walking on tandem or without visual feedback) | 2 Moderate (ataxia visible in normal walking; difficulties, when walking on tandem) | 3 Marked (broad-based, staggering gait; unable to walk on tandem) | 4 Severe (unable to walk without support; wheelchair bound) | 5 Most severe (bedridden) | | |
| 9.2.1 Romberg | 0 Negative | 1 Positive | | | | | | |
| 9.2.2 Dysmetria - finger to nose test | 0 Normal | 1 Moderate pathologic | 2 Severe pathologic | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9.2.3 Tremor - finger to nose test | 0 None | 1 Slight to moderate (amplitude < 0,5 cm – 1cm); may be intermittent, may be intermittent | 2 Marked amplitude (1-2 cm) | 3 Severe amplitude (> 2 cm) | | | | |
| 9.2.4 Dysdiadochokinesia | 0 Absent | 1 Slight (minimal slowness of alternating movements) | 2 Moderate (marked slowness of alternating movements) | 3 Severe (severe irregularity of alternating movements) | 4 Most severe (inability to perform alternating movements) | | | |
| 9.2.5 Tremor – eye lid | 0 None | 1 Slight | 2 Marked | | | | | |
| 9.2.6 Nystagmus | 0 No nystagmus | 1 Nystagmus present | Which?. | | | | | |
| 9.2.7 Kayser-Fleischer ring in the cornea | 0 Absent | 1 Present | | | | | | |
| 9.2.8 Tremor – tongue | 0 None | 1 Slight (amplitude < 0,5 cm); may be intermittent | 2 Moderate (amplitude 0,5-1,0 cm); may be intermittent | 3 Marked amplitude (1-2 cm) | 4 Severe amplitude (> 2 cm) | | | |
| 9.3.1 Chvostek sign | 0 Negative | 1 Positive | | | | | | |
| 9.3.2 Labial reflex | 0 Negative | 1 Positive | | | | | | |
| 9.3.3 Mentolabial reflex | 0 Negative | 1 Positive | | | | | | |
| 9.3.4 BSR (bizeps brachii reflex) | A No reflex | B Hyporeflexia | C Normal | D Hyperreflexia | E Clonus | | | |
| 9.3.5 PSR (quadrizeps reflex) | A No reflex | B Hyporeflexia | C Normal | D Hyperreflexia | E Clonus | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9.3.6 Intentional tremor - heel-to-shin test | 0 Absent | 1 Slight (slight terminal tremor) | 2 Moderate (marked terminal tremor) | 3 Marked (kinetic tremor throughout intended movements) | 4 Severe (severe kinetic tremor heavily interfering with everyday life) | 5 Most severe (maximal form of kinetic tremor making intended movements impossible) | | |
| 9.3.7 Ataxia - heel-to-shin test | 0 Absent | 1 Slight (slight hypermetria in heel-to-shin test) | 2 Moderate (hypermetria and slight ataxic performance of heel-to-shin test) | 3 Marked (marked swaying: unable to stand with feet together) | 4 Severe (pronounced ataxia in performing heel-to-shin test) | 5 Most severe (unable to perform heel-to-shin test) | | |
| 9.3.8 Pyramidal signs | 0 Absent | 1 Present | | | | | | |
| 9.3.9 Sensory disturbances | 0 Absent | 1 Present | | | | | | |
| 9.3.10 Bradykinesia | 0 Absent | 1 Present | | | | | | |
| 9.3.11 Hypo-mimia | 0 Absent | 1 Present | | | | | | |
| 9.4 Blood pressure systolic | _____/ | | | | | | | |
| diastolic | _____ mmHg | | | | | | | |
| 10 Specific Tests AFTER TREATMENT for 14 days | # | | | | | | | |
| 10.1.2 Name of the tester - Code | A Stefan Maydl | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10.3 Handwriting example | 0 Normal | 1 Mildly abnormal; slightly untidy, tremulous | 2 Moderately abnormal; legible, but with considerable tremor | 3 Markedly abnormal; illegible | 4 Severely abnormal; unable to keep pencil or pen on paper without holding hand down with the other hand | | | |
| 10.4.1 Forward digit span test (part of Wechsler Memory Scale) | ___ Score | | | | | | | |
| 10.4.2 Backward digit span test (part of Wechsler Memory Scale) | ___ Score | | | | | | | |
| 10.5 Match Box Test (from MOT) | ___ seconds | | | | | | | |
| 10.6 Finger Tapping Test (from MOT) | ___ points | | | | | | | |
| 10.7 Frostig Score | ___ Score: | | | | | | | |
| 11 Specimens AFTER TREATMENT for 14 days | # | - | - | - | - | - | | |
| 11.2 Urine (spontaneous urine sample 10 ml) | 0 Yes | 1 No | | | | | | |
| 11.2.1 Proteinuria? | 0 Negative | 1 15-20 mg/dl | 2 30 | 3 100 | 4 300 | 5 > 2000 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11.3 Blood (EDTA-blood 10 ml) | 0 Yes | 1 No | | | | | | |
| Treatment necessary 99 Project | 0 = No | 1 = Yes | | | | | | |
| 12 Appendix | | | | | | | | |
| 12.1.5. Do you or did you eat the local fish from Naboc River (Tilapia, Haluan, Clamps) | 0 = No | 1 = Yes | | | | | | |
| 12.1.1 Did you ever work in the Diwalwal area | 0 = No | 1 = Yes | If yes, for how many _____ year(s)? | | | | | |
| 12.1.2 Did you ever work as a ball miller | 0 = No | 1 = Yes | If yes, for how many _____ year(s)? | | | | | |
| 12.1.3 Did you ever work as a smelter | 0 = No | 1 = Yes | If yes, for how many _____ year(s)? | | | | | |
| 12.1.4 Do you use Naboc water for drinking purposes | 0 = No | 1 = Yes | If yes, for how many _____ year(s)? | | | | | |
| 12.1.5. Do you or did you eat the local fish from Naboc River (Tilapia, Haluan, Clamps) | 0 = No | 1 = Yes | | | | | | |