

MERCURY SAFETY PRODUCTS LTD

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TABLE OF CONTENTS

	PAGE
Foreword.....	1
Introduction.....	3
Mercury Toxicity: Adverse Effects on Health.....	6
Mechanisms of Mercury Toxicity.....	7
Mercury and Reproductive Health.....	11
Treatment of Mercury Toxicity.....	12
Mercury in Dentistry.....	12
Post 'Panorama' - a New Approach.....	14
The Assessment of Mercury Burden.....	16
Exposure Risk Factors for the Dental Team.....	18
COSHH and HSE; What they mean for the Dentist.....	19
Risk Management in General Practice.....	21
Dealing With a Mercury Spillage.....	24
Survey of UK Dental Practices.....	30
Contact Names and Addresses.....	32
PRACTICE DIAGNOSIS QUESTIONNAIRE - Evaluate Your Own Practice.....	33
Bibliography.....	40
<u>Tables and Figure</u>	
Health Issues in Dentistry Today.....	4
Clinical Symptoms of Mercury Toxicity.....	10
Disposition of Mercury in Man.....	8

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FOREWORD TO THE FIRST EDITION

This manual is the result of two year's research into mercury toxicity in dentistry, and its management. While brief, occasional items on this topic are sometimes included in textbooks, there has not been a dedicated work published which adequately covers the subject.

Mercury toxicity from dental amalgam did not feature in the BDS undergraduate course in the 1970s, and is largely ignored today despite gathering evidence that most practices in the UK do little to control their own risk of exposure to mercury vapour.

The aim of the manual, which was written in collaboration with a practising dentist of 20 years experience in both private and NHS dentistry, is to provide the dentist and staff with a working understanding of the hazards of working with this useful but potentially dangerous material.

The Practice Assessment Section is based on the available literature and is a weighted questionnaire covering the many and varied risk factors in any dental suite. The overall score for your own practice provides the opportunity for goal-setting and improvement by managing each risk factor.

Stephen Hewitt MSc PhD FRSH

Ruddington, Notts
1992

FOREWORD TO THE SECOND EDITION

Since the publication of the first edition, much has happened in the area of dentistry and mercury. The BBC TV programme Panorama in October 1992 sought to alert the public to the toxicity of amalgam fillings; attitudes in the following years have polarised considerably.

Many journal articles (and organisations such as the British Dental Association) have attempted to reassure the profession that amalgam restorations can continue to be used, while concerned bands of dentists have set up their own organisations such as the IAOMT - the International Academy of Oral Medicine and Toxicology laying down guidelines for the systematic replacement of mercury-based restorations with 'safer alternatives'.

For my own part, I have given many talks to regional dental

postgraduate groups throughout the UK, based on this book and the research effort which has continued. The second edition contains a number of asides based on comments received from my dental audiences. These have been included as a stimulus for the reader and have been separated from the main text as Talking Points, identified by being enclosed in a text box. It is my hope that this revised edition will continue to inform the profession about mercury toxicity in dentistry, enabling a rational approach to the important issue of self-protection for the dental team.

I would like to take this opportunity to thank my wife, Mandy, for her continued support and help in researching this project and dedicate this edition to our three sons, Andrew, Peter and Sam.

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INTRODUCTION

Dentistry has changed dramatically in the last ten years. The development of high technology methods such as intra-oral cameras, PC-based patient management systems, ultrasonic root canal measurement, light-cured resins and electronic pain relief has placed an additional burden on the dentist who wishes to benefit from these advances; that of continual retraining.

Patients have changed, too. Fluoridation and effective preventative dentistry have conspired to reduce the amount of basic restorative work available to the general dental practitioner, as have financial pressures from the NHS. Most up-to-date practices have introduced an element of marketing into their operation, offering increasingly cosmetic dental treatment to patients who are now prepared to pay for this. These changes are forced upon the dentist who wishes to maintain their income and to build a successful practice image.

Other problems have surfaced during the last two decades which are not just economic but which threaten the basic health of the dental team, the dentist being most at risk. These are the occupational hazards of dentistry: potentially fatal cross-infection with AIDS or hepatitis; the stress of continually working at a cost-effective rate; the everyday exposure to hazardous materials. Awareness of these risks is part and parcel of the dentist's work. And responsibility for the dental team; chairside assistants, hygienist, receptionist and practice manager who share the same working environment also lies with the dentist, who is legally responsible for their welfare under COSHH (Control of Substances Hazardous to Health) and HSE (Health and Safety Executive) regulations.

Scientific literature on occupational exposure of the dental team to mercury vapour has been published since the 1960s; however the mechanisms underlying its toxicity have only recently been properly examined. The literature now contains several surveys of dental practices worldwide which suggest that many of these, particularly in the UK, carry a high risk to health on account of the raised levels of mercury contamination.

The detailed medical examination of individual dental professionals with overt mercury toxicity has heightened the need to take action to reduce this hazard. More recently, concern has been voiced about the effects of mercury vapour on the reproductive health of men and women in the dental team.

The following table illustrates the range and complexity of occupational health issues facing the dental team.

HEALTH ISSUES IN DENTISTRY TODAY

	<u>HAZARD</u>	<u>SOURCE</u>	<u>MANAGEMENT</u>
Chemical Hazards	Mercury toxicity	Amalgams old & new	Regular monitoring service; discipline in use; adequate training for assistants
Carcinogens /Cytotoxics	Resins/accelerants Glutaraldehyde	Acrylics Biocides	Adequate ventilation during use; training; correct disposal
Eye injury	Strong inorganic acids	Surface etchants in syringes	Use of eye protectors; care in use
Biological Hazards	HIV Hepatitis	Needle-stick injury: cross infection with patients	Rigorous precautions; use of safe-sharp device; good history taking; decontamination between patients
	Upper respiratory tract infection	Infective patients	Use of face mask; high volume suction to avoid aerosol formation
Physical Hazards	Ionising radiation	X-ray equipment	Regular maintenance of equipment; monitoring service; care in use
	Hearing damage	Ultrasonic scalers,turbines, vacuum equipt.	Regular maintenance, optimal location and updating of equipment
	Ultra-violet light	Light-cured resins	Care in use; eye protection
	Postural problems	Poor working technique and rate	Appropriate exercise; reassessment of chair ergonomics; specialist training
Mental Hazards	Prolonged stress	Working method	Stress management course; review leisure and exercise
	Suicide risk	Financial concerns	Review patient profile and practice building efforts Professional advice

Table 1.

The dentist should not need to be reminded that it is becoming increasingly common for employees suffering damage to their health through

Talking Point

I have seen a steady rise in the number of dentists asking about urine mercury monitoring for one of their staff who has been complaining about specific health problems - headaches and frequent illness, for example. The results of urine tests are usually within normal limits, but in most cases the staff member has left the practice within a year. Dentist employers must be sensitive to employee needs in order to avoid accusations of constructive dismissal.

occupational factors to seek compensation from their employer.

Despite the multifactorial nature of mercury as a health hazard in the dental practice, each aspect can and should be tackled to reduce the overall risk. It is the purpose of this book to help the dentist directly assess their own mercury status and to effectively minimise the risk of toxicity. This publication draws together, for the first time, the literature on mercury exposure of the dental team as a series of practical steps which relate to every practice and dental team.

MERCURY TOXICITY - ADVERSE EFFECTS ON HEALTH

Historical Aspects.

Some of the mental and physical effects of chronic exposure to mercury are known to us all, immortalised in Lewis Carroll's Mad Hatter in 'Alice in Wonderland'. Mercury salts were used historically in the manufacture of felt hats and absorption of these compounds through the skin gave rise to body burdens sufficient to cause the symptoms of madness among this profession. Likewise, the use of mercury salts in the 19th Century for the treatment of syphilis gave rise to severe side effects and many fatalities (see Table 2).

Mercury toxicity made headline news in this country after the release of waste containing mercuric chloride (a catalyst in the production of plastics) into the bays of Minemata and Niigata, Japan in 1953 and 1960. Methylation of the metal by plankton and its subsequent incorporation into the food chain caused acute toxicity in victims eating fish caught in that region. Although immediate fatalities were apparently limited to 52 persons, hundreds of children and adults have since developed degenerative neurological disorders presenting as paraesthesia, ataxia, dysarthria, hearing and visual loss. In these regions, cerebral palsy too has persisted at a high 6% incidence of births.

In 1972, large quantities of grain treated with methyl mercury fungicide for planting were accidentally distributed to villagers in Iraq. Despite official warnings, much of the grain was ground and made into bread. In the disaster which followed, 6530 people were hospitalised and at least 500 died of mercury poisoning.

Mercury poisoning used to be widespread in such industries as mirror making and cinnabar (mercury ore) mining. There is international concern at present over the illegal dumping of thousands of tonnes of mercury every year, used for extraction of gold from ore, in the Brazilian Amazon area. Many hundreds of cases of mercury toxicity have been reported in the area and ecologists are very concerned about health effects once the water table is contaminated. More primitive gold extraction techniques involve boiling off mercury from gold-mercury amalgam in open pots over a fire.

Mercury compounds have in the past been used as diuretics, anti-infectives, laxatives, eye and skin treatments, but these uses have now been superseded by more appropriate drugs. In modern times, exposure, and therefore toxicity is limited mainly to dentistry; thermometer, barometer and mercury arc equipment manufacture; pigment, fungicide, insecticide and dry cell battery

manufacture. Disposal of mercury-containing domestic batteries on council dumps poses an enormous ecological problem; however this does help to put the dental use of mercury into perspective. It was estimated in the US in 1989 that discarded household batteries accounted for 86% of dumped mercury, while dental amalgam represented just 0.6% and has been declining steadily in quantity over the past three decades.

MECHANISMS OF MERCURY TOXICITY.

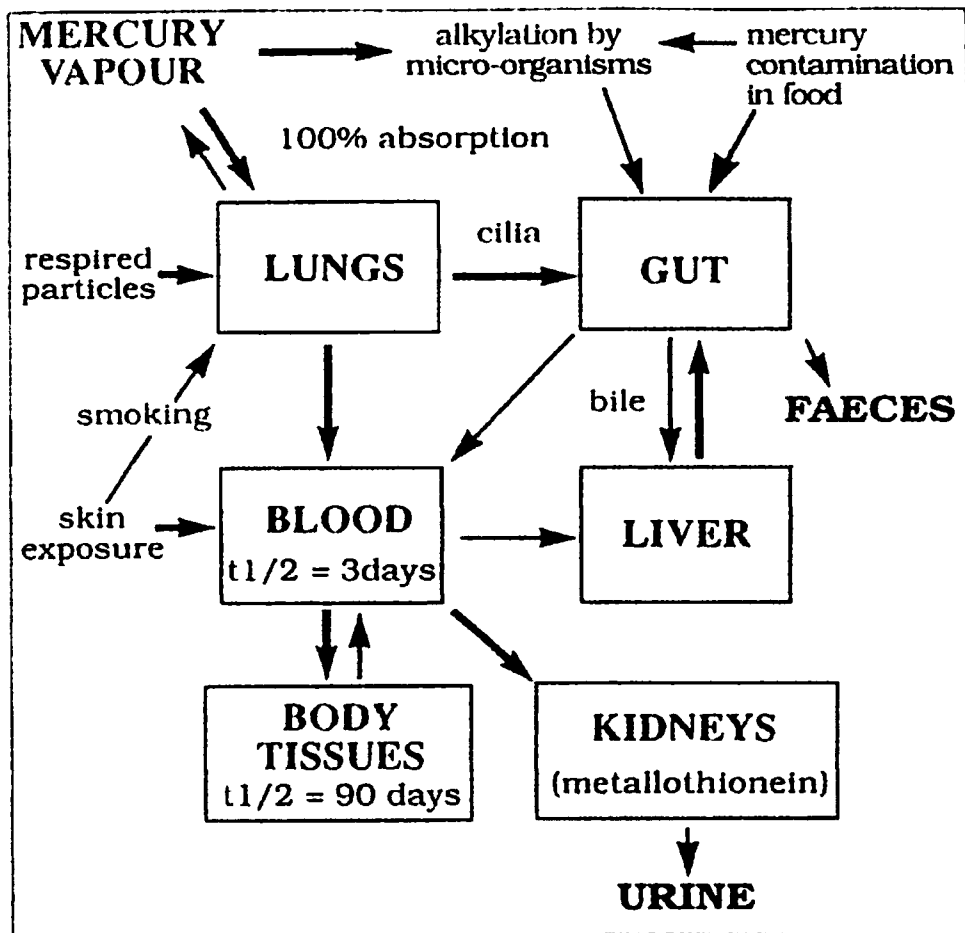
Dentists are exposed to mercury vapour and to mercury-rich amalgam dust; this is the 'fall-out' of aerosols generated during removal of amalgam restorations. Skin exposure to native mercury used to be common when amalgams were mixed by hand in a chamois leather, but this practice has almost ceased.

On occupational exposure to mercury, absorption is mainly via the lungs; mercury vapour is absorbed to an extent of between 90 and 100% by this route (see Figure 1). Dust and droplets on the skin and in the gut are absorbed to a minor extent (circa 15%) but doses to these regions are often high.

Some biotransformation of inorganic mercury to short-chain alkyl (methyl and ethyl) forms occurs in micro-organisms in the mouth and in the gut; absorption of these organic forms is relatively efficient (80 to 100%). Distribution of absorbed mercury throughout the body readily occurs via the blood and mercury partitions reversibly into all organs, including the brain and nerve tissue, which have a higher affinity for the organic forms.

Whilst the half-life of mercury in the blood has been estimated as about 3 days, mercury in body tissues clears slowly, with a half-life of about 90 days. Cessation of exposure will not therefore have immediately beneficial results, in the event of mercury poisoning.

Both inorganic and organic mercury compounds have an avid affinity for thiol (-SH) chemical groups and this is the property which renders them toxic. Most proteins, and all enzymes, contain these thiol groups; this explains both the binding of mercury to all body tissues and many of the biological effects. Most mercury compounds are potent but unspecific enzyme inhibitors, affecting membrane permeability and hence nerve conduction and tissue respiration. In this respect, the biochemical effects of mercury resemble those of black widow spider venom.



MERCURY DISPOSITION IN MAN

Talking Point

Based on the half-life of 90 days, the dental team member exposed to mercury will be at 'steady state' or equilibrium with his or her working environment after one year - about 4 half-lives. In practical terms, this means that urine monitoring for mercury is inaccurate before the person has spent a year in the practice. It also means that the dentist who retires due to mercury-induced ill health will not actually feel better until about a year later, when his or her mercury level has dropped by 93%.

This theoretical concept was dramatically illustrated by a dentist I met at a post-graduate meeting - he confirmed that having left the profession because of hand tremor and mental problems (diagnosed by his GP as Alzheimer's disease, but the dentist knew his mercury exposure was high through poor mercury hygiene), his symptoms slowly resolved until he felt normal one year later.

Disposal of the body's burden of mercury is via the urine and faeces, although minute amounts are detectable in expired air. Excretion via the liver occurs in bile and reabsorption of some of this mercury does take place. However, the kidney is equipped with an efficient, energy-dependant mechanism for disposing of metals such as mercury.

Renal tissue contains a thiol-rich protein called metallothionein; exposure to toxic metals triggers the production of this protein which binds tightly to the metal, retaining it in the kidney tissue in a relatively harmless form. As long as the kidney's capacity for production of metallothionein is not overwhelmed, mercury excretion can eventually balance intake, thereby limiting worsening of symptoms. However, acute high doses of mercury, or an increase in the chronic dose level can readily precipitate renal failure, one of the classic symptoms of mercury poisoning.

A small proportion of total body mercury is excreted in various forms directly in the urine without being bound to protein. In low dose, steady state conditions, such as the dentist who has worked at a similar exposure level for years, the urinary output very accurately reflects the total body burden.

CLINICAL SYMPTOMS OF MERCURY TOXICITY

Characteristic of Chronic, Low-Dose Exposure

Erethism (nervousness, irritability, mood instability, blushing)
Tremor
Personality change
Suicidal tendency
Paraesthesia
Impaired hearing
Speech disorders
Visual disturbance
Abnormal reflexes
Disturbed gait
Gingivitis
Impaired nerve conduction
Renal damage
Adverse outcome of pregnancy
Infertility
Pneumonitis
Glioblastoma (brain cancer)
Immune system dysfunction

Characteristic of Acute, High-Dose Exposure

Gastroenteritis
Mouth pain
Abdominal pain
Vomiting
Excessive salivation
Anuria
Uraemia
Nephrosis
Anorexia
Ataxia

Table 2.

MERCURY AND REPRODUCTIVE HEALTH

Chronic mercury exposure can seriously impair fertility and outcome of pregnancy. In one study, 45 women dentists and 31 DSAs were questioned about their reproductive history and hair samples were taken to estimate mercury exposure. A positive association was found between elevated mercury levels and incidence of malformations and aborted pregnancies. Mercury exposure also resulted in menstrual cycle disorders, arising from interference with the hypothalamo-pituitary-gonadal axis.

Talking Point

Fertility problems are experienced by one in six couples. During my programme of post-graduate talks, I have noticed that most of the questions from women dentists are concerned with infertility issues. It seems that the incidence of fertility problems in young women dentists may be higher than that in the general population. Certainly urine mercury analysis would be a useful first step for women members of the dental team experiencing infertility problems.

During pregnancy, mercury passes readily through the placenta; the concentration in cord blood is elevated above the level of the maternal blood. There is therefore a risk to the foetus in chronically-exposed pregnant women, although case studies to date are equivocal. One case report describes the birth of a severely brain-damaged baby to a woman dentist who was exposed to mercury vapour levels in excess of the TLV during pregnancy. In the most recent report, a Swedish dentist was exposed to mercury vapour during her pregnancy through a leaking amalgamator; the foetus showed mild kidney inflammation but was born clinically healthy. The World Health Organisation stated in 1991 that 'the exposure of women in child-bearing age should be as low as possible'.

In men, organic forms of mercury were found to cause hypospermia, a reduction in libido and impotence in some subjects. Evidence of minor genetic damage (aneuploidy) was found, thought to be caused by interference of the metal with thiol groups in the spindle apparatus of dividing cells.

More recently, an adverse effect of mercury on sperm motility was reported and another report describes an increased rate of spontaneous abortion in women whose partners were occupationally exposed to mercury vapour.

THE TREATMENT OF MERCURY TOXICITY

As explained above, the relatively long half-life of mercury in the body rules out immediate improvement in the symptoms of toxicity even if exposure is stopped.

The usual sequence for treatment of overt mercury toxicity, as specified by the National Poisons Unit is:

- 1) cease exposure
- 2) measure blood and urine levels to assess body burden
- 3) oral or intravenous treatment with chelating agents containing a thiol group, which binds avidly with mercury. Examples are dimercaprol, penicillamine, N-acetyl-D,L-penicillamine and 2,3-dimercapto-propane-1-sulphonate.

A related agent, DMSA (dimercaptosuccinic acid) has recently been shown to rapidly mobilise and stimulate excretion of the mercury burden; some 50 to 70% of the stimulated excretion in occupationally exposed workers occurred in just 8 hours.

There is growing evidence that nutritional supplements offer protection against mercury toxicity, both in animal models and in man. In particular, the antioxidant nutrients seem to interfere with the biochemical processes underlying the toxic effects; vitamins C and E, beta carotene and the mineral selenium have been researched in detail. Products of this type are available over the counter from pharmacies; supplements containing very high levels of active ingredients should be avoided, however.

MERCURY IN DENTISTRY

The production of metallic mercury is limited to about ten thousand tonnes each year, worldwide. Estimates of the amount used in dentistry suggest that about 150 tonnes are used in dental restorations each year, the average dentist using 2 or 3 pounds (1 to 1.5 kg) annually. This seems insignificant compared with up to 150 kilotonnes released each year into the biosphere by degassing of the earth's crust and by burning fossil fuels.

However, in the confined space of a contaminated dental surgery, the comparatively low partial pressure of free mercury means that at room temperature, saturation of air with mercury vapour can theoretically give rise to levels of 20 mg per m³. This is a massive 400 times the recommended time-limited value (TLV) of 0.05 mg per m³ proposed by the World Health Organisation for occupational exposure. The TLV is the theoretical amount to which an adult can be occupationally exposed during an 8 hour day without supposed adverse effects on health.

By contrast, the normal atmospheric level of mercury vapour has been measured as between 1 and 4 ng (0.000001 to 0.000004 mg) per cubic metre and is the result of natural processes combined with pollutant emission and, for example, the release of mercury from dental fillings by cremation.

It is easy to see, therefore, that unchecked mercury contamination of the dental surgery can theoretically give rise to vapour levels well in excess of the accepted working safety limit. In surveys of mercury concentrations in the atmosphere of dental practices, it has been established that at least 10 percent of surgeries have vapour concentrations greater than 0.05 mg per cubic meter and the occupants are therefore at risk of mercury toxicity. But how sure are we of the TLV guidelines ?

In 1992, a researcher in Singapore determined the mercury vapour level in the surgeries of 98 dentists in practice for an average of 5.5 years, and whom he then subjected to a battery of psychomotor and neurological tests.

The average mercury vapour level was 0.014mg per cubic metre - about one-third of the TLV - however, the dentists scored an average of 14% worse in the tests than unexposed control subjects. The unavoidable conclusion of this important study is that even at one-third of the TLV for mercury vapour, measurable impairment of key psychomotor processes was demonstrated.

The wide variety of health problems associated with chronic exposure to mercury vapour are listed in Table 2. Of all the symptoms listed, the most readily induced appears to be that of tremor, which has been reported to occur at vapour concentrations in excess of 0.1 mg per cubic meter, that is, twice the TLV. 'Tremor' in this context is defined as the inability to hold still a 15lb weight.

Mercury amalgam has been used in dental restorations since the 1830's

Talking Point

I have met five or six dentists who mentioned that their father had also been in the profession but who had retired early when they felt unable to work due to hand tremor. At the time, mercury poisoning had not been suspected nor tested for, however.

and despite occasional debate it remains the most commonly-used restoration material, notwithstanding the growing popularity of more natural-looking polymer material for use in anterior teeth.

POST 'PANORAMA' - A NEW APPROACH

Much has been made in the last ten years, especially in the 'popular health' press, of cases in which an allergy to amalgam fillings has been alleged to have caused serious health problems. In the individuals affected, it was considered necessary to replace all their mercury-containing restorations with composite and the reported results have been dramatic. The safety of mercury-based amalgam restorations in teeth has been questioned from time to time; the earliest critiques in the literature are papers by a German chemist called Alfred Stock, published in the 1930s. As a result of Stock's work, a special clinic was set up in Berlin to investigate amalgam safety.

Amalgam fillings do slowly release minute quantities of mercury into saliva by leaching, and thence into the body (mercury vapour is detectable in the breath of persons with amalgam fillings). It has also been demonstrated that tooth grinding (bruxing) increases mercury release from the fillings; the concentration of mercury vapour in the mouth can exceed the TLV when chewing gum is used. These effects are transitory, however, except when the subject is a heavy user of gum and has more than six fillings, when the oral atmosphere can exceed the TLV for several hours.

These doses are, in most cases, very small and are comparable with the intake of mercury from food. Nevertheless, the evidence that in some individuals these amounts of free mercury can compromise health is becoming more abundant. In the USA late in 1991, a specialist review panel of the Food and Drug Administration dismissed calls for a ban on dental amalgam, stating that there was insufficient evidence linking any specific disease with mercury from dental fillings and in Britain, the British Dental Association has continued to support the placement of mercury amalgam restorations.

However in the medical literature since 1990, there has been a steady stream of reported case histories from patients with a wide variety of symptoms ranging from insomnia to multiple sclerosis, all of whom have experience dramatic improvement in their condition once all mercury-containing fillings had been removed. This assertion is actually illogical, since the removal of multiple amalgam restorations in a short time causes a distinct pulse of mercury loading to the body, persisting for some weeks; under these conditions, one would expect the symptoms to worsen.

Parallel with these case histories have been a series of papers demonstrating that mercury can indeed interfere with the immune system and its components, giving credibility to the concept of the 'mercury sensitised' patient with classical allergy symptoms to mercury. Indeed, such was the public interest in the preventative removal of amalgams for

health reasons, that when the Princess of Wales underwent this operation, it made the newspaper headlines in 1992.

The BBC TV documentary programme 'Panorama' , broadcast in October 1992 brought together a collection of human and animal toxicity studies, most of which were in the pre-publication stage, since a careful examination of the literature revealed that almost none of the Panorama evidence had been published (and therefore peer-reviewed). Nonetheless, from that day on, dentists have been expected to field complex questions about mercury exposure risk to the patient and advise on amalgam replacement strategies.

Talking Point

It is perhaps ironic that in dental practices which favour amalgam replacement, the dental team is potentially exposed to greater quantities of amalgam dust than in other practices, due to the larger number of amalgam restorations removed every week.

In the last year, evidence has been published showing that true mercury sensitivity does occur in genetically-susceptible people, who exhibit immune system-modulated diseases, the severity of which can be altered by the mercury burden of the patient. These people are quite rare - perhaps one in every 50,000 of the population, but they respond to classical patch-testing tests using mercury compounds and frequently show cross-reactivity to other heavy metals such as cadmium.

Many dentists now offer amalgam replacement programmes for patients and guidelines are available from organisations such as the IAOMT for procedures to be followed during amalgam removal in order to avoid the pulse of mercury exposure which normally accompanies restoration removal. Typically, this will involve the following:

- nutritional support with antioxidant nutrients in the three months leading up to removal and for six months afterwards
- routine use of rubber dam
- separate air supply for patient, delivered by nose mask
- protective clothing for the patient
- use of high volume suction and on-tooth air scavengers

The Future of Amalgam as a Restoration Material

Concern over mercury amalgam in the early 1990s has reshaped the future for this material. As highlighted in the Panorama TV broadcast, one of the leading producers of dental amalgam products, Degussa, no longer

manufactures nor sells amalgam. This decision was made after recent EEC directives placed responsibility for injury to people on manufacturers of the product.

National guidelines on mercury amalgam use vary considerably:

Britain: The British Dental Association supports continued use of amalgam

USA: The Food and Drug Administration pronounces mercury amalgams as having 'Generally Regarded as Safe' status

Sweden: Placement of amalgams to be phased out by 1997

Austria: Amalgam-free by year 2000

Germany: German dental association recommends alternatives for children under six, pregnant women and kidney patients and bans production of gamma-2 amalgam, which is more susceptible to corrosion in the mouth

WHO: TLV to be reviewed; statement has been issued that 'no amount of exposure to mercury vapour can be considered totally harmless'

Mercury Sensitisation and Accumulation in Dentists.

Dentists, too, can be among these people affected by mercury sensitisation. There have been many documented cases of contact dermatitis among dentists sensitised to mercury, but these are perhaps minor issues compared to the serious health risks of chronic occupational mercury exposure throughout the profession as a whole.

Evidence published in 1989 suggests that mercury is able to travel easily from the oronasal cavity to the floor of the cranial cavity, where it is concentrated into the pituitary gland. The pathway is thought to be the olfactory nerves or the cranial venous system; these bypass the detoxifying effect of the liver which ameliorates the effect of lung and gut doses of mercury. Pituitary glands taken post-mortem from Swedish dentists showed that the mercury level in the pituitary gland was, on average, 2.5 times (and in one case 169 times) that in the brain cortex.

MEASURING THE MERCURY BURDEN

Regular monitoring of all hazardous materials is an accepted part of working practice under the Control of Substances Hazardous to Health Regulations (COSHH) 1988. In the absence of overt signs and symptoms

of mercury toxicity in dental staff, a biochemical test which assesses the degree of exposure is required. Since tissue sampling is obviously not possible, and remote detection by, for example, x-ray fluorescence is not widely available, analysts are restricted to a limited range of biological samples.

Mercury levels in the blood do reflect the amount absorbed; however, the metal is quite rapidly cleared into the tissues (the half-life is 3 days) and one sample may not be representative of periodic exposure. Hair and nail tissue are quite good indicators of exposure to the organic forms of mercury such as methyl and ethyl mercury, but do not accumulate inorganic mercury sufficiently to form the basis of an accurate analytical method.

Mercury is however excreted in the urine in amounts which accurately mirror the total body burden; the long half-life in the body tissues (90 days) effectively smoothes out differences in day-to-day exposure. Since the amount of urine produced varies through the day, a standardisation process is needed for accuracy. Some analysts have opted for 24 hour urine collections, which tend to be impractical for the busy professional. Others correlate the mercury content of the urine to a standard specific gravity to compensate for the effects of dilution; sometimes it is linked to the creatinine content, which is relatively constant.

Measurement of the concentration of mercury vapour in the air of dental practices has been carried out in several surveys published in the literature. The simplest method uses a chemically-impregnated paper disk which is exposed to the practice air for a period then 'developed' to assess the exposure risk.

This system has limited use in potentially exposing a health risk to their staff through elevated mercury vapour levels. While it can be useful in relating the practice exposure risk to the theoretical time-limited value (TLV), the method excludes mercury absorbed via the skin and by inhalation of aerosol material by the dentist; two major routes of absorption.

For those practices where personnel are found to have a high mercury burden, air sampling can help identify the source of the contamination. This is usually carried out by sophisticated 'sniffer' apparatus operated for 24 hours in various locations in the surgery during a working day. Mercury vapour is adsorbed on to a gold 'element' according to the concentration and flow rate. At the end of the fixed exposure time, trapped mercury is driven off by heating and assayed by atomic absorption spectrophotometry. Hire rates for this type of equipment are usually prohibitive for general practice, at around £600 per session.

EXPOSURE RISK FACTORS FOR THE DENTAL TEAM

1) The Dentist

The dental surgeon is exposed to a particulate aerosol containing mercury each time a mercury restoration is removed. Likewise, packing and condensing new amalgam restorations releases mercury at the amalgam surface, which then vaporises. During the working day, therefore, the dentist is exposed periodically to relatively high levels of vapour at face level, in addition to background levels present in the operating room.

These background levels are the main contributor to long term exposure, and hence to health risk, and are the sum of many factors covered in detail in the Practice Assessment section of this manual.

2) The Dental Surgery Assistant

Part of the DSA's job is to prepare amalgam, and to maintain (and fill, where appropriate) the amalgamator. Spillage of elemental mercury, if incorrectly cleaned up, contributes to the background level of mercury vapour. However, it is still common practice is some surgeries for the DSA to finally prepare the amalgam by expressing excess mercury from the mix.

This is done by squeezing the amalgam in a piece of thin leather, and if gloves are not worn (which is likely if this technique is being used), quite large transdermal doses of mercury are possible.

Even if this rather antiquated method is not used, leakage of elemental mercury from the capsules of amalgamators can give result in the exposure of the skin to mercury, in the DSA. Despite current concerns about cross-infection, not all DSAs are issued with surgical gloves for routine patients; this simple precaution would avoid much of the mercury exposure risk to the DSA.

3) The Hygienist, Receptionist and Cleaner.

Whilst the hygienist is not actively involved in the placement or replacement of amalgams, they are usually situated in rooms adjoining the main surgery, as is the receptionist. In most practices, air from the surgery can easily mix with the general atmosphere, rather than being expelled by a negative pressure ventilation system. Furthermore, it is very common for all the floors to be cleaned at once, using the same mop, with all the doors open. This merely results in a redistribution of mercury-containing residues from the surgery floor into the adjoining rooms. The vapour pressure of mercury in these rooms is then determined, in theory, by the efficiency of ventilation.

Poor cleaning practice inevitably results in the accumulation of mercury in the cleaning implements, aiding further distribution throughout the surgery complex. Whilst the cleaning personnel are not exposed to the practice atmosphere for long periods, there is an obvious risk of high levels of mercury vapour in the cleaner's storeroom. Furthermore, we are aware that in a great many practices, this room doubles as the room in which cleaning personnel are allowed to smoke and drink.

In this way, each member of the dental team is at risk, for distinct reasons, yet directly linked to the overall mercury hygiene in the practice as a whole.

COSHH AND HSE; WHAT THEY MEAN FOR THE DENTIST

Prior to the introduction of the Control of Substances Hazardous to Health (COSHH) Regulations 1988, the principal guidance to dentists regarding their obligations towards the safety of their staff was stated in the 1974 Health and Safety at Work Act. The exact relevance to dentists is pointed out in advice sheets issued by the British Dental Association. For example, advice sheet A3, issued in November 1982 states:

The dentist's duty as an employer is to ensure so far as is practicable the health and safety and welfare at work of all his employees. In particular he must ensure safe handling and storage of any dangerous or potentially harmful articles or substances and provide a working environment for his employees that is safe and without risks to health.

The COSHH Regulations 1988 were introduced in order to manage existing risks to health within all sections of the workforce, and to prevent ill health in the future. Numerous articles have been written detailing the implications for each profession; the following serves to summarise the relevance of these new regulations to the dentist as an employer.

COSHH required that after 1st January 1990, no work which is liable to expose anyone to substances hazardous to health shall be carried on unless an assessment has been made. This means that where work involves using substances which are hazardous to health, then the risk must be properly evaluated. In addition, steps must be taken to control that risk, in accordance with the whole of the COSHH recommendations.

The dental team is exposed to several inorganic and organic chemicals such as cleaning and biocidal agents; solvents; photographic materials; resins and catalysts. Some of these represent new developments in the field of dentistry and have only recently been brought in to some practices. Yet mercury, which has a dramatic potential for harm, has been in use for

many decades. Most dentists are aware of this potential for harm, but have not taken steps to control the hazard.

In the Health And Safety Executive handbook on COSHH assessments published in 1988, the following advice is given:

If there is uncertainty about the risk (to health); the nature of the hazard is known, but there is uncertainty about the degree and extent of exposure, the recommended course of action is:

- 1) Measure and compare exposures where possible (obtain specialist occupational hygiene advice if necessary to carry out a survey)
- 2) Determine what has to be done about improving control of exposure
- 3) Decide what arrangements are needed to sustain control.

Screening services are available, offering the dentist an accurate means of meeting these objectives in full, in relation to mercury exposure. The COSHH Regulations are now fully in place and prosecutions within other industries have occurred, resulting in the closure of work places. The nature of mercury contamination is such that if a dental practice were to be served with a closing order under COSHH, the practice would be closed while the surgeries were stripped out and refitted.

The COSHH regulations have now been largely replaced by the EEC-backed Health and Safety 1993 regulations known as the 'six-pack' which require full documentation of all work procedures involving hazardous materials and equipment. Under these guidelines, all practices with five or more employees are required to have a written safety policy and practice inspections by Health and Safety Executive inspectors will be conducted on a regular basis.

RISK MANAGEMENT IN GENERAL PRACTICE

A Practical Guide to Reducing Mercury Exposure

This section of the booklet describes the individual factors contributing to mercury exposure in general practice. Each factor can be examined in relation to your own practice, using the Practice Assessment Section. The following pages explain the significance of the contributing factors; full understanding of these will enable the dentist to train their staff better and will assist decision-making regarding surgery design and maintenance.

1) The Dentist

Several studies have identified that total mercury burden is related to the number of years in practice; in a study of 85 New York dentists, mercury (measured in this instance using hair levels) was found to show a significant linear trend with the number of years in practice (range 2 to 40 years). A similar investigation into urinary mercury excretion by more than 4200 dentists throughout the United States showed a good correlation between years of practice and mercury excretion (and therefore burden), peaking at age 50 to 54 years.

Another study of 238 US dentists showed a relationship between mercury burden and the number of years at the present practice location. This finding has also been described for dental assistants in a survey of 52 DSAs in the US.

It is tempting to speculate why this should be; the relationship may be a combination of simple accumulation of mercury, suggesting that within the working lifetime of the dentist, steady-state kinetics are not reached, and of the changes in mercury awareness afforded by the dentist's own training. The latter two reports further suggest that contamination of the surgery may indeed worsen with time.

Several studies, based in countries around the world, have shown a clear relationship between mercury excretion and both the number of hours of practice per week and between the number of amalgam restorations placed per week. These correlations are easier to comprehend, considering that each operation involving amalgam represents a 'unit dose' of mercury to the surgery and its occupants.

Specialities within the dental profession also appear influence the level of mercury exposure. In orthodontists, for example, the average urinary mercury level was about one-quarter that of general practitioners and was close to that of people not occupationally exposed to mercury. Specialists

in periodontics, paedodontics, endodontics and prosthetics had, on average, mercury excretion levels that were half those of general practitioners, but twice those of orthodontists.

2) The Surgery - Heating , Ventilation and Aspiration

The main source of mercury exposure in most surgeries is mercury vapour from the amalgam dust produced during removal of restorations. It is intended that all of this material - along with the biohazardous aqueous aerosol which accompanies it - is removed by the suction apparatus. However, as discussed in a later section, many surgery aspiration systems are inadequate, allowing an aerosol cloud to escape during the operating process.

Talking Point

It is a source of concern that the majority of UK dentists with whom I spoke, work with aspiration units which vent into the practice's atmosphere, rather than outside the building. Effluent air from these units will contain significant levels of mercury vapour, and should be vented externally if background contamination is to be minimised.

Ventilation of the operating room is paramount in determining chronic exposure levels of mercury vapour. The ideal is a ducted air system which sweeps stale surgery air to the exterior of the building with sufficient air changes per hour to keep mercury vapour levels minimal. In an ideal situation, the surgery should be kept at negative pressure relative to the remainder of the practice rooms. This effect may also be achieved using an extractor fan in the surgery, but in one survey, it was found that where these were fitted the majority of dentists did not use them, for reasons of noise.

Methods of heating which force air induction or extraction also help to sweep contaminated air from the surgery, although, extraction is obviously preferable. Thus a fuel burning fire ducted to the exterior will act as an extractor; ducted hot air heating will also have this effect, although mercury-laden air may be swept into the other rooms in the practice. Storage heaters, circulating hot water radiators, underfloor heating and free-standing bottled gas heaters do not have a ventilating effect, but rather serve to raise the temperature-dependant mercury vapour concentration.

Recycling air conditioners have particular hazards associated with them. One study showed that air was returned to the surgery with 20 percent

more mercury vapour than was entering the unit. Such air conditioners contain air filters which act as a mercury reservoir. The British Dental Association recommend that recycling air conditioners should not be used to heat surgeries unless fitted with a mercury-trapping filter. A free-standing surgery air filtering unit using replaceable activated charcoal filter is available from Eurofilters in Scotland.

A surprising number of practices still have carpet or carpet tile flooring; these are most common in traditional but 'up-market' practices run by older dentists. A useful way to convince dentists of the pervasive nature of mercury-rich amalgam dust is to persuade them to lift the carpet in the dental surgery; in every case there will be a fine deposit of dust under the carpet which forms a silvery sheen when wiped with a finger. Obviously this is a major mercury exposure risk; the carpet or tiles should be replaced as soon as possible.

One dentist described to me how he took his surgery carpet to the local council tip for disposal; on arrival he noticed small globules of mercury on the car boot floor; these had coalesced due to vibration during the car journey - clear evidence of contamination.

Recent attempts to reduce heating costs by energy conservation have meant that many practices today have been fitted with double glazed windows and draught-proofing on the doors. While these measures are beneficial to heating bills, they can have a profound adverse effect on mercury vapour accumulation within the operating room.

3) The Surgery - Flooring Material

The operating room, and in particular, the area of floor surrounding the dental chair, is the main site of deposition of the mercury-rich particulate aerosol generated by the removal of amalgam fillings. Detailed surveys using mercury 'sniffer' apparatus have shown that the concentration of vapour is greatest in the area surrounding the chair, close to the floor. From this initial deposition site, the contamination is spread to the remainder of the surgery (and sometimes throughout the entire practice) by inappropriate cleaning methods.

The flooring material used in each surgery has a major influence on the mercury vapour levels in that room. For example, if the floor is carpeted, spillages of mercury and deposited particles are confined to fairly small areas, but will build up significantly over time. Wood floors are also absorbent and in surgeries with major contamination, act as reservoirs of mercury. A combination of underfloor heating and carpeting is particularly dangerous.

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Another problem with carpeting (or carpet tiles) is the method of cleaning. The use of a vacuum cleaner on mercury-contaminated carpeting is an efficient way of vaporising mercury residues in the carpet and should of course never be used.

On the other hand, hard-surfaced floors such as concrete/stone finishes and hard tiles are relatively impervious to mercury. However, spillages will travel far on such a hard surface, and the cleaning method used, that of mopping, serves to readily spread the contamination.

Vinyl flooring is considered by many to be best; it is easily surface-cleaned, and relatively non-absorbent to mercury vapour. However, it is important not to have crevices on the floor between the vinyl sheets. For this reason, vinyl tiles are not ideal unless a sealant is used between them. It is recommended that where vinyl flooring is used, it should be fitted seamless, and finish about 10cm (4 inches) up the walls, to contain any spillages and to make cleaning easier.

4) Dealing with a Mercury Spillage.

If the spillage is in a machine, such as an amalgamator, the device should be switched off and isolated by removing the plug immediately. Ventilation should be increased by opening windows and the heating turned down or off.

Putting on protective gloves, place the machine in a large polythene bag, labelled with a suitable warning, and preferably take it outside the surgery. Later, the device can be disassembled and any visible globules of mercury removed using a syringe from a spillage kit. Tilt the machine to allow mercury to be freed from the mechanism, and use a brush to clean the inside.

Most devices will not be made of absorbant material but could be sponged with a decontaminant paste of calcium hydroxide and sulphur if necessary.

Do not allow electrical components to become wet, however, due to the hazard of electric shock on reconnecting.

If you are not confident about cleaning the apparatus, then contact the manufacturer, your local Health and Safety advice office, or the Family Health Services Authority for advice.

If the spillage is on a work surface, ascertain whether it has been restricted to that area or has reached the floor. Avoid kicking loose globules of mercury into the corners of the room, or into other rooms. Putting on protective gloves to avoid skin contact, pick up as much loose mercury as possible using a syringe, then use the brush to coalesce smaller particles.

Sprinkle mercury adsorbant onto the area then brush this into the scoop

Talking Point

Since the start of my postgraduate talks, many dentists have asked me to recommend a commercial mercury spillage kit which meets their needs and will pass HSE inspection. In the absence of a suitable kit which has to have a high specification at low cost, I have since designed such a spillage kit, which is available from the publishers and from several dental distributors in the UK; please refer to Contact Names section on page 32.

and place in the disposal jar, which should be tightly sealed. Locally confined spillages on hard floors can also be dealt with in this way; carpet requires more careful decontamination with a specialist alloy wool or paste adsorbant, followed by cleaning with industrial shampoo. A vacuum cleaner should NEVER be used to collect a mercury spill.

5) The Operating Room - Routine Floor Cleaning.

The more often the operating room floor is cleaned, the less likely deposited mercury-rich material is to accumulate over time. A good compromise would be twice weekly, but ideally the floor should be cleaned daily. Cleaning should be done using a damp mop which is kept expressly for cleaning the surgery floor.

If carpeting is fitted, it should be vacuum cleaned with all the windows in the room opened and the doors closed. The surgery mop should be clearly identified as such, and stored in a well-ventilated (and preferably outside) area. It is important to train your cleaner to understand the reasons for a special cleaning procedure in the surgery rooms.

Although proprietary cleaning solutions for vinyl and stone-finished floors are satisfactory, it is highly desirable to use a cleaner which will remove mercury contamination from the floor. A suitable cleaner can be made using a 1 percent aqueous suspension of calcium hydroxide and powdered sulphur. This inexpensive mixture is an excellent mercury vapour suppressant, but should be made fresh before use as follows:

Two heaped teaspoonsful of calcium hydroxide and two heaped teaspoonsful of powdered sulphur are briskly stirred into a half gallon of warm water. It is advisable to wear gloves for this procedure.

The surgery floor is mopped over with this mixture and then cleaned with a proprietary cleaner. The same mop can be used for both, if well-rinsed between applications.

6) The Operating Room - Work Surfaces, Cupboards

Much of the advice being given to the dental team concerning decontamination procedures to prevent cross-infection is also applicable to mercury vapour risk. All of the surfaces in the operating room should be faced with an impervious material and should be kept as free of equipment and other items as possible.

It is then relatively easy to keep these surfaces well dusted and to clean them with the mercury vapour suppressant suspension occasionally. Open shelves should not be used in the dental surgery, as they collect dust too readily. Use 'kitchen-type' cupboards with doors, instead.

Many practices operate a scrupulous cleaning programme for the area immediately surrounding the dental chair but only clean the tops of cupboards every year. All the dust which settles in the surgery will be contaminated to some extent with mercury.

The work surfaces should be adjusted so that they do not slope backwards; one of the best documented cases of mercury toxicity after a spillage occurred when the metal rolled across the work top and fell behind the unit, to gradually poison the occupants over the next few months. Ideally, all work tops should be fitted with a lip at the rear to prevent this.

Whoever cleans these surgery surfaces should take the opportunity of using disposable cloths to do this; these can then be immediately removed from the surgery for disposal.

6) The Dental Team - Gloves and Masks.

Latex gloves are now worn routinely by the dentist as a precaution against cross-infection. In most surgeries, the DSA, too, should wear gloves and this will offer significant protection against skin exposure to mercury.

Talking Point

It was alarming to hear from a regional DSA trainer that nearly half of the DSAs in her area were not allowed to wear gloves for economy reasons. Similarly, a survey of UK dentists published in 1995 showed that 37% did not wear gloves for every patient treatment and inspection

For the dentist, skin exposure risk is highest when removing old amalgam work using a high speed burr. The mist of coolant water contains a mercury-rich aerosol which deposits on the face, hair and clothing of the

operator. The DSA too is at risk from this source of contamination, although the dentist, being closer to the patient, is at greater risk via the inhaled route. In nearly all surgeries the DSA is responsible for preparing the amalgam mix and skin contact here is possible, necessitating the use of gloves by the DSA.

An analysis of particle size of the aerosol produced while removing an amalgam restoration showed that most of the particles were within the respirable size, that is, around 20 microns or less. Using a paper face mask definitely reduces the mercury level in urine, and hence the level of

Talking Point

It is now possible to buy masks impregnated with absorbant charcoal to prevent inhalation of mercury vapour. These masks are functional at up to twice the accepted TLV for atmospheric mercury vapour - that is, at up to 0.1mg per cu metre for one month's continual use. It is usual to wear a paper mask over the mercury vapour-proof mask to prevent the risk of bio-contamination. These masks are now available from the publishers

personal exposure.

In another study designed to evaluate the particle size of amalgam-bearing aerosols, the effect of wet and dry cutting and of suction efficiency were measured. It was found that the use of wet cutting (water-cooled high speed burr) greatly reduced the number of respirable particles, as did high volume suction, for obvious reasons. It is therefore advisable to use both these options when removing old amalgam work, in addition to a face mask.

The latter study also showed that even when the dental operative field was strictly controlled by the use of rubber dam, and a combination of wet cutting and high suction was used, there was still a significant dose of fully respirable particles (2 microns diameter or less) to the operator.

The method of compacting of new amalgam fillings also has a profound effect on levels of mercury vapour at the dentist's face level during the operation. Condensing the amalgam not only packs the cavity but mechanically expresses any excess metallic mercury from the mix, thereby ensuring maximum strength.

Hand carving and hand compacting have been shown to produce the least free mercury bioavailable to the operator. When high volume suction is used at the same time, the risk from this procedure is almost nil. Mechanical compactors however, tend to produce a rather coarse aerosol

of mercury-rich material whilst ultrasonic compactors produce a fine aerosol which is within the respirable range of particle size. Obviously, the use of high volume suction during compaction is to be advised. Surgery aspirator units are becoming more sophisticated and state-of-the-art units now incorporate an amalgam separator which avoids contamination of effluent water with solids. Such units are expected to become mandatory as the EEC directives governing practice effluent streams come into force.

7) The Dental Team - Personal Hygiene.

Continual exposure to mercury-bearing aerosols results in heavy deposition on the clothing of the dentist and DSA. This gives the potential for high levels of exposure via skin contact, unless the clothing in question is changed frequently, preferably daily.

The choice of hand-drying equipment is important, too. Consider the consequence of washing the hands after deposition of mercury residue on the skin. Some of the material will be washed off, depending on the efficiency of cleaning; observers note that personnel rarely soap their forearms, yet when gloves are worn, this site represents the area of highest deposition. Much of the remainder of the mercury would be transferred to a cloth towel, for redistribution to the skin of other users and evaporation into the atmosphere.

A hot air dryer seems more hygienic, but in this case, is a very effective means of vaporising mercury from the skin. The safest option is that of disposable paper towels (which should be discarded into a bin with a seal around the lid) or of a roller towel.

8) Storage, Use and Disposal of Mercury-containing Materials.

Many dentists are aware of the hazardous nature of metallic mercury, and store their stocks and bottles of waste amalgam in a tank of water. However, the vapour is freely soluble in water and can still contribute to the background contamination of the surgery, particularly if the storage area is close by.

The avid binding between mercury and thiol groups has been discussed already; leakage of mercury from stock (and waste) bottles can be stopped by the addition of used X-ray fixer solution (containing sulphur compounds) to the tank of water. This is an effective and cost-free method of reducing risk. Alternatively, a dilute solution of potassium permanganate may be used.

Mercury stocks and waste should never be kept in the surgery, but

preferably in a separate, well-ventilated room. The siting of the amalgam preparation area is important, too. The material does have to be prepared in the surgery in most cases, but in some surgeries, the amalgamator could be situated in an adjacent room with forced ventilation.

Mechanical amalgamators are a source of mercury contamination; frictional heat applied to the alloy/mercury capsule drives off mercury vapour into the surrounding atmosphere. The amalgamator should never be situated close to a source of heat, such as a radiator, autoclave, steriliser or heating duct, for this reason.

Various studies have sought to establish which brand of mechanical amalgamator is the safest; the consensus of opinion appears to be that where capsules are reusable, wear on the two halves results in an incomplete seal and the loss of small particles of mercury during mixing. This can also be found in some machines using single usage plastic capsules.

A strip of adhesive tape placed around the two halves of the capsule will often indicate whether leakage is occurring during mixing; tiny globules of mercury will be seen adhering to the tape. Mechanical amalgamators are certainly safer than hand-mixing the amalgam, due to the risk of spillage and the high likelihood of skin exposure during mixing (trituration).

Waste amalgam and large pieces of old restoration material are often kept for recovery of the metals, however little thought is usually given to the contents of the spittoon and suction apparatus (aspirator). A considerable quantity of fine amalgam fragments passes through these items of surgery equipment and are retained in the trap section. There is great potential for evaporation of mercury from these, particularly from the spittoon, which is often allowed to dry out in many surgeries. When these items are cleaned, it is essential that the residual material is treated as mercury waste and stored under fixer solution for proper disposal.

Recently, attention has been given to the safety of aspirator units, in which air exiting from the motor unit is usually returned to the surgery atmosphere. However, this air is often laden with mercury vapour, and measurements of mercury concentration around aspirator units has revealed concentrations which are alarmingly high. Ideally, the aspirated air should vent outside the surgery, as discussed previously. For advice, consult the manufacturer or installation specialist.

9) Training the Dental Team.

Each member of the dental staff, from the practice principal to the cleaner,

has a role to play in the maintenance of a working environment which is safe. When new staff join the team, or at practice meetings, it is an ideal opportunity to train your staff to respect the health risks arising from incorrect handling of dental materials such as mercury. The information should be presented as part of a campaign to tackle existing risk factors and to reduce the likelihood of contamination occurring in the future.

Staff (and dentists) should be forbidden to smoke, eat or drink, store food or apply cosmetics in the operating room. The hands should be carefully washed before any of these activities to avoid transfer and ingestion of mercury. Accidental contamination of cigarettes with mercury ensures that virtually all the material is absorbed by the body, such is the efficiency of absorption via the lungs.

10) Updating and Redesign of the Operating Room.

The above section has discussed the ways in which design and operator factors can influence the overall risk of mercury contamination in the surgery. When the opportunity arises to replace equipment, or refit the operating room, protection against mercury exposure should play a major role in your decision-making process. Use the opportunity to question manufacturers about their own products and safety features.

Remember, it is in your interests to ensure that the occupational risk to health in your surgery is kept to a minimum.

MERCURY CONTAMINATION PATTERNS IN UK PRACTICES; 1990 SURVEY.

The author collaborated in a small-scale survey of mercury contamination in UK dental practices in 1990. Respondents supplied urine samples for analysis by the best available method (duplicate determination of mercury by atomic absorption spectrophotometry, expressed as micrograms per mg creatinine, checked by internal standard).

Each respondent also stated their role in the practice; dentist, assistant, hygienist or administrator/cleaner. Several distinct patterns of high urine levels were apparent, suggesting contamination for various specific reasons.

For example, in some practices a single high reading was found in isolation. This suggests operator error leading to skin absorption or inhalation of mercury and it is usually quite easy to find the reason, using systematic elimination of each factor as described above.

In the majority of practices, most members of the team had a low exposure, with one dentist and one DSA having a high urine mercury level. Most often, these two people worked together, suggesting either that the operating room may be contaminated (by, for example, mercury spilt behind a work unit or on a carpet), or that the DSA or dentist were using equipment or methods of practice which affected them both.

In one multi-surgery practice, the finding of moderately high levels of mercury throughout the staff prompted a thorough investigation into the ventilation system and cleaning practices. In theory, the newest member of the team should show a comparatively low urine level, under these circumstances, if they have only worked in the practice for a matter of months.

By using the Practice Assessment questionnaire in the GREY section of this manual which follows, the dentist in each case was able to identify and to take positive action to counter sources of mercury contamination in their own practice.

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