The amount of mercury in the wastewater of three dental clinics from United Arab Emirates over a period of 3 to 17 days was quantified using cold vapor-atomic absorption spectrometry technique. The total Hg concentration in the wastewater of these clinics ranged from 25 to 146 µg per day. The Hg concentration in the wastewater samples collected from the outlets of the dental chairs after dental treatments varies depending on the type of dental treatment: the average Hg concentration in the samples of only amalgam restoration is 39 µg per sample (std. dev. 37, range 4-142); for samples with amalgam restoration plus other types of dental treatment is 24 µg per sample (std. dev. 24, range <MDL-77); and for sample with no amalgam restoration is 18 µg per sample (std. dev. 16, range <MDL-55).

Introduction

Amalgam is the most commonly used dental filling material for more than 200 years (Arenholt-Bindslev & Larsen, 1996; Counter & Buchanan, 2004; Horsted-Bindslev, 2004). One of its major components, mercury, is of a particular concern due to its potential adverse effects on humans and the environment (Arenholt-Bindslev & Larsen, 1996; Counter & Buchanan, 2004; Horsted-Bindslev, 2004; Hylander & Goodsie, 2006). The estimated annual mercury consumption for dental applications is 5-4% worldwide (approximately 500 metric tons of mercury) (WHO, 1976; Mukherjee et al., 2004; Vandeveen & McGinnis, 2005). Even though the use of amalgam as a restorative material has declined recently, the removal of this material from patient's teeth and the subsequent discharge of it into the environment will continue as long as existing restorations remain in place and amalgam is continued to be used as a dental filling material. According to recent investigations, dental clinics appear to be responsible about appreciable amount (10-70%) of the daily mercury burden that has been released into the environment via sewage treatment plants (Hrummond et al., 2005, Adeghembs & Watson, 2004).

Mercury is known to bioaccumulate in fish and other living organisms and therefore can pose an environmental mercury burden on the entire food chain (Zhou & Wong, 2000; Berzas Nevado et al., 2005; Kennedy, 2005; Hylander & Goodsie, 2006). Among the groups that are directly exposed to mercury are the dentists and their patients, where significant increases in their plasma mercury concentration have been reported compared to those of control groups (Tezel et al., 2001; Harakeha et al., 2002; Jones et al., 2007; Zolfaghari et al., 2007). On the other hand, the public and the environment are indirectly exposed to this element via mercury emissions from incinera-

Analysis of Mercury in Wastewater of some Dental Clinics in United Arab Emirates

Sausan Al Kawas, Imad A. Abu-Yousef, Sofian Kanan, Mohamed El-Kishawii, Abubaker Siddique, Naser Abdo and Amjad Shraim
nated waste have been described in several countries. Current literature suggests that mercury emissions from dental clinics are reduced by an improved design of the wastewater discharge system, use of high-pressure water cleaning, and frequent replacement of amalgam separators and filters (Vandenave & Meunier, 2000; Drummond et al., 2004; Al-Khatib, 2004; Hylander et al., 2006; Hylander et al., 2006). For example, Arenholt-Bindslev et al. (1996) reported that the use of Hg separators has reduced the amount of Hg in dental clinics from 270 mg Hg per dentist per day (range 65–842) to only 55 mg Hg per dentist per day (range 12–99). As a result, many countries such as Switzerland, Germany and Denmark have introduced a mandatory installation of amalgam separators in dental clinics (Arenholt-Bindslev & Larsen, 1996; Arents-Holden & Larsen, 1996; Arents-Holden, 2004). Use of amalgam separators is still uncommon. Additionally, no data have been reported concerning the mercury burden in wastewater in UAE or other GCC countries. However, the results of this study will contribute to the efforts of the Ministry of Health in reducing the mercury concentration in the wastewater by implementing measures on handling and discharging of dental clinics’ mercury-containing waste.

Materials and Method

Equipment

An atomic absorption spectrometer (Spectra AA 220 FS, Varian) equipped with a gas generator (VG-77, Varian) and a T-shaped quartz absorption accessory (VGA-77, Varian) was used for the determination. The instrumental parameters are listed in Table 2.

Reagents and Solutions

All chemicals were of analytical grade. Nitric acid, hydrogen peroxide, and hydrochloric acid were purchased from Panreac Quimica (Barcelona-Spain), sulfuric acid (GHB, 99.5%), sodium chloride (GHB, 99.5%), and sodium carbonate (GHB, 99.5%) were purchased from Merck (Darmstadt, D.F., Germany). All plastic and glassware was soaked in 4 M nitric acid for a minimum of 12 h before use.

Hydroxylamine hydrochloride was added if the eluate of 15 min. after the 1st treatment was found to be enough to complete the digestion. Water was added to each sample of the 3rd category after filtration using Schleicher & Schuell filter papers (5 µm) to a volume of 100 mL. All calibration solutions, blanks, and CRM have been treated in the same way. Total mercury determination was carried using Cold Vapo-Absorption Spectrometry. The instrumental parameters are listed in Table 4 (for details of necessary parameters).

To ensure that the obtained results are of high quality, several quality control measures have been undertaken. The accuracy of the results could be confirmed by "calibration verification check" (CVC) concept, where a 20.0 and 50.0 µg/L Hg solutions were prepared from the stock standard solution but using different working solutions from those used to construct the calibration curves. Results of these CVCs, as shown in Table 3, are 20.0 and 50.0 µg/L Hg solutions were taken from those used to construct the calibration curves. Results of these CVCs, as shown in Table 3, are 20.0 and 50.0 µg/L Hg solutions were taken from Table 3.

Table 2. Mean concentration (µg/L) and range of Hg mass in samples collected from various clinics in UAE along with the type of treatment undertaken.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Type of treatment</th>
<th>Hg concentration, µg/L</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>amalgam restoration</td>
<td>25.8</td>
<td>20-28</td>
</tr>
</tbody>
</table>


