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ABSTRACT

Dental amalgam is 50% metallic mercury (Hg^0) by weight and causes Hg exposure. The first assessment of Hg exposure and risk from dental amalgam in Canada was published in 1996. Recent data provided the opportunity to update that assessment. During the Canadian Health Measures Survey (CHMS; 2007 to 2009) the number of tooth surfaces specifically restored with dental amalgam was recorded. Data were also collected on the concentration of Hg in urine of survey participants. These data were employed to determine Hg exposures in the Canadian population. Also determined was the number of amalgam-restored tooth surfaces that would not result in exposure exceeding the dose associated with Canada's reference exposure level (REL) for Hg^0. Based on the CHMS data, 17.7 million Canadians aged $\geq$ 6 years collectively carry 191.1 million amalgam surfaces, representing 76.4 million amalgam-restored teeth. Average Hg exposures were: Children -- 0.065 μg Hg/kg-day; Teens -- 0.032 μg/kg-day; Adults -- 0.033 μg/kg-day; and Seniors -- 0.041 μg/kg-day. Of Canadians with dental amalgam restorations, 80.4% experience a daily dose of Hg that exceeds the Canadian REL-associated dose. The number of amalgam surfaces that will not result in exceeding the REL-associated dose varied from 2 amalgam surfaces (children, both sexes) to 7 surfaces (adult males).

Key Words

mercury, exposure, risk, dental amalgam, Canada.

INTRODUCTION

Dental amalgam restorations (also known as 'silver' fillings) are approximately 50% metallic mercury (Hg^0) by weight and are still a common dental filling material used in Canada. An assessment of mercury (Hg) exposure and risks from dental amalgam was completed for Canada in 1995 (Richardson and Allan 1996; also released as Health Canada 1995a). Dental amalgam fillings are a major source of Hg exposure in Canada, compared to food (including fish), indoor and outdoor air, drinking water and soil (Health Canada 1996, 1995a; Richardson and Allan 1996; Richardson *et al.* 1995). The primary route of exposure to Hg from amalgam is via inhalation of Hg^0 vapor emanating from in-place amalgam fillings (Richardson *et al.* 2011; USFDA 2009; Richardson and Allan 1996; Health Canada 1995a; WHO 1991). Increasing

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dental amalgam load has been associated with altered urinary porphyrin profiles indicative of alteration of the heme synthesis pathway (Geier *et al*. 2011; Woods *et al*. 2012).

Maternal amalgam fillings also result in exposure of the fetus, as well as exposure to infants via breast feeding (Palkovicova *et al*. 2008; Ursinyova *et al*. 2006; Luglie *et al*. 2005; Ask-Bjornberg *et al*. 2003, 2005; Lindow *et al*. 2003; Ask *et al*. 2002; Vahter *et al*. 2000; Lutz *et al*. 1996; Drasch *et al*. 1994, 1998; Da Costa *et al*. 2005; Drexler and Schaller 1998; Oskarsson *et al*. 1996).

The previous assessment of Canadian population Hg exposure and risks from dental amalgam determined that daily Hg exposure from amalgam ranged between 0.031 μg/kg bodyweight per day and 0.05 μg/kg bodyweight per day (Richardson and Allan 1996), with each amalgam-filled tooth (which average 2.5 filled surfaces per filled tooth) delivering an estimated daily dose of approximately 0.22 μg Hg^0/day. That 1995 Canadian assessment relied on unpublished population data of decayed, missing, and filled teeth (DMFT), collected during Health Canada's Nutrition Canada Survey (NCS; 1970 to 1972), in combination with the simple assumption that all in-place fillings were composed of amalgam, an assumption considered reasonable at that time.

Use of amalgam in Canada is declining (Nicolae 2010), and recent data on the frequency of amalgam dental restorations are now available for the Canadian population. Between 2007 and 2009, Health Canada and Statistics Canada conducted the Canadian Health Measures Survey (CHMS; see Statistics Canada 2011a,b; Health Canada 2010a,b), a statistically representative population survey of 5,604 Canadians aged 6 years to 79 years. Unique to this survey was the collection of data for survey participants of the number of tooth surfaces that were specifically restored with dental amalgam. This is the first North American population-based survey to specifically quantify the dental amalgam load. Although the U.S. National Health and Nutrition Examination Surveys (NHANES) of 2001 to 2004 compiled data on the number of restored tooth surfaces, NHANES did not differentiate or identify the specific restorative materials present (discussed by Richardson *et al*. 2011). Given this recent quantitative data on the amalgam load in individuals of a representative Canadian survey, and the noted declining use of amalgam in this country, it was considered important to update the assessment of Canadian population exposure to Hg from dental amalgam.

The CHMS is further unique because urine analysis for Hg concentration (UHg) was conducted, the results of which provide a direct measure of the incremental increase in UHg per amalgam-filled tooth surface (*i.e.*, the slope of the regression of UHg on amalgam surface count). Within the CHMS, of the total sample of 5,604 Canadians surveyed, 97.1% provided urine samples for quantification of UHg, of which 2,737 were ≥ the minimum quantifiable amount (0.03025 nmol Hg/mmol creatinine) (Statistics Canada 2011c). Numerous smaller studies have demonstrated that Hg concentration increases in urine as amalgam load increases (discussed and reviewed by Richardson *et al*. 2011). A preliminary tabulation summary of CHMS data on UHg as a function of amalgam surface count was provided by Nicolae (2010), which is presented graphically in Figure 1.

Employing data provided by the CHMS, the purpose of this paper was to update the assessment of exposure to and risks from Hg^0 from dental amalgam in the Canadian population. This paper does not address exposure to methyl Hg that may result from the methylation of amalgam-related Hg in the oral cavity or gastrointestinal tract (Summers 2010; Leistevuo *et al*. 2001; Heintze *et al*. 1983; Rowland *et al*. 1975). Nor does this study quantify exposures to silver and other metals that are mixed with Hg^0 to create amalgam.

METHODS

The CHMS dataset was accessed via the secure data portal available through the Saskatchewan Research Data Centre (SKY RDC; University of Saskatchewan, Saskatoon, SK, Canada). Basic information on this survey is presented in Table 1. Statistics and analyses were prepared using Excel 2007® (Microsoft Corp. 2007), including the Data Analysis ToolPak®.

Methods of CHMS data collection will not be repeated herein. Methodological details are available from Statistics Canada (2011b). Details on the oral health component are also available from Health Canada (2010b). CHMS methods were also summarized by Nicolae (2010).

The focus herein was to determine the exposure to Hg from dental amalgam among participants of the CHMS, and then to extrapolate those results to the Canadian population ≥ 6 years of age, employing statistical weighting factors — the number of Canadians that each survey participant represents — provided with the CHMS data. Subsequently, the number of Canadians expected to exceed the dose associated with the Canadian chronic reference exposure level (REL) for Hg^0 was quantified, as well as the number of amalgam-filled tooth surfaces that should not, on average, result in exceeding the dose associated with that Canadian REL.

Survey participants were grouped into the following age groups, consistent with risk assessment practice in Canada (see Health Canada 2004):

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- Children aged 6 to 11 years;
- Teens aged 12 to 19 years;
- Adults aged 20 to 64 years; and
- Seniors aged ≥ 65 years.

Health Canada (2004) defines Adults as up to 59 years of age, and Seniors as ≥ 60 years of age. However, this was altered herein to match the institutional definition of the Senior age category in Canada (see Turcotte and Schellenberg 2006).

General Approach to Exposure Assessment

Chronic exposure to Hg^0 from dental amalgam results in a steady state where daily uptake and total daily excretion (via urine + faeces) of Hg can be considered to be in equilibrium (Weiner and Nylander 1995; Rothstein and Hayes 1964). Therefore, determining the total daily amount of Hg excreted as a result of the presence of dental amalgam equates to the daily dose from that source. Hg doses were derived for each participant of the CHMS according to the methods applied by Richardson *et al*. (2011) for the U.S. population. In general terms:

1. The incremental Hg concentration in urine was determined as a function of each person's number of amalgam-filled tooth surfaces (μg Hg/g creatinine/surface x number of surfaces). CHMS data on UHg in units of nmol Hg/mmol creatinine were converted to μg Hg/g creatinine prior to analysis.

2. The total Hg excreted via the urine in 24 hours was determined by multiplying the Hg concentration in urine due to amalgam (as µg Hg/g creatinine) by the amount (grams) of creatinine excreted in urine over 24 hours.
3. The total daily absorbed dose of Hg from amalgam was then determined by dividing the total amount of Hg from amalgam excreted in urine by the proportion of total daily Hg excretion that occurs via the urine pathway alone, thus accounting for excretion via both urine and faeces.

Steps 1 to 3 above are represented by the following equations:

$$UHg_{Incremental} = N * B \quad (1)$$

where $UHg_{Incremental}$ = incremental urinary Hg concentration (µg Hg/g creatinine) that is due to the presence of amalgam-filled tooth surfaces; N = number of amalgam-filled tooth surfaces, B = increase in UHg per amalgam-filled surface ([µg Hg/g creatinine]/surface),

$$UHg_{Excreted} = UHg_{Incremental} * CCR * BW \quad (2)$$

where $UHg_{Excreted}$ = Hg excreted via urine in 24 hours (µg Hg/day), CCR = creatinine clearance rate, creatinine excreted per kg bodyweight in 24 hours, (g creatinine/kg-day), BW = bodyweight (kg)

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$$Hg_{Absorbed} = UHg_{Excreted} / (P*BW) \quad (3)$$

where $Hg_{Absorbed}$ = Total Hg absorbed in 24 hours (μg/kg-day), P = proportion of total Hg excretion via urine (unitless).

Finally, combining Equations 1 to 3:

$$Hg_{Absorbed}(\mu g/kg\text{-}day) = [N * B * CCR]/ P \quad (4)$$

To define the number of amalgam-filled tooth surfaces that should not, on average, result in exceeding the dose associated with the Canadian REL for Hg^0, Equation 4 can be re-arranged to solve for N (number of amalgam surfaces) when $Hg_{Absorbed}$ is set equal to the REL dose, as follows:

$$N = Dose_{REL} \times P/[B \times CCR] \quad (5)$$

where $Dose_{REL}$ = the absorbed dose (μg/kg-day) associated with the Canadian REL for Hg^0 of 0.06 $\mu g/m^3$

Defining Values for Exposure Variables in Equations 1 through 5

Data recorded during the CHMS specifically included the number of amalgam surfaces in each survey participant, their gender, bodyweight and age. The CHMS data permitted the direct determination of variable B, the incremental increase in UHg per amalgam surface; this variable is the slope of the linear regression of UHg (as µg Hg/g creatinine) on individuals' amalgam surface count. This linear regression was conducted separately for males and females of each age group. The slopes of these regressions were employed to define variable B uniquely for each gender group within each age category. Values (± standard error) of B were:

- Female children: 0.056 (±0.005) µg Hg/g creatinine/amalgam surface (R^2 = 0.43);
- male children: 0.053 (±0.005) µg Hg/g creatinine/amalgam surface (R^2 = 0.40);
- female teens: 0.047 (±0.004) µg Hg/g creatinine/amalgam surface (R^2 = 0.43);
- male teens: 0.022 (±0.002) µg Hg/g creatinine/amalgam surface (R^2 = 0.37);
- female adults: 0.025 (±0.001) µg Hg/g creatinine/amalgam surface (R^2 = 0.32);
- male adults: 0.015 (±0.001) µg Hg/g creatinine/amalgam surface (R^2 = 0.17);
- female seniors: 0.025 (±0.003) µg Hg/g creatinine/amalgam surface (R^2 = 0.29); and
- male seniors: 0.019 (±0.002) µg Hg/g creatinine/amalgam surface (R^2 = 0.36).

All regressions were linear and all slopes were significant at $p \ll 0.0001$.

Fish consumption, resulting in exposure to methyl Hg, also influences UHg concentration, likely due to the metabolic demethylation of methyl Hg in the body with subsequent excretion of the resulting inorganic Hg via the kidneys (ATSDR 1999). However, this influence is small relative to, and less statistically significant than, the influence of amalgam fillings on UHg (Levy *et al*. 2004; Link *et al* 2007; Jarosinska *et al*. 2008). Confounding of variable B by fish consumption is not anticipated since variable B specifically quantifies the incremental increase in UHg associated with the presence of amalgam surfaces, and it can be assumed that the rate, range, and variability of fish consumption are not dependent on or associated with increasing amalgam load in any given age and gender group; *i.e.*, for each age and gender group, it can be assumed that fish consumption does not increase as the number of amalgam surfaces increases.

Variable CCR, daily creatinine clearance rate, is proportional to body mass (Welle *et al*. 1996; Wang *et al*. 1996). Twenty-four hour creatinine clearance rates range between 0.015 and 0.025 g/kg bodyweight (Thomas 1993). For the present study, the value for variable CCR was defined randomly between the minimum and maximum from Thomas (1993), independently for each participant of the CHMS. This method was applied equally to males and females, and for all age groups. This randomization approach was considered better than simply assuming that everyone had the same creatinine clearance rate (such as the maximum value of 0.025 g/kg-day, for example), since creatinine clearance varies between individuals.

Variable P, the proportion of total daily Hg excretion via urine, provides the basis for determining total combined excretion of Hg from amalgam via urine + faeces. In other words:

$$\text{Total Hg excretion} = [\text{urinary excretion}] / P \qquad (6)$$

Hg excreted via the urine, as a proportion of total excretion, increases as Hg dose increases (Rothstein and Hayes 1960, 1964; Cember 1962; Morcillo and Santamaria 1995). At the low dose associated with a single amalgam surface, 10% of Hg excretion occurs via the urine (*i.e.*, variable P = 0.1), with this increasing to 40% (0.4) for a daily Hg dose associated with all (or most) teeth being restored with amalgam. The maximum number of restored tooth surfaces observed for the U.S. population was 128 (Richardson *et al*. 2011), which would be associated with a urinary excretion rate of 40% (see Richardson *et al*. (2011) and Richardson (1999) for more details). The proportional excretion of amalgam Hg in urine can then be derived as a function of the specific number of amalgam surfaces, as follows:

$$P = 0.1 + [(N - 1) \times 0.00236] \quad (7)$$

where P = proportion of total Hg excretion via urine (unitless); and N = number of amalgam-filled tooth surfaces.

RESULTS

Of the total population of 27,642,167 Canadians aged 6 years and older represented by the CHMS, 63.95% of this population possesses one or more amalgam-restored tooth surfaces (Table 1). Canadians with amalgam fillings collectively carry 191.1 million amalgam surfaces, representing 76.4 million amalgam-restored teeth (2.5 restored surfaces on average per amalgam-filled tooth; Richardson *et al*. 2011).

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Estimated Hg exposures for the Canadian population, resulting from the presence of amalgam fillings in their teeth, are summarized in Table 2. Of the 17.7 million Canadians aged 6 years and older that possess one or more amalgam-filled tooth surfaces, 14.2 million (80.4%) exceed the Hg dose of 0.011 μg/kg-day that is associated with the Canadian chronic REL for Hg^0 (REL = 0.06 μg Hg^0/m^3; Health Canada 2008; Richardson *et al*. 2009). See footnotes to Table 2 for derivation of the REL-associated dose.

The numbers of amalgam-filled tooth surfaces that will not exceed the Hg dose associated with the Canadian REL are presented in Table 3. Values are listed separately for females and males of each age group, owing to the different value of B (incremental increase in UHg per amalgam surface) used in Equation 4 for each age group and gender combination. Children can have 2 amalgam surfaces, male teens up to 5 surfaces, adult males up to 7 surfaces and senior males up to 6 amalgam surfaces before exceeding, on average, the REL-associated Hg^0 dose. The allowable number of amalgam surfaces in females is lower than that for males in all age groups.

DISCUSSION

Lowest Reported Increases in Urine Hg per Amalgam Surface

CHMS data demonstrated that UHg in Canadians increases as amalgam load increases (Figure 1), consistent with other investigations of UHg as a function of the number of amalgam-filled tooth surfaces (Geier *et al*. 2012; earlier studies reviewed by Richardson *et al*. 2011). The incremental increases in UHg per amalgam surface (variable B, above) employed for exposure calculations herein were lower than other reported values; previous studies indicated a value of B between 0.08 and 0.09 µg Hg/g creatinine/surface for persons ≤ 18 years of age, and between 0.06 and 0.07 µg Hg/g creatinine/surface for those > 18 years of age. The maximum value of B determined from the CHMS data was 0.056 µg Hg/g creatinine/surface (female children), with B declining to as low as 0.015 µg Hg/g creatinine/surface for adult males. The values used herein, being lower than those reported in other literature, significantly reduce the likelihood of over-estimating Hg exposures for the Canadian population; exposures would have been up to 4 times greater for some age/gender groups if literature values for variable B had been used.

Accuracy of Exposure Estimates

The results presented herein represent a significant improvement in accuracy and reliability of exposure estimates, compared to the 1995 Canadian assessment of Hg exposure and risks from dental amalgam. This improvement in accuracy and reliability is due to the following factors:

- Significantly greater supporting data provided by the CHMS, including the direct measurement of the number of amalgam surfaces, bodyweight and age.
- The application of age/gender group-specific increases in UHg per amalgam-filled tooth surface, determined directly from the CHMS data.
- The ability to accurately extrapolate to the entire general population by application of statistical weighting factors provided with the CHMS data.

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Canadian Hg Exposures from Amalgam Relative to other RELs

The reference exposure level employed herein for risk characterization (REL = 0.06 μg/m^3; REL-associated dose = 0.011 μg/kg-day) was developed in Canada following Canadian practices for regulatory toxicology (see Richardson *et al*. 2009). However, Canada is not the only jurisdiction to establish a reference exposure level for Hg vapor. Others include:

- California EPA (2008): REL = 0.03 μg/m^3; REL-associated dose = 0.005 μg/kg-day
- WHO (2003): REL = 0.2 μg/m^3; REL-associated dose = 0.036 μg/kg-day
- USEPA (1995): REL = 0.3 μg/m^3; REL-associated dose = 0.054 μg/kg-day

(REL-associated doses derived as per footnote to Table 2)

Virtually 100% of Canadians exceed the Hg dose associated with the REL published by the California EPA. Obviously, fewer exceed the doses associated with the RELs of the U.S. Environmental Protection Agency (USEPA) and the World Health Organization (WHO). It is noteworthy that average Hg exposure from amalgam in Canadian children exceeds the USEPA and WHO RELs. All of these agencies have defined their REL from the same basic toxicology and key study (discussed by Richardson *et al*. 2009) and, therefore, the numeric differences in the REL values among these agencies are due to differences in policy and practice rather than science; differences particularly reflect variation in the uncertainty factors and modifying factors applied in deriving the RELs. As a result, it was considered most appropriate to characterize the

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risks of Hg exposure from amalgam in Canada employing the Canadian REL, thereby considering the policies and practices of regulatory toxicology in this country.

Regulation and Management of Chemical Exposures that Exceed RELs

The proportion of the Canadian population predicted to exceed the REL-associated dose for Hg^0 due to dental amalgam is large, and would not generally be supported or permitted by regulation for other sources of Hg exposure. RELs are important in the context of the risk assessment and risk management of chemical exposures, and environmental regulation. For example, all provinces as well as the federal government in Canada require measures to reduce exposure and risk where chemical exposures from sources such as contaminated sites exceed published RELs. The *Guidelines for Canadian Drinking Water Quality*, which are used to regulate municipal drinking water quality across the country, are derived to deliver a dose via tap water consumption that does not exceed Canadian RELs (Health Canada 1995b).

The previous assessment by Health Canada (Richardson and Allan 1996) employed Canadian dental health data collected between 1970 and 1972 and assumed that all in-place fillings were composed of dental amalgam. The trend in dental care since that time has been away from dental amalgam and towards aesthetic (tooth-colored) dental restorative materials. Nicolae (2010) reported that between 2000 and 2010, the placement of dental amalgam had declined by 50% or more, while the placement of composite resin fillings had at least doubled. A similar trend is underway in the United States (Beazoglou *et al*. 2007). However, the rate of placement of amalgam does not translate immediately to reduced amalgam load or reduced Hg exposure. The service life of an amalgam filling, prior to needing replacement, can extend over decades (Opdam *et al*. 2010; Sunnegårdh-Grönberg *et al.* 2009; Käkilehto *et al*. 2009).

The amount of amalgam still being carried in the teeth of the Canadian population is high; reportable in metric tonnes. A typical amalgam-filled tooth (from 1 to 5 filled surfaces) contains approximately 1 gram of amalgam (Reinhardt *et al*. 1983) and, therefore, 500 mg of Hg. With the Canadian population aged ≥ 6 years possessing a total of 76.4 million amalgam-restored teeth, the total mass of Hg carried in those teeth is approximately 38 metric tonnes. This amalgam will continue to contribute Hg to municipal wastewater systems through excretion in urine and feces, ultimately contributing Hg to Canadian surface waters, landfills, and the atmosphere (Van Boom *et al*. 2003) for the foreseeable future. Atmospheric emissions due to cremation of cadavers possessing amalgam restorations will also continue (Mari and Domingo 2010; OSPAR Commission 2003; AMAP/UNEP 2008.), particularly with the rate of cremation in Canada, as a funeral option, nearing 60% (NFPA 2012) and its popularity steadily rising in North America (CANA 2008).

However, it is apparent from the decline in amalgam placement, and increase in use of composite resins (and likely other alternate materials) (Nicolae 2010; Beazoglou *et al*. 2007), that viable alternative (non-Hg) restorative materials exist and reliance on dental amalgam for the restoration of carious teeth is no longer necessary or essential. Perhaps the current efforts by the United Nations Environment Programme (UNEP 2009) to negotiate a global treaty to eliminate industrial and commercial uses of Hg, negotiations that include dental amalgam, in combination with the increasing preference for tooth-colored dental restorative materials, will lead to regulatory reconsideration of the 'essentiality' of dental amalgam (see GOC 2011) as a dental restorative material in Canada.

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Figure 1. Geometric mean concentration of Hg in urine as a function of age group and range of amalgam-filled tooth surfaces. Age group data for sexes combined. Error bars represent the 95% upper confidence limit on the geometric mean. Data transcribed from Nicolae (2010: Appendices Tables 1B through 5B).

Table 1. Summary information on the CHMS, Cycle 1 (2007--2009).

Age group	Gender	Age range	Percent of those surveyed with completed	Number of amalgam surfaces	Population with no amalgam	Population with ≥ 1 amalgam tooth surface	Average number of amalgam surfaces for population

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			completed oral health exams				population with ≥ 1 surface
		Years	%	N: Range	N	N	N
Children	Female	6 to 11	99.6%	0--27	779318	282545	7.4
	Male		99.4%	0--29	788700	307667	6.8
Teens	Female	12 to 19	99.4%	0--36	1153007	456662	5.3
	Male		99.6%	0--26	1269497	438016	5.0
Adults	Female	20 to 64	95.7%	0--53	2600199	7375678	11.2
	Male		95.9%	0--60	2813288	7083477	10.9
Seniors	Female	≥ 65	71.6%	0--47	284813	909582	13.5
	Male		73.8%	0--64	277234	822485	12.9
Totals					9,966,056	17,676,111	

Table 2. Numbers of Canadians with amalgam that exceed the dose associated with the Canadian reference exposure level for Hg^0.

Age group	Age range	Population with amalgam and Hg exposure ≤ REL dose[a]	Population with amalgam and Hg exposure > REL dose[a]	Mean Hg Dose from amalgam
	Years	N	N	µg/kg-day
Children	6 to 11	30,028	560,184	0.065

Teens	12 to 19	283,370	611,308	0.032
Adults	20 to 64	2,889,037	11,570,117	0.033
Seniors	≥ 65	256,712	1,475,355	0.041
Totals		3,459,147	14,216,964	

a. REL = 0.06 μgHg^0/m^3; REL-equivalent dose calculated as: 0.06 μgHg^0/m^3 *15.8 m^3/day*80% Hg^0 absorbed÷70.7 kg adult bodyweight; average bodyweight and inhalation rate from Health Canada (2004); Hg^0 absorption rate after WHO (1991); REL-associated dose derived using adult characteristics (as per USEPA 2004) as all toxicological data underlying RELs for Hg^0 is based on studies of adults.

Table 3. Safe numbers of amalgam-filled tooth surfaces (N), that will not result, on average, in exceeding the REL-equivalent dose of Hg^0.

Age Group	Gender	REL dose	P[a]	B[b]	CCR[c]	N[d]
		µg/kg-day		µg Hg/g creatinine/surface	g creatinine/kg-day	
Children	Female	0.011	0.15	0.056	0.015	2.0
	Male	0.011	0.15	0.053	0.015	2.1

Teens	Female	0.011	0.15	0.047	0.015	2.3
	Male	0.011	0.15	0.022	0.015	5.0
Adults	Female	0.011	0.15	0.025	0.015	4.4
	Male	0.011	0.15	0.015	0.015	7.3
Seniors	Female	0.011	0.15	0.025	0.015	4.4
	Male	0.011	0.15	0.019	0.015	5.8

a. P = assumed proportion of total daily Hg excretion via urine; B = incremental increase in UHg per amalgam surface; CCR = assumed daily (24 hour) creatinine clearance rate in urine; N = number of amalgam surfaces not causing exceedence of Hg REL dose.

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