Commentary
Emission accomplished: formal and informal mercury sources in South Africa

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Mercury (Hg) is a naturally occurring element that is present in air, water and soil. It exists in three main forms namely elemental mercury, inorganic mercury compounds and organic mercury compounds (WHO, 2007). The atmosphere is the leading transport pathway of mercury emissions, while land and ocean processes maintain a central role in mercury redistribution among terrestrial, marine and freshwater ecosystems (Driscoll et al., 2013). The biogeochemical cycling of mercury is complex, comprising various transport and transformation progressions that define the fate of mercury and the health risks on ecosystem and humans (Liu et al., 2011).

Mercury is an obstinate pollutant that bio-accumulates and biomagnifies across trophic levels (Kidd et al., 2012). Akin to only a few metal elements, it amasses through food webs to quantities that are conspicuously higher in upper trophic level organisms compared with primary producers or consumers (Kidd et al., 2012). Numerous pathways exist for human mercury exposure including through air, food, water, pharmaceuticals and cosmetics (Williams et al., 2011). The form of mercury determines the route of exposure, absorption, distribution and target organ toxicity (Park and Zheng, 2012) and human exposure to mercury can result in numerous acute and chronic manifestations including neurological problems (Bose-O'Reilly et al., 2010; Schmidt, 2012). Methylmercury, which passes more readily into the brain, is commonly considered the more toxic species, predominantly among children (Schmidt, 2012; Zillioux, 2015). Consumption of methylmercury-contaminated fish is the main route of exposure to organic mercury (Holmes et al., 2009). Conversely, this poses a public health challenge because fish are highly nutritious with substantial health benefits (Mergler et al., 2007). Furthermore, fish are culturally important for many societies and create an essential global commodity (Mergler et al., 2007).

Currently, anthropological activities account for approximately 30% of the total mercury entering the atmosphere annually (UNEP, 2013). In 2001, the United Nations Environmental Programme (UNEP) commissioned a global assessment of mercury in response to mounting concern regarding mercury emissions as well as unremitting mercury poisoning incidence reports (Dabrowski et al., 2008; DEA, 2011). The assessment, in the form of country-specific inventories, quantifies mercury emissions from several sources (Dabrowski et al., 2008). The most recent global mercury inventory has identified the role of artisanal and small-scale gold mining (ASGM) and coal burning as the largest constituents of anthropogenic emissions, tailed by the production of ferrous and non-ferrous metals, and cement production (UNEP, 2013). In a global response to phase out mercury, the Minamata Convention on Mercury was adopted in Japan in October 2013. Minamata disease is caused by mercury toxicity and results in extreme neurological damage (Larson, 2013). Hence the name and locality of the Convention is indeed apt in memory of the first case of Minamata disease identified nearly six decades earlier (Sharma, 2014). According to Selin (2014), the Convention is a key addition to the patchy treaty landscape on hazardous substances.

In keeping with global trends and efforts, high quality, continuous mercury monitoring is now underway in South Africa (UNEP 2013). Global patterns have identified South Africa among the countries with the highest levels of elemental mercury in the air (UNEP 2013). The South African mercury inventory, completed in 2011, flagged the key anthropogenic mercury sources as coal combustion, crude oil, ferrous and non-ferrous metals, artisanal mining and consumer products. In response to high mercury emissions from coal combustion, South Africa has recently made inroads into mercury characterization of coal and coal combustion products. This will inform best practices regarding air pollution control devices and/or coal-washing (Kolker et al., 2014). Unintentional mercury emissions from similar sectors such as mining, smelting, and production of iron and non-ferrous metals, cement product and oil refining can also be reduced with the use of pollution control measures at power stations and industrial plants (UNEP, 2013). However, this will depend on scientific aptitude and political will, both of which are complex and interrelated (Selin 2005).

Arguably, the more challenging mercury exposure sources to tackle are those from the informal sectors. South African examples include (but are not limited to) illegal mining operations, socio-cultural and ritualistic practices and the use of prohibited cosmetics. The poverty-driven ASGM industry is on the increase in many low- and middle income countries largely due to the rising gold price (Basu et al., 2015). Elemental mercury is used to extract gold from ore by forming "amalgam", a mixture comprising roughly one part mercury to one part gold (Gibb and O'Leary, 2014). Despite the fact that the miners and those involved in the trade may be exposed to dangerous levels of elemental mercury vapour, data on health outcomes are scarce and little is known about linkage to healthcare (Gibb and O'Leary, 2014; Basu et al., 2015). With an association of illegality, 'Zama-Zama' is the colloquial South African name for 'artisanal' gold miners (Nhlengetwa and Hein, 2015). According to the Chamber of Mines (2015), the value of illegal gold mining is up to 10% of annual South African gold production which in 2013 was over R72 billion. However, in line with the global trend, the occupational and environmental hazards associated with the informal ASGM trade in South Africa remain largely undocumented.

In order to reduce mercury-related diseases, the World Health Organization (WHO) has accentuated the need to identify traditional practices involving mercury. Up until recently, socio-cultural use of mercury in South Africa was merely anecdotal. So much so, that in the South African mercury inventory the response to the question on mercury use in traditional medicine was that the practice is non-existent (DEA, 2011). However, newly published research on mercury use in South African traditional medicine revealed that 39% (n=78) of traditional health practitioners (THPs) stated that they administer mercury (*isigidi*) for healing purposes (Street et al., 2015). Moreover, this finding is cumulative with 95% of the mercury-using THPs stating that they learnt how to use it from companion THPs (Street et al., 2015). This is of concern in a country with approximately 27 million consumers of traditional medicine (Mander et al., 2007).

A third example of a locally-threatening mercury source is that of the cosmetics industry's informal sector. Mercury is a common ingredient found in skin lightening products in the form of creams and soaps (WHO, 2011). Mercury-containing skin lightening cosmetics are available locally to meet the demands of the South African population (Dlova et al., 2012). A recent cross-sectional study revealed that from six hundred African and Indian women residing in South Africa, 33% used skin lightening products (Dlova et al., 2015). Hence, according to the South African mercury inventory of 2011, women using skin lightening creams and soaps have been identified as vulnerable populations. Stronger regulations and restrictions need to be imposed on readily accessible cosmetics (Dlova et al. 2012), especially those available at informal trading sites.

Despite having identified potential sources of mercury, the extent of mercury exposure in local South African communities remains largely unknown (Oosthuizen et al., 2010). Much directed and interdisciplinary work is needed in order to document, regulate and remedy the locally-relevant mercury-emitting activities. Nonetheless, each implemented change is bound to have its own repercussions, with 'one risk traded for another' (Larson, 2013). In South Africa, community mobilization is vital in order to reach the ultimate goal, namely to protect human health and the environment from the adverse effects of mercury.

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