

Abstract

Healthcare wastes contain potentially harmful microorganisms, inorganic and organic compounds that pose a risk to human health and the environment. Incineration is a common method employed in healthcare waste management to reduce volume, quantity, toxicity as well as elimination of microorganisms. However, some of the substances remain unchanged during incineration and become part of bottom ash, such as heavy metals and persistent organic pollutants. Monitoring of pollution by heavy metals is important since their concentrations in the environment affect public health. The goal of this study was to determine the levels of Copper (Cu), Zinc (Zn) Lead (Pb), Cadmium (Cd) and Nickel (Ni) in the incinerator bottom ash in five selected County hospitals in Kenya. Bottom ash samples were collected over a period of six months. Sample preparation and treatment were done using standard methods. Analysis of the heavy metals were done using atomic absorption spectrophotometer, model AA-6200. One-Way Analysis of Variance (ANOVA) was performed to determine whether there were significant differences on the mean levels of Cu, Zn, Pb, Cd and Ni in incinerator bottom ash from the five sampling locations. A post-hoc Tukey's Test (HSD) was used to determine if there were significant differences between and within samples. The significant differences were accepted at $p \leq 0.05$. To standardize the results, overall mean of each metal from each site was calculated. The metal mean concentration values were compared with existing permissible levels set by the WHO. The concentrations (mg/kg) were in the range of 102.27 - 192.53 for Cu, Zn (131.68 - 2840.85), Pb (41.06 - 303.96), Cd (1.92 - 20.49) whereas Ni was (13.83 - 38.27) with a mean of 150.76 ± 77.88 for Copper, 131.66 ± 1598.95 for Zinc, 234.60 ± 262.76 for Lead, 12.256 ± 10.86 for Cadmium and 29.45 ± 18.24 for Nickel across the five sampling locations. There were significant differences between levels determined by one-way ANOVA of Zn ($F(4, 25) = 6.893, p = 0.001, p \leq 0.05$) and Cd ($F(4, 25) = 5.641, p = 0.02$) and none with Cu ($F(4, 25) = 1.405, p = 0.261, p \leq 0.05$), Pb ($F(4, 25) = 1.073, p = 0.391, p \leq 0.05$) and Ni ($F(4, 25) = 2.492, p = 0.069$). Results reveal that metal content in all samples exceed the WHO permissible levels for Cu (100 mg/kg), while those for Ni were below the WHO set standards of 50 mg/kg. Levels of Zn in three hospitals exceeded permissible level of 300 mg/kg while level of Pb exceeded WHO set standards of 100 mg/kg in two hospitals. Samples from four hospitals exceeded permissible level for Cd of 3 mg/kg. This study provides evidence that incinerator bottom ash is contaminated with toxic heavy metals to human health and the environment. This study recommends that hospitals should handle the bottom ash as hazardous

wastes and there is need to train and provide appropriate personal protective equipment to healthcare workers, waste handlers, and incinerator operators and enforce compliance to existing regulation and guidelines on healthcare waste management to safeguard the environment and human health.