This study (16) concludes 2,5-TDA was detectable in 39 of the hairdressers. Two controls also had elevated 2,5-TDA in urine samples, however they used personal hair dye more than 4 days before they provided urine samples which shows elimination may take more than 4 days. P-PDA was detectable in urine samples of four hairdressers. Also, use of gloves was found to have no influence on internal exposure of hairdressers.

30.3.4 Study 4

Nohynek et al. (2015) (17) measured systemic exposure after hair dyeing with oxidative hair dyes containing 2.0 or 1.0% [14C]-PPD in humans. This study is the first complete investigation of absorption, plasma kinetics, metabolism, and excretion of oxidative hair dyes in humans following a hair coloring procedure under conditions of a hairdresser salon.

Studies A (2.0% PPD) and B (1.0% PPD) used PPD with radioactivities of 4.40 or 4.44 GBq/mmol with a radiochemical purity of 97.6 or 98.7%, respectively. PPD concentration at application was 2.0% in study A after mixing the contents of the two bottles. PPD concentration at application was 1.0% in study B, after mixing the contents of the two bottles. In study A, the mean amount of PPD applied was 1.20 ± 0.16 g (0.86 to 1.41 g). In study B, the mean amount was 0.65 ± 0.11 g (0.45–0.95 g).

Thirty-two subjects, aged 20–34 years, 4 females and 28 males, participated in this study. Subjects had a similar approximate hair length of 5 cm.

Participants were divided into four groups with four people per group for each study. Over the course of a 3-day period, each group completed hair dye application and biological sampling. Radioactivity was measured in two samples of 200 µl by scintillation counting. Mean quantity of radioactivity in the four vials used in each study was 16.9 (range: 15.0–18.5) MBq for Study A and 26.0 (range: 24.6–27.4) MBq for study B. Hairdressers used their professional judgment along with the hair length and density of each subject to determine the amount of hair dye individually applied. The oxidative hair dye (30–50 g) with either 4% PPD (Study A) or 2% PPD (Study B) was weighed and [14C]-PPD tracer was added. Then an equal weight of developer was added. Contents were mixed with a brush in coded mixing bowls. To determine the amount applied to the study subjects, the amount remaining in the bowls and brush was subtracted by the amount prepared. The mean amount of radioactivity applied was 3.12 ± 0.60 MBq (2.08–4.33) in Study A and 3.30 ± 0.56 MBq (2.22–4.03) in Study B. The final specific activity was 155.9 ± 28.4 dpm/µg PPD in Study A and 306.6 ± 42.8 dpm/µg PPD in Study B.

Hair dye was applied to each subject by an experienced hairdresser with standard tools and utensils of professional hair salons. Hair dye was applied to hair with within 15–20 minutes, left for 30 minutes, rinsed with water, and washed twice with shampoo. Hair conditioner was put into hair for 5 minutes, rinsed with water, and dried via blotting with towels. All used materials were collected for determination of radioactivity including all water used for washing and rinsing. Hair was dried with an electric hair dryer and clipped using an electric clipper. Remaining hair was shaved with an electric razor. Ten successive adhesive tape strippings were used to collect stratum corneum in an area of 2×10 cm^2 on the right side of the scalp. Blank tape strips were taken from the forearm. A protective cap was worn after tape stripping overnight to obtain shed skin. Twenty-four hours after hair dying, a second set of 10 successive tape strippings were collected from the left side on the scalp. Strippings were cut into two parts: one part was used for radioactivity analysis and the other for chemical analysis (only study B). Tape strippings of each group were pooled for analysis. All materials were stored for radioactivity analysis.

As described by Nohynek et al. (17), urine samples were collected before treatment and over the intervals 0–12, 12–24, and 24–48 hours after the start of hair dye application. Blood samples were collected by arm vein puncture 30 minutes before hair dye application, and 2, 4, 6, 10, 24, 48 hours after the start of hair dye application.

To determine radioactivity, liquid scintillation counting (LSC) was used. Scintillation counting was done with Ultima Gold XR™ scintillation liquid, except plasma samples, skin strips, and