

# Acute Kidney Injury Following Usage of Formaldehyde-Free Hair Straightening Products

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Acute kidney injury is manifested by sudden deterioration of kidney functions, with or without reduction of urine output. The spectrum of injury ranges from mild to severe, sometimes requires renal replacement therapy. The initial workup includes a patient history to identify the use of nephrotoxic medications or systemic illnesses that may cause poor renal perfusion or directly impair renal function. Formaldehyde which present in cosmetic products; is toxic to many parts including respiratory, renal, and neurologic systems. Here, we have reported 2 cases of acute kidney injury (AKI) after using formaldehyde free hair straightening protein presented with acute tubular injury, responded to corticosteroid therapy.

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## INTRODUCTION

Formaldehyde (FA) is a colorless and highly water-soluble aldehyde that is widely used due to its chemical properties<sup>1</sup> and plays an important role in the structure of products that are part of routine daily activities. It is present in liquid-based home cleaning agents, deodorants, toothpastes and cosmetic products.<sup>2,3</sup> Systemic application of FA can cause glomerular pathologies and thickened tubular and glomerular basement membranes. Additionally, it causes the intratubular vessels congestion, vacuolization and dilatation of distal tubules.<sup>4</sup> A report by Center for Research in Occupational and Environmental Toxicology (CROET) at the Oregon Health Sciences University (OHSU) USA has mentioned that FA is present in high percents in hair-smoothing products that labeled FA free or did not mention formaldehyde on its packaging or material safety data sheet.<sup>5</sup> The formaldehyde content of these samples ranged from 6.4 to 10.8 percent and averaged approximately eight percent. In this case report, two patients with AKI following the use of FA free hair straightening products are presented.

## CASE REPORT 1

A 10-year old female patient, came to emergency room with severe persistent vomiting for 3 days not responding to treatment with oral and parenteral anti emetics. There was no history of fever, diarrhea, constipation, jaundice, upper respiratory tract infection. Drug history was negative. The clinical examination revealed a fully conscious but irritable non-toxic child. Her body weight and height were appropriate for her age. She had tachycardia (heart rate 128/ min), dyspnea (respiratory rate 35/ min), and high blood pressure (blood pressure 140/95 mmHg), with normal body temperature (36.8 °c). There was no pallor, jaundice or cyanosis. Her neck veins were congested with tender hepatomegaly. We noticed that the girl had severe erythema and inflammation of the scalp and forehead and her mother said that it resulted from the hair straightening protein she had used one week earlier. Lab tests and abdominal ultrasound results are shown in Table 1. Hemodialysis was done for the patient. Her C3, C4, ANA, anti dsDNA, CRP, and HCV-, HBV-, and HIV- antibodies were negative. Urine analysis was unremarkable. Renal biopsy

**Table 1.** Laboratory Data and Ultra Sonography of the 2 Cases on Admission

	Case 1	Case 2
Urea (mg/dL)	320	290
Creatinine (mg/dL)	13.2	9.9
PH	7.25	7.31
PCO2	25	32
PO2	90	120
HCO3-	9	14
O2 Saturation (%)	96	99
Na (mEq/L)	141	132
K (mEq/L)	4	5.8
Ca (mmol/L)	0.9	1.2
PO4 (mg/L)	5.5	4.8
Total Bilirubin (mg/dL)	0.9	1.1
ALT (U/L)	30	25
AST (U/L)	33	30
Albumin (g/dL)	3.5	3.4
Hb (g/dL)	11.4	11.5
PLTs (c/mm)	177.000	275.000
TLC (c/mm)	10.700	8.400
Abdominal Sonography	Bilateral Grade 1 Nephropathy	Bilateral Grade 1 Nephropathy

was done and 20 mg/kg/dose methyl prednisolone was given for three days during which 3 sessions of hemodialysis based the patient's labs and clinical volume overload were done afterward oral prednisone (60 mg/m<sup>2</sup>/d) started. At day 5 after admission her urine output gradually improved with subsequent improvement in her kidney function tests. The pathology report revealed picture of acute tubulo-interstitial nephritis

## CASE REPORT 2

17-year old female patient, single, with no special habits, referred to emergency unit with persistent vomiting started a week ago and renal impairment with no previous assessment of renal function. In physical examination: The patient was drowsy. Vital signs were normal. Systemic examination was normal apart from healed eruptions on scalp following the use of hair straightening protein. The patient admitted urgently. Hemodialysis started. Other investigations were requested (Table 1). As like as above mentioned case 1 all her serological tests for immune diseases and virology tests were negative and urine analysis was normal apart of RBCs (15-20). Renal biopsy was done and corticosteroids 40 mg/d started. HD was done for 3 sessions and then stopped. Serial assessment of renal function tests showed

gradual improvement and the patient discharged with normal KFTs. Renal biopsy showed picture of acute tubulo-interstitial nephritis.

## DISCUSSION

In both cases the presenting picture of AKI was in favor of AIN (rapid deterioration of kidney function, no signs of glomerulonephritis, absence of significant urine abnormalities and metabolic acidosis). Negative drug history and absence of preceding acute illness with the coincident use of hair straightening protein in both cases, favors that the nephrotoxic agent is related to whole presentations. In reviewing the composition of preparations used in two cases, it was included (Bis-cerearyl Amodimethicone, Cyclopentasiloxane, Behentrimonium Methosulfate, Di sodium EDTA, Keratin, Collagen and other components as perfumes and tonics). None of these compounds is known to cause acute renal failure in a single exposure. The duration of hair care session was 4 hours in case 1 and six hours in case 2, which seems to be sufficient for systemic absorption of the product components either topically or by inhalation. In our two cases, the presence of skin inflammation and erosions suggest systemic absorption of the hair compound integrants through the skin. As the pathology report takes time to be accessible and unavailability of formaldehyde detection test, steroids were given based on the clinical presentation and laboratory findings. The rapid response to steroid therapy supports our diagnosis of a toxin insult. Oral steroids continued for one month and gradually withdrew over the next 3 months. Although the brochure of the compound used didn't mention formaldehyde as one of its integrants but many of these products are found to contain formaldehyde although labeled formaldehyde free.<sup>6</sup> In a study done by Pierce et al., they reported that professional hair smoothing treatments--even those labeled "formaldehyde-free" have the potential to produce formaldehyde concentrations that meet or exceed current occupational exposure limits.<sup>7</sup> Similar finding was reported by Maneli et al. who found out that of 7 commercial keratin treatment brands, 6 had formaldehyde levels that were 5 times higher than the recommended level; these included 5 brands labeled formaldehyde-free.<sup>8</sup> Formaldehyde when inhaled or absorbed through the skin is metabolized into formic acid in the liver

and erythrocytes and is then excreted, either with the urine and feces or via the respiratory system.<sup>6</sup> The toxic effects of formaldehyde occur in several systems of the body, and both experimental and clinical investigations have attempted to clarify the toxic effects of formaldehyde on the urinary system. It has been observed that acute tubular necrosis can develop due to the edematous obstruction or acute renal failure caused by the intravesicular formalin administration for the treatment of chronic hemorrhagic cystitis.<sup>9</sup> It was found that acute renal failure developed following hypotension in an individual who ingested 150 mL of liquid formalin to commit suicide.<sup>10</sup> In a study of alcoholic patients, it was demonstrated that methanol, which metabolizes into formaldehyde and formic acid, causes tubular necrosis of renal tissue, subsequently resulting in renal failure.<sup>11</sup> Although our two cases markedly improved and kidney function returned normal, but they raised an alarm to a widely used preparations all over the world that can be harmful to the kidneys and may causes chronic kidney disease on repeated exposures.

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