

## **Hair Dye Poisoning: An Important Aetiological Factor in Acute Renal Failure in Gezira, Sudan**

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### **Abstract:**

**Introduction :** Hair dye containing paraphenylene diamine (PPD) is widely used in Sudan for cosmetic reasons and the compound is known to be allergic and highly toxic.

**Objectives:** To study the prevalence and clinical features of hair dye poisoning (HDP) among patients with acute renal failure (ARF) and the outcome of management in Gezira, Central Sudan.

**Patients and methods:** This is a retrospective hospital based study, conducted in Gezira Hospital for Renal Diseases and Surgery (GHRDS) on 171 (105 females and 66 males) patients with ARF, during the period from June 2006 to May 2007.

**Results:** Total number of patients presenting with Hair dye poisoning (HDP) was 55. Hair dye poisoning (HDP) was the most common cause of ARF in 32.16% (n=55) patients followed by severe malaria in 24.56% (n=42), severe sepsis\septic shock in 16.96% (n=29), dehydration and volume depletion in 13.45% (n=23), urinary tract infections in 10.53% (n=18) and obstructive uropathy in 2.34% (n=4) of the cases. Patients with HDP were two males (3.64%) and 53 females (96.36%), and the most commonly affected age group was 15–24 years in 70.91% of the cases. Most cases of HDP were due to suicidal attempts in 76.36% (n=42) and were encountered in the majority of cases by females (97.62%). Other features of HDP were angioneurotic oedema in 25.5%, dark discoloration of urine in 100%, abdominal pain in 32.7%, flaccid paraplegia in 18.2%, cranial nerves palsies 14.5% and convulsions in 5.5% of cases.

Outcome of treatment of ARF due to HDP showed complete recovery in 81.8% and progression to chronic kidney disease (CKD) in 18.2% of the patients. Mortality rate was zero.

**Conclusion and recommendation:** HDP due to PPD intoxication is the main causative factor of ARF in GHRDS. Both public and official awareness is needed about the serious complications of this substance. Interdisciplinary collaboration is necessary for management, proper treatment and help to minimize complications and improve outcome.

**Keywords:** Gezira, Hair Dye Poisoning, Paraphenylene diamine, Renal Failure

**Introduction:**

Hair dye poisoning (HDP) is one of the important causes of intentional self harm in the developing world. This has been reported in Sudan and the Arab region <sup>(1, 2, 3, 4)</sup>. Hair dye containing paraphenylene-diamine causes severe toxicity and lethal effects in humans. These include angioneurotic oedema leading to upper airway obstruction, rhabdomyolysis, acute renal failure (ARF), severe metabolic acidosis, neurological toxicity and cardiac toxicity leading to myocarditis, arrhythmias and sudden death <sup>(5)</sup>. ARF is one of the major and commonest complications of HDP in Sudan. <sup>(5, 6, 7, 12, 17)</sup>

Paraphenylene diamine (PPD), also known as diaminobenzene, is a coal-tar derivative, an aromatic amine, which on oxidation produces Bondrowski's base, which is allergenic, mutagenic and highly toxic. The chemical is a common ingredient in many industrial and cosmetic applications such as dyes for fabrics, fur and dark makeup. One of the most dangerous applications of PPD is when it is added to henna to fasten black coloration for temporary skin tattoos and hair painting <sup>(1, 3, 6)</sup>. This is known as Black Henna which is widely used among Sudanese females.

A person who has been exposed to PPD repetitively is known to develop a desensitization phenomenon. Hence, further exposures could present with atypical features, especially absence of severe allergic reactions and angioneurotic oedema. <sup>(6)</sup>

The characteristic triads of the clinical features encountered are early cervicofacial angioneurotic oedema with stridor, rhabdomyolysis with chocolate colored urine and acute renal failure. Whenever this combination occurs in poisoning, HDP is the most likely cause <sup>(5, 6, 8, 9, 10)</sup>. ARF signifies the severity of intoxication. <sup>(3, 6, 11)</sup>

PPD is known to be excreted through the kidneys. Hence, ARF follows direct tubular or interstitial nephrotoxicity <sup>(8, 9)</sup> and rhabdomyolysis. The mechanism of rhabdomyolysis has been investigated in rats by Yabe K <sup>(10)</sup>. PPD can bring about rhabdomyolysis by promoting calcium release and leakage of calcium ions from the smooth endoplasmic reticulum, followed by continuous contraction and irreversible change in the muscle's structure. Rhabdomyolysis is the main cause of acute renal failure and the morbidity and mortality are high once renal failure develops. Hypovolemia and the direct toxic effects of PPD or its metabolites on the kidneys

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also contribute in the development of ARF. Histologic changes of acute tubular necrosis have been described in PPD poisoning. <sup>(11)</sup>

ARF occurs usually 48 to 72 hours following hair dye ingestion <sup>(1, 5, 6)</sup>. Hence, it is essential to do base line renal function tests in all patients with acute HDP.

Symptoms and signs of ARF should be looked for as part of the conservative management protocol for HDP, including urine output and color. There is no specific antidote available and the initial management of ARF includes forced diuresis with frusimide and intravenous infusion of saline and bicarbonate. But in the event of oliguria, metabolic acidosis, renal failure or shock aggressive therapy by alkalization of urine, use of corticosteroids, vasopressors and renal replacement therapy, including all forms of dialysis, should be considered as early as possible. (5, 6, 12, 13)

The objective of this study is to determine the prevalence and clinical features of HDP among patients with ARF and the outcome of management.

**Patients and Methods:**

This is a retrospective hospital based study, conducted in Gezira Hospital for Renal Diseases and Surgery (GHRDS), Wad Medani, central Sudan, in the period from June 2006 to May 2007. Study was conducted on a group of one hundred seventy one (171) patients who fulfilled the criteria for the diagnosis of ARF conforming to the guidelines of the GHRDS, including sudden and reversible renal impairment within days to weeks without pre-existing renal disease.

The sample was studied for all patients diagnosed as acute HDP complicated with ARF and were referred to GHRDS. HDP was diagnosed clinically in every patient presented with history of dye ingestion, angioneurotic oedema and dark brown/black discoloration of urine.

The severity of renal failure was defined as advanced renal failure requiring renal replacement therapy by dialysis. Patients with chronic kidney disease (CKD) were excluded from this study. Hemodialysis (HD) or peritoneal dialysis (PD) was introduced early in all patients with HDP. Patients were followed until recovery, progression to CKD or death.

The data was collected carefully from hospital records, studied and analyzed for demographic features, medical data, history, clinical examination and investigation such as biochemical, hematological and renal ultrasound when indicated.

Results were analysed and expressed as percentages tables and graphs forms. The data was collected carefully from hospital records, analyzed by using SPSS (version 17).

**Results:**

HDP was the most common cause of ARF in 55 (32.16%) patients followed by Malaria in 42 (24.56%), Severe Sepsis/Septic Shock in 29 (16.96%),

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Dehydration and volume depletion in 23 (13.45%), Urinary tract infections in 18 (10.53%) and obstructive uropathy due to prostate enlargement in 4 (2.34%) patients (Table 1).

The majority of cases of HDP were females 96.36% (53\55) and males were only 3.64% (2\55) with a female to male ratio of 26.5:1 (Table 1 & 2).

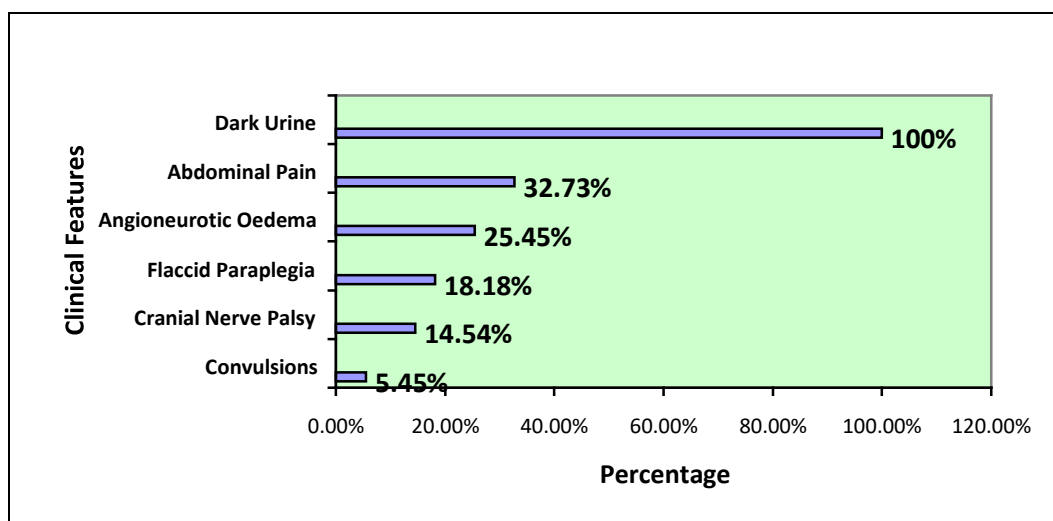
**Table (1): Causes and sex distribution of patients with ARF.**

Causes of ARF	Male	Female	Total No.	Percentage %
Hair dye poisoning	2	53	55	32.16%
Severe Malaria	25	17	42	24.56%
Severe Sepsis\Septic Shock	13	16	29	16.96%
Dehydration	12	11	23	13.45%
Urinary tract infections	10	8	18	10.53%
Obstructive uropathy	4	0	4	02.34%
Total	66	105	171	100.00%

Of those 55 cases of HDP, 42 (76.36%) were suicidal attempts, 8 (14.55%) were accidental ingestion and 5 (9.09%) were due to unknown reason. The majority of the suicidal attempts 41 (97.62%) occurred in females.

Regarding the age distribution we found the most commonly affected age group with HDP was 15–24 years, followed by age groups 25-44, and 5-14 years, with a frequency of 70.91%, 16.36% and 12.73%, respectively.

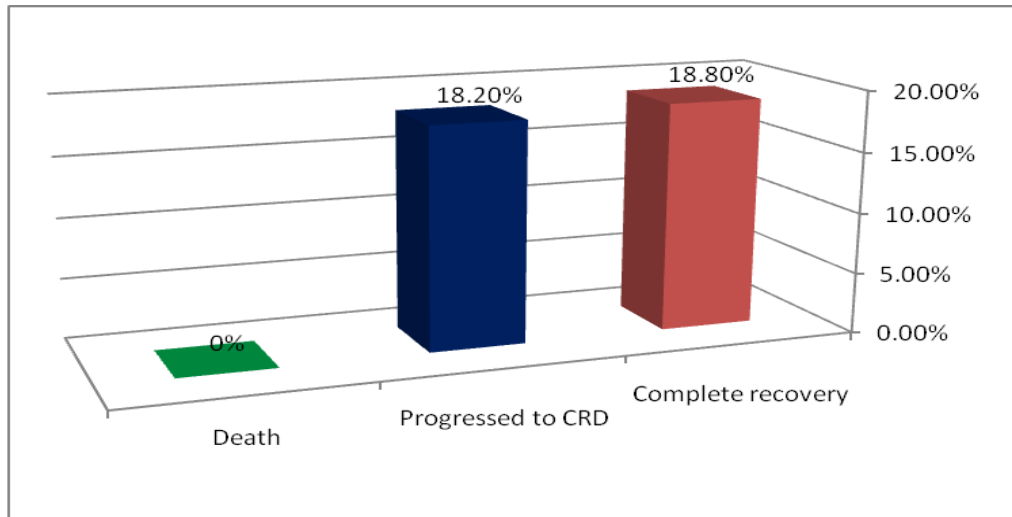
Clinical features of patients with HDP, besides ARF, included angio-neurotic oedema and strider in 14 (25.45%), dark brown\black discoloration of urine in 55 (100%), abdominal pain and cramps in 18 (32.73%), flaccid paraplegia in 10 (18.18%), cranial nerves palsies 8 (14.54%), and convulsions in 3 (5.45%) (Figure 1).



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**Figure 1: Other clinical features of hair dye poisoning with ARF.**

The outcome of HDP following treatment showed that Forty five (81.8%) of all patients with HDP had complete recovery and the rest (18.2%) had progressed to chronic kidney disease (CKD). Mortality was not encountered in the study group (Figure 2).



*Figure 2: The outcome of treatment of ARF due to HDP*

**Discussion:**

HDP due to PPD intoxication is the leading cause for ARF in about the third (32.16%) of the study sample (55/171). The vast majority of cases (96.4%) were females and nearly all of them (97.62%) ingested the dye on suicidal attempts. Moreover, almost three quarters (72.7%) of this condition occurred in adolescence and young adults in the age group ranged between 15-24 years. This should draw public and official attention towards this serious and potentially killing problem which is common in our community.

This could be explained as an outcome of different social, economical and psychological backgrounds. Females in this age were extensively use Hair/Henna dye for social reasons (1, 2, 6, 9). Taking into account that many of the available dye forms in the market are not conforming to the manufacturing and trading legislations. Of those some are smuggled and contain high concentration of the PPD, important example been what is known as “stone dye”.

A previous retrospective study was carried out by Kaballo et al in Omdurnan on 89 patient with ARF. They found HDP the second most common cause for ARF in 12 (13.48%) after volume depletion in 33 (37.1%) of cases, due to variable fulminant infections (particularly malaria and typhoid fever) and snake bite. This also reflects

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HDP as an important single cause for ARF compared to volume depletion as commonest cause, yet caused by multiple etiologies.<sup>(13)</sup>

Clinical feature of HDP in the study are similar to those found in most series, with the main agreed upon features including angioneurotic oedema, brown/black coloration of urine and ARF<sup>(1, 2, 3, 5, 9, 11)</sup>. The painless Angioneurotic oedema and black urine being the most constant features of HDP.<sup>(5, 6)</sup>

Cranial nerves palsies were observed mainly in the lower cranial nerves leading to pharyngeal and laryngeal paralysis and incompetence. These were evident by nasal regurgitation of fluids, neurological dysphagia, weak and hoarseness of voice and chocking. Thus, it is necessary, as part of the conservative management, to keep tracheostomy tube and naso-gastric tube in situ so as to protect airway from aspiration besides feeding by the latter. Otherwise aspiration, chest infection, dehydration or shock might occur and aggravating metabolic acidosis, oliguria and ARF.<sup>(1, 2, 5, 6)</sup>

In this study, there is no reported death of PPD intoxication, despite the high reported cases of angioneurotic oedema (25.5%), which was found to be the main cause of death in this country<sup>(1, 2, 6, 9)</sup>. This could be explained by the mode of death due to acute HDP. When lethal doses are taken death is usually due to upper air way obstruction, cardiac toxicity or central nervous toxicity. This occurs usually in the first 24 to 48 hours following ingestion of the dye. While ARF occurs commonly in survivals and is evident 48 to 72 hours after ingestion of the dye.

The relatively low incidence of angioneurotic edema in the study group could be explained by two reasons. Firstly, it could have been subsided as the angioneurotic edema usually persists for only few days. Secondly, there is a possibility that some cases did not develop the oedema from the beginning due to the desentaziation phenomena mentioned earlier.<sup>(6)</sup>

Despite of the seriousness of HDP the outcome and prognosis of ARF is good and recovery is the rule, provided that the condition is discovered early and properly managed through team approach.

**Conclusion and recommendation:**

HDP due to PPD intoxication is the main causative factor of ARF in GHRDS. This study highlighted the prevalence and clinical features of HDP among patients with ARF. This serious and life threatening condition which affects youth population should raise the awareness and concern of both the public and authorities. Early patient assessment and interdisciplinary collaboration is necessary for proper management, helps to minimize complications and improves outcome.

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