

# PLATINUM-SALT SENSITISATION AND OCCUPATIONAL ASTHMA IN A NON-PLATINUM REFINERY WORKER

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**Introduction:** Cases of sensitisation to platinum salts within platinum-processing sectors (particularly platinum refineries and motor-vehicle, catalytic-converter production) have been extensively described. However, the occurrence of platinum-salt sensitisation outside of these sectors is less well known. We present a case of platinum-salt sensitisation in a chemical plant worker cleaning reactors from platinum refineries.

**Methodology:** A 32-year-old man working at a chemical plant presented at the National Institute for Occupational Health's Occupational Medicine Clinic for evaluation of potential work-related asthma. A medical evaluation, including spirometry and a skin-prick test for sodium hexachloroplatinate and ammonium chloroplatinate salts (platinum salts), was performed.

**Results:** The worker had convincing evidence of occupational asthma induced by platinum salts: there was a temporal association between lower respiratory symptoms and workplace exposure; he had objective evidence of asthma; and he had exposure to a known cause of occupational asthma, namely, platinum salts. Positive skin-prick tests to two platinum salts – an 11 mm wheal average for sodium hexachloroplatinate and a 10 mm wheal average for ammonium chloroplatinate – provided support that platinum salts were the causative agent.

**Conclusion:** This case demonstrates that platinum-salt sensitisation and resultant allergic diseases can occur outside the traditional industries associated with exposure to platinum salts. Healthcare providers should be aware of this, and occupational health services need to prevent sensitisation through appropriate hazard control – in this case cleaning of reactors at the refinery – and to consider medical surveillance of exposed workers. Thorough workplace health-risk assessments are required to adequately identify potential exposures.

**Keywords:** platinum compounds, allergy, skin-prick test, occupational exposure, reactors

## INTRODUCTION

Platinum salts, such as sodium hexachloroplatinate, ammonium hexachloroplatinate and ammonium tetrachloroplatinate, are well known as potent sensitisers and causes of allergic diseases.<sup>1–6</sup> Workers at risk of developing respiratory sensitisation and allergic diseases such as rhinitis, asthma, urticaria and contact dermatitis are those exposed to the complex, halogenated platinum salts in industrial settings such as refining operations, platinum-containing catalytic-converter manufacturing, electroplating and electrolysis operations, and within other miscellaneous operations (eg

chemists and technicians). Table I provides a list of examples of industrial processes and activities where common forms of complex, halogenated platinum salt are encountered. Workers in refineries and catalytic-converter plants are most at risk of sensitisation.<sup>3,7–9</sup>

South Africa is the world's largest producer of platinum and the country's refineries employ the greatest number of exposed workers both locally and globally. Hence, numerous cases of allergic diseases caused by platinum-salt sensitisation have been documented in these refineries.<sup>11,12</sup> Previous incidences

**TABLE I: INDUSTRIAL PROCESSES AND ACTIVITIES WHERE THE MOST COMMON FORMS OF COMPLEX, HALOGENATED PLATINUM SALTS, NAMELY, CHLOROPLATINATES, MAY BE ENCOUNTERED<sup>10</sup>**

| PROCESSES/ACTIVITIES          | CONTACT WITH SOLUTIONS                                          | AIRBORNE AEROSOLS                                               | CONTACT WITH SOLIDS                                             | AIRBORNE PARTICULATE                                            | FUME                     |
|-------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|--------------------------|
| Materials receipt             | <input type="checkbox"/>                                        |                                                                 | <input type="checkbox"/>                                        | <input type="checkbox"/> or <input checked="" type="checkbox"/> |                          |
| PGM* concentrate dissolving   | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        | <input type="checkbox"/> or <input checked="" type="checkbox"/> |                          |
| Separation and refining       | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        |                                                                 |                          |
| Salts production              | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        | <input type="checkbox"/> or <input checked="" type="checkbox"/> |                          |
| Supported catalyst production | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        | <input checked="" type="checkbox"/>                             |                          |
| Metal and alloy production    |                                                                 |                                                                 | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        | <input type="checkbox"/> |
| Packaging                     | <input type="checkbox"/>                                        | <input type="checkbox"/>                                        | <input type="checkbox"/> or <input checked="" type="checkbox"/> | <input type="checkbox"/> or <input checked="" type="checkbox"/> |                          |
| Cleaning                      | <input type="checkbox"/> or <input checked="" type="checkbox"/> | <input type="checkbox"/> or <input checked="" type="checkbox"/> | <input type="checkbox"/> or <input checked="" type="checkbox"/> | <input type="checkbox"/> or <input checked="" type="checkbox"/> |                          |
| Maintenance                   | <input type="checkbox"/> or <input checked="" type="checkbox"/> | <input type="checkbox"/> or <input checked="" type="checkbox"/> | <input type="checkbox"/> or <input checked="" type="checkbox"/> | <input type="checkbox"/> or <input checked="" type="checkbox"/> |                          |

Key: PGM\* – platinum group metals; ☐ – Often chloroplatinate-containing; ☒ – Powders and massive metal (ie finely divided platinum metallic powder form converted by electron-beam melting)

of platinum-salt sensitisation ranging from 9%<sup>11</sup> to 41%<sup>13</sup> have been reported among platinum refinery workers in South Africa. We could find no publications on the occurrence and extent of platinum-salt sensitisation outside of refineries in South Africa. This includes the autocatalyst industry, despite this industry being a fairly large employer.<sup>14</sup>

Platinum-salt-induced conditions are typical of an immunoglobulin E (IgE)-mediated response: conjunctivitis, rhinitis, urticaria and asthma are typical manifestations.<sup>3</sup> The first report of occupational asthma (OA) caused by platinum salts was recorded in the early 1900s in workers in a photographic studio that used paper containing potassium chloroplatinate.<sup>15</sup> Since then, OA caused by platinum-salt sensitisation has been noted as a common disease among platinum refinery workers.<sup>1,3,15</sup> Typically, the bronchial reactions elicited in platinum-induced occupational asthma are immediate, that is, soon after onset of exposure, but dual reactions with an additional late response some hours later have been described.<sup>1,16</sup>

Commonly used diagnostic criteria for OA also apply to platinum-salt-induced disease. These criteria are:

- temporal associations between exposure to the putative causative agent and asthma symptoms or signs – including the onset of symptoms or reversible airflow limitation after first exposure;
- improvement away from exposure and worsening on re-exposure;
- objective evidence of asthma, and
- exposure to an established cause of the disease.

Positive tests of sensitisation to the putative causative agent support the diagnosis. Skin-prick test/s (SPT/s) are the preferred method of demonstrating platinum-salt sensitisation as they have been shown to have high sensitivity and specificity.<sup>12,17,18</sup> A SPT is 100% specific to complex halogenated platinum salts in unexposed subjects<sup>19</sup> and has a sensitivity of 80–90%. Also, with continued exposure to platinum salts at the same level that caused sensitisation a positive SPT is 100% predictive for the development of symptoms.<sup>11</sup> An SPT reaction  $\geq 3$  mm larger

than the negative control is read as a positive test.<sup>21</sup> Early identification of sensitisation and early removal from exposure after symptom onset improve prognosis.<sup>20</sup>

Given the paucity of information on platinum-salt sensitivity unrelated to platinum refineries, we present a case of OA from exposure during the refurbishment of reactors.

## CASE REPORT

A 32-year-old man, Mr M, presented to the National Institute for Occupational Health's (NIOH) Occupational Medicine Clinic for evaluation of potentially work-related asthma. He worked at a chemical plant, cleaning chemical reactors (known as GLVs) from platinum refineries before they were refurbished for re-use. Mr M was confident that the reactors came from platinum refineries and this was confirmed in discussion with workplace management. He was provided with a filtering facepiece respirator. His job also involved spray painting, grinding plates and operating a crane. The spray-painting process included the use of a coating that was prepared using a base paint and a hardener. Typically, hardeners contain isocyanates, established causes of OA, but this exposure was not pursued further.

The patient's symptoms started with a blocked and runny nose. Some months later he developed an episodic tight chest and wheeze which worsened progressively. The chest symptoms were work-related in that they started within an hour of reactors being off-loaded at his worksite. He also developed symptoms when working in a small workshop in which the reactors were housed. His symptoms improved when not exposed to reactors and when on vacation, and they worsened on his return to work. He had no history of childhood asthma or of asthma prior to starting work at the plant.

Mr M was diagnosed with asthma after demonstrating an unequivocal response to inhaled bronchodilators: his FEV<sub>1</sub> improved by 400 mL (from 2.72 L to 3.12 L) and 15%. Serial peak flows were not done because the symptoms were convincingly work-related and the positive test of sensitisation (see Table II) supported the diagnosis of an occupational cause.

A SPT was done with sodium hexachloroplatinate and ammonium hexachloroplatinate salts, to determine possible platinum-salt sensitisation. The skin reactions were strongly positive to both platinum salts (see Table II).

Post diagnosis, the patient was accommodated at work in that he no longer cleaned the reactors and a workers' compensation claim was recommended. He was started on 50/250 micrograms fluticasone salmeterol inhaler twice daily. His symptoms abated and spirometry returned to within reference values after asthma treatment and with reduced exposure to reactors: FEV<sub>1</sub>/FVC = 81%; FVC = 3.34 L (88% of predicted); and FEV<sub>1</sub> = 2.79 L (84%).

**TABLE II: SKIN-PRICK TEST REACTIONS TO POSITIVE AND NEGATIVE CONTROL SOLUTIONS AND CHLOROPLATINATES**

| TEST SOLUTION                                                                       | SPT RESULT |
|-------------------------------------------------------------------------------------|------------|
| Sodium hexachloroplatinate (Na <sub>2</sub> PtCl <sub>6</sub> )                     | 11 mm      |
| Ammonium hexachloroplatinate ((NH <sub>4</sub> ) <sub>2</sub> [PtCl <sub>6</sub> ]) | 10 mm      |
| Negative control                                                                    | 0 mm       |
| Positive control                                                                    | 7 mm       |

## DISCUSSION

OA was diagnosed in a patient exposed to platinum salts at a chemical plant refurbishing reactors used in platinum refineries. The diagnosis of platinum-salt-induced asthma could be confidently made as all the commonly applied diagnostic criteria for OA were met, and the history of symptoms following exposure to the reactors and severe SPT reactions to chloroplatinates support the diagnosis of platinum-salt-induced disease.

Reports of platinum-salt sensitisation in settings other than refining of the metal or the autocatalyst industry are scant, but not absent. However, in South Africa, sensitisation and allergic diseases to platinum salts have been reported only in platinum-production workers. To our knowledge, this is the first case report of a South African platinum-salt-sensitive worker exposed outside of production plants. The worker was exposed when cleaning chemical reactors (GLVs) from refineries that were contaminated by platinum salts. The patient may have been exposed to isocyanates, an established cause of OA, but he did not show symptoms when spray-painting and had positive SPTs to platinum salts, factors against isocyanates as a cause of his asthma.

The case has a number of implications for occupational health practice. Healthcare providers need to be alert to the possibility of exposure to platinum salts outside of platinum production and the autocatalyst industry. Unusual exposure settings will probably be identified only through a detailed occupational exposure history, something that should be done in all working patients with adult-onset asthma.<sup>22</sup> Routine medical surveillance using symptoms and SPTs for platinum-salt sensitisation is commonplace in industries where platinum salts are an integral part of the workplace process; refineries exemplify this. This surveillance is important as it can lead to the detection of individuals with platinum-salt sensitisation early in the course of the condition, even before the onset of symptoms,<sup>11,17,23</sup> and steps can then be taken to reduce exposure and hence improve prognosis.<sup>3,23</sup> But the need for surveillance may not be appreciated if the salts are incidental or peripheral to the workplace's business. This case makes the point: there was no surveillance programme in place at his workplace. Thorough workplace health-risk assessments are required to adequately identify potential exposures and, therefore, the need for hazard control and medical surveillance. Preventing diseases from platinum salts and other hazards is dependent on control of excessive exposure. Decontamination of the reactors should have been carried out at the platinum refinery as downstream industries are unlikely to have an appreciation of the risks and the skills to deal adequately with an uncommon hazard. This principle has more general application in occupational health.

## CONCLUSION

This case demonstrates that platinum-salt sensitisation and resultant allergic diseases can occur outside the well-known industries associated with exposure to platinum salts. Healthcare providers should be aware of this, and occupational health services need to prevent sensitisation through appropriate hazard control – in this case cleaning of reactors at the refinery – and to consider medical surveillance of exposed workers. Thorough workplace health-risk assessments are required to adequately describe potential exposures.

## DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

This article has been peer reviewed.

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