

## Glue Sniffing: A Review

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### ABSTRACT

Inhalant abuse is a prevalent and often overlooked form of substance abuse in adolescents and young adults. It causes a euphoric feeling, may become addictive and can be a serious health concern associated with significant morbidity and mortality. Acute effects of inhalants include sudden sniffing death syndrome, asphyxia, and traumatic injuries. Chronic inhalant abuse can damage the brain, heart, lung, kidney, liver, and bone marrow in addition to being an important cause of psychosocial and economic problems. This article is proposed to emphasize on the harmful effects of glue-sniffing, its prevention and management.

*Key Words:* addiction, sniffing, youth,

### INTRODUCTION

Glue sniffing, also known as solvent abuse is defined as the deliberate inhalation of volatile substances for the purpose of recreational self-intoxication. It is the most common form of inhalant abuse, which continues to be a significant problem especially among the youth. It is appealing to adolescents as it is relatively inexpensive, legal in some countries, and readily available. The “high” achieved occurs rapidly and disappears fairly quickly compared with other drugs. Thus, a user can sniff and still be sober at school, place of work or at home, making detection difficult for teachers, colleagues or parents.

In the past it was thought to be simply a social problem among teenagers but there is now evidence that it can cause sudden death, even in first time users, and that chronic use may result in serious organ system dysfunction. There is also a likelihood of the abuse continuing into adulthood that can have social, economic and long-term medical consequences. Glue sniffing is often a stepping-stone to harder drugs. It should therefore not be underestimated and appropriate measures on its prevention and treatment ought to be addressed.

### Epidemiology

Inhalant use, which includes glue sniffing, is widely prevalent. It has been reported that nearly 20 % of adolescents in the USA have experimented with its use<sup>1</sup>. The mean age of first-time inhalant abusers is 13 years<sup>2</sup>, with onset occurring in children as young as 6 to 8 years old. Usage declines by the age of 17 to 19 years though some abusers continue into adulthood. Moreover it is a precursor to abuse of other illicit drugs in later years<sup>3</sup>. A large number of heroin addicts and IV drug abusers have a past history of inhalant use<sup>4</sup>, which is more common in those from a lower socioeconomic background, particularly those from chaotic, broken homes and abusive families<sup>5</sup>. Other risk factors for inhalant abuse include those with aggressive behaviour, low self esteem, positive family history of abuse or alcoholism, peer pressure, poor academic achievement, abuse or neglect and those who have been exposed to violence or assault. Heavy inhalant abusers, especially females, are more likely to have had a background of childhood abuse, whether physical or sexual, than non-abusers or lighter abusers<sup>6</sup>.

In Singapore, the first case of glue sniffing was reported in 1977 in a 15-year old American boy who

was found dead in his room with airplane glue, an adhesive used to attach pieces of a scale model kit together, in his nostrils. He had high level of toluene in the blood<sup>7</sup>. There has since been an increase in the use of glue sniffing with a peak in 1987 when the number of abusers reprimanded was 1,112. A decline in the use of glue- sniffing was noted in the following decade but unfortunately it is making an alarming comeback. According to central narcotics bureau data reported in Straits Times in April 2008, the number of inhalant abusers caught in 2007 was 644 compared to 403 in 2006 and only 120 in 2005. Out of the 644 abusers, 70% were students under the age of 20. 80% were males. The reasons for the abuse quoted by most of them were peer pressure, boredom and inquisitiveness. Glue sniffing is a criminal offence in Singapore and a police case is therefore mandatory. Inhalant abusers may be classified as experimenters, intermittent users or chronic abusers.

### Methods of Abuse

Inhalation is usually achieved through:

- Sniffing (nasal inhalation) of vapours directly from an open container or a surface soaked with the substance;
- Huffing (oral inhalation) from a rag or cloth soaked in a volatile substance that is held over the mouth or nose; or
- Bagging which involves breathing in and out of a paper or plastic bag filled with a small amount of a volatile substance.

Concentration of the substance inhaled from sniffing is lower than that from huffing. Hence the user typically starts by sniffing and later on progresses to higher doses to intensify the desired euphoria by huffing<sup>8,9</sup> or bagging, the latter being the most toxic since the effect may be intensified by hypoxia and hypercapnia as a result of the exhaled air being reabsorbed<sup>10</sup>. Inhalants can be classified into three groups namely volatile solvents, nitrous oxide and alkyl nitrites, which are also known as poppers. Toluene and xylene, found in many types of glues and solvents, are the most common aromatic hydrocarbons of abuse. The readily available consumer products used are glues, cement, paint, lacquers, gasoline, dry-cleaning fluids, correction fluids, and butane lighters. Glue, which is easily available in bicycle shops, is the most commonly

Table 1. Commonly used products for abuse.

Liquids	Aerosols
Model glue	Paints
Gasoline	Butane Fuel
Contact cement	Cooking sprays
Lacquers	Cosmetics
Dry cleaning fluids	Toiletries

abused substance followed by lacquer and thinner that can be obtained from hardware stores (Table 1). Inhaled nitrites have been abused in the past particularly by men, who have sex with men to intensify sexual experience as they are known to enhance sexual feelings, penile engorgement, and anal sphincter relaxation<sup>11,12</sup>.

### Clinical Manifestations

Toluene, the main component of volatile glues, lacquer thinners and aerosol paints is the chemical responsible for most clinical toxicity. The effects are either from acute intoxication or from organ system dysfunction as a result of chronic and persistent abuse.

Inhalants cause an initial excitatory response through the release of epinephrine and activation of the dopamine system, followed by central nervous system depression mediated by the use of GABA pathway<sup>1</sup>. Activation of the dopamine system by toluene has been shown to be the factor causing the pleasurable effects of glue sniffing. Other effects of toluene include damage to myelin which is essential for the proper functioning of the central and peripheral nervous system. Inhaled chemicals are rapidly absorbed through the lungs into the bloodstream and quickly circulated to the brain and other organs. Toluene is metabolised via the cytochrome P-450 system to benzoic acid, which is then conjugated with glycine to form hippuric acid<sup>13</sup>. The initial high achieved after inhalation is of rapid onset and short duration. It manifests as a sense of euphoria, excitation, dizziness, disinhibited behaviour and exhilaration similar to alcohol intoxication, thus resulting in psychological dependence. Repeated inhalations by the user to prolong the intoxication will develop in headache, slurred speech, diplopia, gait abnormality, delusions, visual hallucinations and disorientation. Continued

Table 2. Helpful diagnostic features of a serious inhalant abuse problem.

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A chemical smell on the breath
Traces of paint or oil stains on clothes or body
Rashes or sores around the nose or mouth, redness of the eyes or a hacking cough
Loss of appetite, drowsiness, dazed appearance or slurred speech
Truancy from school
Decline in performance at school
Untidy appearance
Gathering in groups in neglected buildings
Restlessness at night
Strange behaviour, such as being nervous or temperamental

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use results in further central nervous system depression manifested by drowsiness, seizures and even coma. Behavioural changes and characteristic odour on breath or clothing are helpful clues to detect cases. Suspected users may also complain of cough, stuffy nose, sneezing, flushing, salivation, nausea, vomiting and photophobia.

Other signs and symptoms of inhalant abuse include spots or sores in or around the mouth, injected sclera, nystagmus, irritability or excitability, anxiety and sleep disturbances. Paint or other stains on the face, hands, or clothes are other indicators of abuse. Severe dryness of facial skin and mucus membranes can also be a feature of repeated, prolonged use of volatile substances<sup>8</sup>. Bacterial infection of the dry and cracked skin may result in perioral and perinasal pyoderma, sometimes referred to as “huffer’s rash”<sup>9</sup>. Dependant inhalant abusers may suffer from a withdrawal syndrome with non-specific symptoms in the form of craving, irritability and insomnia.

Diagnosis of inhalant abuse is difficult since there are no specific laboratory tests to confirm solvent inhalation. A thorough history and a high index of suspicion are thus essential. Table 2 shows some helpful diagnostic features of inhalant abuse.

### Clinical Toxicity

Inhalant use is a serious public health concern especially among the youth and has many adverse medical consequences with significant morbidity and mortality. Death due to inhalant abuse can occur by several mechanisms. Indirect causes are from aspiration of vomit during coma, asphyxia

due to the sniffing bag being sealed over the nose and mouth, and accidental trauma due to poor judgment resulting from the intoxication. Death may also result directly from vagal inhibition, anoxia, respiratory depression, and cardiac arrhythmia<sup>14</sup>. “Sudden sniffing death” was first reported by Bass in 1970<sup>15</sup>. It is thought to be caused by the sudden release of catecholamine that can trigger ventricular fibrillation when the acutely intoxicated inhalant abuser exercises, is hallucinating or is suddenly startled. Risk of fatal arrhythmias is increased by concomitant use of alcohol, cocaine or any sympathomimetic. Suffocation, aspiration, and accidental injury accounted for approximately 45% of deaths attributable to inhalant abuse with sudden sniffing death syndrome accounting for the remainder as found in a study carried out in Britain between 1981 and 1985<sup>16</sup>. In Singapore out of a total of 19,000 post-mortems performed between 1983–1991, 33 had toluene in their blood; 6.1% of the deaths were from acute toluene poisoning and the remainder was associated with falling, drowning, or jumping. Thus there was a correlation between the intoxicating effect of toluene and high incidence of fatal accidents amongst its users<sup>17</sup>.

Chronic exposure to inhalant use can produce significant damage to several organs, including the brain, heart, lung, kidney, liver, bone marrow and skeleton. The resultant manifestations are summarised below.

- **Neurological**  
The central nervous system (CNS) is the most vulnerable system in the body to the toxic effects of inhalants. Acutely, it causes CNS depression

manifested by slurred speech, diplopia, abnormal gait, disorientation, and visual hallucinations which are all reversible. Neurons are particularly prone to the solvent properties of inhaled compounds because of their high lipid content<sup>18</sup>. Encephalopathy characterized by euphoria, hallucinations, nystagmus, seizures, and coma<sup>19</sup>, cerebellar damage<sup>20</sup> and peripheral neuropathy<sup>21</sup> are well-established consequences of chronic glue sniffing. Abuse of N-Hexane, a component of many types of glue, should always be considered in the differential diagnosis of a demyelinating polyneuropathy, which would include chronic inflammatory cause and HIV related neuropathy<sup>22</sup>.

Axonal swelling revealed by sural nerve biopsy is a feature of glue sniffing neuropathy and this will help in differentiating it from the above causes<sup>21</sup>. Cranial nerve damage manifested by opsoclonus, anosmia, optic atrophy, tinnitus, and sensorineural hearing loss has also been described<sup>23,24</sup>. Other possible consequences of long term glue sniffing are cognitive dysfunction and dementia<sup>25</sup>. These neurologic abnormalities usually occur 2 or more years of regular abuse of toluene<sup>23</sup> which has a severe impact on central nervous system myelin<sup>26</sup>. Though they are reversible, chronic persistent abuse may cause permanent neurological damage in some cases<sup>27</sup>.

#### ■ Cardiovascular

Cardiac arrhythmias are the most common causes of sudden sniffing death. Ventricular dysrhythmias<sup>15</sup>, sinus bradycardia<sup>28</sup> or heart block induced by hypoxia<sup>29</sup> are the recognized mechanisms. Chronic toxicity to the cardiovascular system includes irreversible myocardial damage and congestive cardiac failure due to chronic myocarditis and fibrosis<sup>30</sup>. Myocardial infarction following toluene abuse has also been reported<sup>31</sup>.

A case of dilated cardiomyopathy in a 21 year old glue sniffer who recovered rapidly and completely after cessation of toluene abuse has been described<sup>32</sup>.

#### ■ Respiratory

Acute pulmonary effects namely bronchospasm, asphyxia and aspiration pneumonitis are recognized complications of inhalant abuse that will manifest as cough, wheezing and dyspnoea.

Long term damage to the respiratory system resulting from chronic glue sniffing includes panacinar emphysema<sup>33</sup> and Goodpasture's syndrome<sup>34</sup>. Pulmonary function tests carried out in 37 young chronic glue sniffers were found to have high residual lung volumes when compared with 20 young control subjects<sup>33</sup>.

#### ■ Renal

Renal disorders associated with chronic toluene abuse include renal tubular acidosis<sup>35</sup>, urinary calculi<sup>36</sup>, glomerulonephritis<sup>37</sup> and Goodpasture's syndrome<sup>34</sup>. Haematuria and proteinuria with otherwise normal kidney function may also be features of chronic abuse<sup>38</sup>. Electrolyte and acid/base disturbances which may be life threatening have also been reported<sup>39</sup>. Hypokalemia is thought to be due to increased mineralocorticoid secondary to volume contraction<sup>35</sup>. Acidosis from toluene poisoning has been attributed to distal renal tubular acidosis or overproduction of hippuric acid metabolite<sup>13,40</sup>. Severe hypophosphatemia from chronic toluene abuse has also been described. It is thought to be due to either renal phosphate wasting or internal phosphate re-distribution<sup>41</sup>.

#### ■ Gastrointestinal

Gastrointestinal symptoms of solvent abuse are nonspecific. Inhalant abusers may develop nausea, vomiting, diarrhea, abdominal cramps and loss of appetite. Transient hepatic damage with elevated enzymes can also be a feature<sup>42</sup>. A case of reversible hepatorenal failure in an adolescent with a history of chronic glue sniffing has also been described<sup>43</sup>.

#### ■ Haematological

Long-term inhalant use may cause blood dyscrasias namely pancytopenia from bone marrow suppression and haemolysis<sup>44</sup>. Malignancies such as leukemia, lymphoma, multiple myeloma<sup>45</sup> and aplastic anaemia<sup>46</sup> are other haematological consequences that have been reported in chronic inhalant abusers.

#### ■ Skeletal

Chronic exposure to toluene has also been shown to affect bone metabolism. It causes bone demineralisation by inducing bone resorption and inhibiting bone formation<sup>47</sup>. Thus chronic glue sniffers are at increased risk of developing osteoporotic fractures in later life.

- **Teratogenic**

Substance abuse during pregnancy poses a great danger to the foetus as most inhalants are highly lipophilic and therefore readily cross the placenta<sup>48</sup>. Toluene abuse during pregnancy can cause spontaneous abortion and premature delivery and is consistently associated with congenital malformation<sup>49</sup> including oral clefts, micrognathia, microcephaly, growth deficiency, developmental delay<sup>50</sup>, craniofacial characteristics as seen in foetal alcohol syndrome<sup>51</sup> and renal tubular acidosis<sup>52</sup>. A neonatal withdrawal syndrome has also been described with chronic inhalant abuse<sup>53</sup>.

- **Social and psychological**

In addition to the above medical consequences, chronic inhalant abuse presents a major problem to society. It is linked with a number of psychosocial problems and other risk behaviours. Inhalant abusers are more likely to suffer from a serious mental illness than non abusers. These adolescents often suffer from low self-esteem and are more prone to have depression and even suicidal thoughts. They have poor family relations, academic problems, and are exposed to substance-using peers and/or parents<sup>54,55,56</sup>. Compared to non-users, delinquency rate is higher among users<sup>55</sup> who are more prone to engage in anti-social or criminal activities. Violent behaviour and weapon carrying have also been closely associated with substance abuse<sup>57,58</sup>. Inhalant abusers have a tendency to sit with a pen or marker near the nose, constantly smell clothing sleeves and would hide rags, clothes, or empty containers of the potentially abused products in closets and other places. They have a wider range of cognitive deficits and personality disorders with more extensive social disruption<sup>59</sup>. Female inhalant abusers are more likely to experience multiple psychiatric disorders as compared to male inhalant users. The disorders seen in inhalant abusers are affective and anxiety disorders, attention-deficit disorder, and antisocial personality disorders. Mood and anxiety disorders are more common in females whereas males are more likely to suffer from anti-social personality disorders. Inhalant users who develop social or specific phobia classically had onset of these disorders prior to initiation of inhalant use; all other mood and anxiety disorders usually occurred after the onset of inhalant use<sup>60</sup>.

## **Prevention**

The most effective way to curtail inhalant abuse is prevention which is of paramount importance since these adolescent abusers are at increased risk of developing extensive medical, psychiatric, and psychological damage and of misusing other illicit drugs in later life. The most valuable prevention approach appears to be education<sup>61</sup>, which should ideally begin before the usual age of experimentation. Paediatricians are well placed to educate children, parents and teachers on the health hazards of glue sniffing. The dangers of sudden death, burns and serious organ damage should be reiterated to youngsters especially those at risk for inhalant abuse. It is extremely important to try and persuade school children not to experiment with inhalants.

Any experimentation with inhalants should be considered as an important risk factor. It would also be useful to include the prevention of substance abuse in the curriculum of primary schools. Training of teachers on substance abuse with emphasis on its prevention and in detecting cases would be very valuable. Factors that may deter adolescents to abuse inhalants include nurturing home environment, supportive parents, high academic success, positive self-esteem, good school, religious involvement and a personal sense of morality. Adolescents who are vulnerable to abuse of inhalants should be provided with alternative activities such as leisure facilities and should be inculcated with traditional cultural values to promote positive lifestyles thus diminishing the risk for inhalant abuse and other destructive behaviours.

## **Management**

Diagnosis of inhalant abuse is difficult and relies almost entirely on a thorough history and a high index of suspicion. No specific laboratory tests confirm solvent inhalation. A chest radiograph may be useful when aspiration is a concern. CT head is indicated in those with neurologic deficits. Laboratory data comprise a complete blood count, comprehensive metabolic panel, and urinalysis. A urine and blood toxicology screen should be considered given the risk of concomitant illicit drug use. Treatment is generally supportive because there are no reversal agents for inhalant intoxication. Acute solvent intoxication should be managed vigorously. The patient's airway, breathing, and circulation should be assessed and stabilised. The use of sympathomimetics



should be avoided in those developing ventricular fibrillation<sup>62</sup>, and beta blockers administered early to protect the catecholamine-sensitised heart. Acid base and metabolic disturbances need to be corrected. Decontamination of skin and clothing and correction of dehydration are also important.

Treatment of chronic inhalant abuse and dependence involves counselling, strict abstinence, appropriate social support and psychiatric intervention. Carbamazepine and haloperidol may be useful drugs in the management of psychosis caused by inhalants<sup>63</sup>.

## CONCLUSION

Glue sniffing certainly poses a significant risk for considerable morbidity and mortality in adolescents and young adults who are often unaware of its health threats. Due to its easy availability and relative low cost, inhalation of toluene containing solvents and glues is widespread and growing. It is therefore important for physicians to be aware of this dangerous form of substance abuse and recognise its effects. Health education, early identification and intervention are the best ways to impede inhalant abuse before it causes serious health consequences.

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