

# SOLVENT USE AND ITS MANAGEMENT — AN OVERVIEW

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## ABSTRACT

Solvents, whose use is widely prevalent across the world, are one of the most common illicit drugs abused in Kerala, especially among the adolescents. However, few solvent users come in contact with the health care system due to their disenfranchisement and social isolation. This selective review outlines the current concepts and clinical management strategies related to solvent use and related disorders. No robust studies are currently available on treatment approaches, and all published treatment guidelines have been based on expert consensus. There are few case reports on use of baclofen, buspirone and lamotrigine in reducing craving and treating solvent dependence. Risperidone, haloperidol and carbamazepine are reported to be effective in the treatment of solvent induced psychosis. Recommended nonpharmacological approaches include cognitive, group, and behavior therapies. Many other aspects of solvent dependence, including course and outcome, have not been studied, despite the fact that use of solvents is associated with significant mortality, morbidity and psychosocial dysfunction. There is an urgent need for a concerted effort to develop effective evidence based interventions to tackle this issue.

Key words: Management strategies, selective review, solvent and related disorders

## INTRODUCTION

Solvent use among adolescents is a major concern across the world. Solvents are easily available, convenient to use, relatively inexpensive, and legal for certain uses; and all these factors promote their use in youngsters.<sup>1</sup> In Kerala, though very few adolescents present to clinical settings with a primary complaint of solvent use, reports from the community, especially the teachers, suggest that experimental use of

solvents is not uncommon. Though their use is underrecognized, solvents have a high propensity to become a “gateway” for the use of other drugs, causing significant morbidity and mortality in all ages.<sup>2</sup>

## DEFINITIONS

Solvents are also called inhalants or volatile substances. The term *inhalant* refers to a wide variety of substances that are rarely, if ever, taken via another route of

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administration.<sup>3</sup> The US National Institute on Drug Abuse (NIDA) classifies solvents into four categories:

- Volatile solvents: glue, paint thinners, petrol, gasoline, correction fluid, and hundreds of other commercial products.
- Aerosols: Hair sprays, deodorants, spray paint, fabric sprays.
- Gases: Medical anesthetics like ether, chloroform and nitrous oxide.
- Nitrites: Amyl, butyl, isobutyl nitrites.<sup>3</sup>

*Solvent use* is the intentional inhalation of a volatile substance to achieve an altered mental state.

## EPIDEMIOLOGY

Hundreds of products containing a single solvent or a mixture of solvents that can produce intoxication if inhaled are commercially available with ease, making inhalants the fourth most commonly abused drug in the world.<sup>4</sup> It is frequently the first drug to be tried by children, often as early as 10 years of age.<sup>4,5</sup> In studies from the west, the prevalence was found to be highest among children, and to decrease as they reach late adolescence and early adulthood.<sup>3,5</sup> Studies across countries place the prevalence in adolescents to be 6 - 11%, and that in people over 18 years to be 8 - 10%.<sup>3</sup> According to the World Drug Report 2014, 0.4 - 6% of seekers for drug treatments worldwide were for solvent use.<sup>5</sup>

Studies on inhalant use from India are scarce, and are mostly case reports or series, mostly from street children, children from juvenile homes, attendees of deaddiction centers and school drop-outs.<sup>1,7,8</sup> In a recent large study among students in high schools and colleges of Ernakulam, 2.4% reported

sniffing of solvents, predominantly whiteners.<sup>9,10</sup> Correction fluid (whiteners) has been reported to be the commonest inhalant abused in India, and the reasons cited for this include their low cost, easy availability, and legal use in homes, schools and offices.<sup>1,8</sup> Like all drugs, motives for the use of solvents too include the need to have fun, get high, be part of a group, deal with problems, etc.<sup>4,7</sup>

## PATTERNS AND METHODS OF USE

Three patterns of use have been found for solvent abuse:<sup>11</sup> *Experimental use* involves irregular use on a few occasions, is mostly seen in early adolescence, and is generally motivated by curiosity or peer pressure. *Regular use* involves the repeated use of solvents on more than a few occasions. This pattern is motivated by enjoyment or fun and is seen in late adolescence, mostly as a part of recreational or social group activity. *Chronic use* consists of long-term regular use which may even be daily use. Subjects would have developed multiple areas of problems/dysfunction by this stage.

Common methods of use are 'sniffing' or 'snorting' which involves the direct inhalation of fumes, 'bagging' from a plastic or paper bag, 'huffing' from a rag or cloth soaked in the substance held over the mouth or nose, 'glading' from air freshener aerosols, and 'dusting' which involves the direct spraying of aerosol cleaners into the mouth or nose. 'Popping' is the use of amyl nitrite by breaking the vials, causing a popping sound.

## MECHANISM OF ACTION

The intoxicating effects of solvents are exerted mainly through their CNS actions. Once sniffed, they are rapidly absorbed by the lungs, and enter the blood stream quickly with quick access to the brain.<sup>12,13</sup> They are rapidly metabolized by the CYP

450 system. About one-fifth is excreted unchanged by lungs. Approximately 15–20 inhalations of 1% gasoline vapor produces effects within five minutes, and the intoxication can last from 30 minutes to several hours.<sup>13</sup> Duration of intoxication may vary depending on the type and dose of the solvents, and is increased if they are used in combination with alcohol. Their CNS action is postulated to be mediated by hyperpolarization of the neurons by action at GABA receptors and inhibition of glutaminergic transmission involving NMDA receptors.<sup>12,13</sup> The reinforcing effects are produced by modulation of mesolimbic dopaminergic activity.<sup>17</sup> The nitrites, however, do not act directly on the CNS, and act primarily by dilating the blood vessels and relaxing the muscles, and are primarily used as sexual enhancers.<sup>3</sup>

### CLINICAL FEATURES

**Acute intoxication:** In early stages, there will be a sense of euphoria or a ‘rush’, light-headedness, disinhibition, excitability, and impulsive behaviour. Other symptoms can include nausea, vomiting, diarrhea, abdominal cramps, and coughing. Those who continue to inhale may experience blurred or double vision, dizziness, disorientation, drowsiness and headache. Higher dosages from prolonged use can result in visual hallucinations, loss of consciousness or death. Electrical excitability of the heart can become abnormal, and this can lead to fatal dysrhythmias.<sup>17</sup> As the users can no longer inhale the solvents once they become drowsy with the increasing doses, coma and death due to intoxication are unusual.<sup>12</sup>

**Withdrawal:** Withdrawal from solvents is mild and self-limiting, and usually lasts only a few days.<sup>23</sup> However, it may last up to a week in chronic users. The symptoms can include irritability, anxiety, depression,

aggressive behaviour, headache, sleep disturbances, tremors, dizziness, nausea and craving.<sup>17,20</sup>

### HARMFUL EFFECTS

**Physical effects:** Neurological toxicity is the most recognized and reported long-term side effect of inhaled solvent abuse.<sup>12,13</sup> Chronic inhalant use also causes toxicity to several other organs, including the brain, heart, lung, kidney, liver, and bone marrow.<sup>12</sup> Common long-term complications of chronic inhalant use are detailed in Table 1.

**Psychosocial effects:** Very few studies have looked into the psychosocial effects of solvent use. Available studies of adults indicate that inhalant users have higher rates of major depression, suicidal ideation and attempts, anxiety disorders and other substance use disorders than non-users.<sup>18,20</sup> Children and adolescents who use inhalants have a very high risk of poly-substance use and psychiatric symptoms.<sup>22</sup> They are also at a higher risk of earlier onset of behaviour problems and antisocial conduct, and are more likely to drop out of school early, have estranged family relationships, be unemployed, socially isolated, homeless and have legal problems.<sup>20,21</sup>

**Mortality:** The leading cause of mortality in inhalant use is “sudden sniffing death syndrome”.<sup>17</sup> This phenomenon is unrelated to frequency or pattern of use, and can occur even after the first inhalation. It happens due to the sensitization of myocardium to epinephrine by inhalants, which results in a fatal cardiac arrhythmia in the event of sudden stress or fright. Such deaths are unpredictable and unpreventable, and leave no post-mortem features.<sup>12,18</sup>

Inhalants can also cause death by various other mechanisms, both, acute and delayed, as detailed in Table 2.

<p><b>Cardiovascular</b></p> <p>Arrhythmia Decreased Myocardial contractility Sinus bradycardia Hypoxia-induced heart block Myocarditis</p> <p><b>Dermatologic</b></p> <p>Burns Contact dermatitis Perioral eczema</p> <p><b>Digestive</b></p> <p>Anorexia Nausea Vomiting Hepatotoxicity</p> <p><b>Hematologic</b></p> <p>Aplastic anaemia Bone marrow suppression Leukaemia</p>	<p><b>Neurologic</b></p> <p>Diplopia Headache Ataxia Slurred speech Depressed reflexes Nystagmus Tremor Cerebellar degeneration</p> <p><b>Neuropsychiatric</b></p> <p>Subcortical-like dementia Decreased IQ Memory loss Poor attention Insomnia Depression Apathy Psychosis</p>	<p><b>Pulmonary</b></p> <p>Cough Dyspnea Wheezing Chemical pneumonitis Emphysema</p> <p><b>Renal</b></p> <p>Renal tubular acidosis Goodpasture's syndrome Electrolyte imbalance</p>
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**Table 1** - Adverse effects of inhalants<sup>12</sup>

**ASSESSMENT**

No laboratory tests are currently available to confirm a diagnosis of inhalant abuse. The clinical diagnosis relies almost entirely on reliable informants, thorough history taking, and a high index of suspicion.<sup>21,27</sup> The easiest way to distinguish between the use of inhalants and other drugs is the smell. Inhalants generally leave a characteristic unpleasant odor on the breath and clothes. People who inhale paint ('chromers') may also have traces of paint on their face and

clothes. Attention must also be paid to other signs and symptoms commonly associated solvent abuse, listed in Table 3.

The following methods may be followed for a patient suspected of using solvents:

**Brief screen:** The aim here is to quickly gather information about the solvent user, especially in emergency services. Areas of assessment can include:

- Reason for consultation

Acute	Delayed
<ul style="list-style-type: none"> <li>• Direct causes: Immediate or "postponed" sudden sniffing death syndrome; methemoglobinemia</li> <li>• Indirect causes: suffocation, aspiration, trauma, drowning, fire, other</li> </ul>	<ul style="list-style-type: none"> <li>• Cardiomyopathy</li> <li>• Central nervous system toxicity: toluene dementia and brainstem dysfunction</li> <li>• Hematologic: aplastic anaemia, leukaemia</li> <li>• Hepatocellular carcinoma</li> <li>• Renal toxicity: nephritis, nephrosis, tubular necrosis</li> </ul>

**Table 2:** Causes of death in inhalant use

Physical Appearance	Behaviour
Paint or oil stains on body or clothing	Dazed appearance
Chemical odour on breath	Dizziness or unsteady gait
Spots or sores in or around mouth	Slurred speech
Rhinorrhoea	Forgetfulness or difficulty concentrating
Injected sclera	Anorexia or nausea
Nystagmus	Irritability or excitability
Diplopia	Anxiety
Stained fingernails	Sleep disturbances

**Table 3:** Signs and symptoms of inhalant abuse<sup>35</sup>

- Type of inhalant used/Frequency/Pattern/Last use
- Use of other drugs
- Perception of harm/risk
- Social/Family supports
- Medical history
- Brief Mental Status Examination

**Full assessment:** This is generally done in inpatient settings, with the aim of gathering information that will help in developing comprehensive plans for management and follow-up. In addition to the aspects described in the brief screen, the following factors too need to be assessed:

- Predisposing, precipitating, and maintaining factors of solvent use
  - Social/family supports
  - Medical history
  - Neuropsychological assessment with a focus on attention span, memory and information processing
  - Mental status examination to find if psychiatric problems are present as antecedents to or consequences of inhalant use
- Full physical examination and appropriate investigations.

**Screening questionnaires:** The Volatile Solvent Screening Inventory (VSSI) and Comprehensive Solvent Assessment Interview (CSAI) are commonly used.<sup>22</sup>

Though they are available for free and assess the various aspects of inhalant use, they are quite complex for use in routine clinical practice.

**Laboratory studies:** Specific toxicology tests are not available in most laboratories. The results may take from several days to weeks to be available, and hence are not useful for immediate diagnosis. Gas chromatography can detect most volatile agents within 10 hours of exposure; but the procedure is not practical for routine use and is unavailable in most settings.<sup>14</sup> Consequently, a thorough history and physical examination are usually more helpful than toxicological screens. Toluene can be detected by checking for Urinary Hippuric Acid (UHA), but the results have to be interpreted in relation to blood toluene levels.<sup>14</sup>

To assess the extent of damage due to long-term inhalant use, tests like full blood count, liver function tests, renal function tests, electrolyte levels, thyroid function tests, creatine kinase, EEG and brain imaging can be used.<sup>12,27</sup>

#### LIMITATIONS IN AVAILABLE TREATMENT RESEARCH

In spite of the high rates of solvent use reported, especially in deprived communities, the social/geographical isolation and the presence of poly-substance dependence and comorbid psychiatric disorders make solvent users an extremely



difficult group to recruit and follow-up for research. The recent Cochrane review on solvent abuse reported that no recommendations with regards to pharmacological treatment can be made owing to lack of robust studies.<sup>21</sup> Evidence base of treatment guidelines published elsewhere has been based on case reports and case series. Clinicians need to be aware of the restricted evidence base of currently available treatment recommendations while considering the suggestions provided here.

### MANAGEMENT OF ACUTE INTOXICATION

Medical attention is usually sought in acute intoxication only when there are serious injuries or other threats to life. No medications currently available can reverse acute inhalant intoxication. Fortunately, the intoxications resolve spontaneously with supportive treatment. A patient suspected to be in acute intoxication needs to be monitored in a clinical setting, in close observation, for approximately 2-4 hours. They should not be left alone for up to 24 hours even if there are no serious symptoms, and for a longer period if symptoms like seizures or impaired consciousness are present. Management should be in a quiet setting and should involve the following strategies:

- Speak calmly and clearly.
- Offer support/food/drinks.
- Ensure safety of patient/staff.
- Remove volatile substance if possible.
- If smell of fumes are present, ensure access to fresh air and safety from fire hazards.
- Monitor cardiopulmonary function, temperature and blood glucose.
- Monitor level of consciousness, neurological status and mood changes.

- If a patient is in intoxication, do not restrain or chase the person as there is a heightened risk of sniffing death syndrome.<sup>17</sup>
- If agitated or aggressive, give minimal therapeutic doses of midazolam IM, diazepam oral/rectal/IV (Monitor for respiratory depression) or Haloperidol. The dosages should depend on the person's body weight, age, general health and other medicines or drugs taken.

### MANAGEMENT OF WITHDRAWAL

- Provide a quiet, safe place to rest.
- Ensure adequate food and hydration.
- Administer paracetamol if required for headache or high temperature.
- Use short acting benzodiazepines for anxiety or minor agitation.
- Induced psychosis mandates special attention to patient safety. Severe agitation will require cautious control with either haloperidol, risperidone, or carbamazepine which have been reported to be effective in management of induced paranoid psychosis.<sup>19</sup>
- Assess and monitor for signs of head injury and infections, especially pneumonia.

### MANAGEMENT IN POST-WITHDRAWAL PHASE

The typical 28-day inpatient treatment programs conventionally used for other drugs is probably too short a period to create some realistic changes in solvent users. They seem to respond best to a program that includes an extended detoxification or "treatment readiness" period that requires more than 28 days.<sup>27,28</sup> Since inhalant use is rarely an isolated issue, it must be dealt with in the context of other psychosocial factors.

Thus the treatment programs must be coordinated, and prepared to use all community resources after building a fundamentally strong therapeutic relationship with the patient.

*Pharmacological approaches:* Isolated studies provide preliminary support for the use of baclofen, started at 10 mg/day and gradually increased to 50 mg/day over one week, to be beneficial in the management of craving and withdrawal and possibly in relapse prevention in patients with dependence.<sup>24</sup> An isolated report suggested that buspirone, at 40 mg per day for two months, was effective in relieving craving for inhalants.<sup>30</sup> Isolated studies suggest efficacy of lamotrigine 100 mg daily for six months and vigabatrin in dependence.<sup>25,26</sup> Risperidone 1 mg twice daily was found to reduce both craving for inhalants and paranoid ideation, and to maintain abstinence for 12 weeks.<sup>29</sup>

Induced psychosis with severe agitation will require cautious control with haloperidol.<sup>19</sup> Case reports also suggest that carbamazepine can be used as first-line treatment for inhalant-induced psychotic disorder, particularly for patients without high levels of psychomotor agitation. For patients with more severe behavioral disturbances, carbamazepine may be initially used, with intermittent use of an antipsychotic to control agitation. Although it remains to be demonstrated that such an approach would enhance efficacy, it would likely reduce adverse effects.<sup>19</sup> However, few reports suggest that psychosis is repaired with abstinence and time alone.<sup>34</sup> Antidepressant medications are not useful in the acute phase of the disorder, but they may be of use in managing coexisting anxiety or depressive illnesses.<sup>16</sup>

*Psychological Approaches:* The most important aspect of any psychological

approach employed would be to establish rapport and therapeutic relationship with the subject, and this can be extremely difficult with solvent users. However, it would be useful to keep an open and nonjudgmental style during assessment to facilitate openness and honesty. Start the discussion by exaggerating the amount the subject may be possibly using, thus indicating that you are open to the subject using a lot (top-high approach). It is important to monitor the client's comfort with the level of disclosure throughout the interview.<sup>27</sup>

*Brief interventions:* Brief interventions are generally opportunistic interventions for clients who have not consulted specifically for solvent use but whose use is detected to be risky.<sup>24,33</sup> They can be completed within 15-20 minutes, with success closely linked to ensuring of follow-ups.

FRAMES is one of the most widely used brief interventions. It was initially formulated as a brief intervention strategy for alcohol use.<sup>33</sup> Its components include feedback, responsibility, advice, menu of options, empathy and self-efficacy. Various trials have shown these components to be effective in reducing harmful use of various substances.<sup>28,31,33</sup>

*Long-term psychological approaches:* All psychological approaches with proven effectiveness in other substance use disorders, including motivational interviewing, cognitive behavior therapy and group therapy, have been tried with this population, mainly with the goal of addressing the maintaining factors of inhalant use.<sup>27,28,32</sup> All these techniques are reported to have some benefit, though the change can be very slow and incremental.<sup>24</sup> Any of the above approaches may be tried, but should include the aspects outlined below:

- Engagement and supportive counselling: Staff should be well trained in therapeutic engagement and good listening skills. Consistency of support and counselling is important.<sup>28</sup>
- Outlining harms: Education about the physical, psychological and neurological harms associated with drug use.
- Understanding drug use: Examine and address the broader reasons why the person is abusing inhalants.
- Offer alternatives to inhalant use: Encourage long-term engagement in non-drug activities.<sup>31</sup>
- Develop coping strategies: Many young people in this group lack the basic skills in assertiveness (refusal skills) and the strategies for controlling and managing their emotions (e.g. anger, sadness). Basic skill development is essential if these appear to be underdeveloped.
- Family interventions: Increasing or reinitiating communication with the family and assisting the family to communicate and support each other better may be a useful strategy. Treatment may include structural family therapy or multi-systemic therapy.<sup>27</sup>
- Group interventions: Explore the dynamics of the individual's inhalant abuse. Most often this is a group activity; so the person needs to transition away from an inhalant-abusing peer group to a more positive peer group. When solvent abusing children are admitted for treatment, they are distant and hard to reach. However, they are anxious to bond quickly to their peer group. Some treatment facilities have utilized this as a treatment opportunity and have

developed a “peer patient advocate” system.<sup>25</sup> Utilizing a peer who is further along in the treatment process provides the incoming youths with someone to “teach them the ropes” and give them support. The treatment staff should closely supervise this relationship.

- Education/Occupational rehabilitation: A very important component for any treatment program. If the patient is a student, adequate support needs to be offered when he/she is sent back to school. If the subject has dropped out of school, effort should be taken to send him/her back to school or to offer alternative education in a supported environment. In the case of older subjects, training for fruitful employment and supported employment should be offered wherever possible.<sup>29,32</sup>
- Neurocognitive rehabilitation: This should be considered for those in the “impaired” range of neurocognitive functioning and in those with impairment in specific areas. This is an important aspect which determines prognosis, especially if subjects have obvious cognitive impairment.<sup>27,31</sup>
- Record keeping: Patient records must be carefully maintained to determine overall effectiveness and need for a change in treatment strategy.
- Ensuring regular follow-ups to detect relapses.

Treatment usually lasts 3-12 months. Treatment termination is considered successful if the youth has practiced a plan to stay abstinent, is showing fewer antisocial behaviors, has a plan to continue any needed psychiatric treatment and live in a supportive drug-free environment, is



interacting with the family in a more productive way, is working or attending school, and is associating with drug-free non-delinquent peers.<sup>27,28</sup>

As in all addictive behaviors, preventive approaches in the form of a community based intervention could be an equally effective strategy to tackle solvent use too. Supply reduction strategies of restricting sales and product modification have been advocated. Legal measures, including community policing, have been shown to be helpful. But a comprehensive community based strategy involving intersectoral partnerships among legislating agencies, retailers, manufacturers and community agencies, both governmental and private, has still not been implemented anywhere in the world. There is thus an urgent need for a concerted effort to improve awareness among various stake-holders to comprehensively tackle this growing issue.

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