Inhalant misuse in youth: time for a coordinated response

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ABSTRACT

- Early adolescence is associated with high rates of experimental inhalant misuse, but only a minority continue to inhale on a regular basis.
- Inhalant misuse is associated with a range of adverse outcomes, including reports of increased morbidity and mortality.
- Research into inhalant use among adolescents is lacking, with limited data available on long-term outcomes or evidence-based approaches to treatment.
- Legislative and supply-reduction strategies have been introduced by a number of states and territories over recent years, but direct funding for specific targeted interventions is lacking.
- Investment and commitment to a national research framework, as well as coordination of local services, is urgently required.

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Inhalant misuse refers to the deliberate inhalation of chemical vapours to produce self-intoxication or altered mental states (such as euphoria), despite the potential for toxic damage to vital organ systems.[1] The most commonly inhaled substances are accessible household or commercial products containing a variety of chemical compounds (Box 1). Given that inhalants are cheap, legal, readily accessible and provide a rapid "high", they are typically one of the first drugs that young people misuse.[4]

Indeed, early adolescence is associated with high rates of experimental inhalant use; fortunately, only a minority continue to inhale on a regular basis.[4] Sniffing spray paint, or "chroming", is the most common form of inhalant misuse in Australia, although petrol sniffing remains a significant problem for Indigenous communities, especially in remote settings.[4-6] The very visible nature of inhalant misuse by both disadvantaged Indigenous and non-Indigenous young people in public spaces, as well as reports of associated injuries and death, has caught the attention of health providers, politicians and the public,[7,8] resulting in a number of recent state and national responses. However, despite the increased morbidity and mortality, research among adolescents who regularly use inhalants is comparatively sparse, with limited data available on long-term outcomes or evidence-based approaches to treatment.

How common is it?

The current literature tends to describe young people who use inhalants as a homogeneous group, with little attention paid to differences in the chemical composition or toxic profile of the substances they inhale. While experimental use of inhalants appears to be relatively common in early adolescence, only a small minority of Australian youth report using inhalants on 10 or more occasions (Box 2).[4] However, the actual rate of inhalant misuse among young people is likely to be somewhat higher, as population or school-based surveys typically exclude young people at high risk of becoming regular users (eg, those not attending school, and the homeless). Furthermore, the epidemiological data collected are predominantly cross-sectional and do not take account of the episodic and cyclical nature of inhalant misuse among youth populations. Indeed, the failure to use longitudinal designs has meant that the natural course of inhalant misuse among Australian youth is uncharted, with limited data available on the correlates and consequences of use over the short and long term. Pathways from experimental use through to misuse or dependence, and the "best bets" for cost-effective interventions are yet to be adequately considered. Research among remote Indigenous communities suggests that petrol sniffing, in combination with alcohol and other drug misuse, can continue for periods in excess of 10 years.[9] Limited comparable data are available for non-Indigenous populations.

What are the risk factors for inhalant misuse?

A number of risk factors for inhalant use and misuse have been identified in the international literature (Box 3). Socioeconomic disadvantage has consistently been implicated as an important risk factor,[10] particularly in Indigenous communities, where isolation (both geographical and social), poverty and unemployment are more likely to be predictive of inhalant use than cultural issues.[14]

Inhalant misuse is frequently associated with severe family dysfunction. Young people who use inhalants typically come from separated or divorced families,[11] with high levels of family conflict and a lack of family support and cohesiveness.[12] Among non-Indigenous young people who use inhalants, there is often a history of physical or sexual abuse,[13] and parental substance misuse and criminality appear to be additional risk factors.[12] It is therefore not surprising that inhalant misuse is disproportionately higher among children and adolescents "in care", or among those involved in the juvenile justice system.[15] Peer influence (especially inhalant use by peers and peer encouragement) also plays a critical role in both initiating and maintaining inhalant use.[11] There is also some preliminary evidence linking inhalant use with poor academic performance;[11] however, it is difficult to determine whether this is related to premorbid low levels of intellectual functioning or high rates of school behaviour problems, truancy and school dropout. While many of these social correlates are similar to those identified among other substance-misusing populations, it is the relatively earlier age of regular use, as well as the associated severe biological and psychosocial consequences, that makes inhalant misuse such a significant public health issue.

What are the effects of inhalant use?

The effects of inhalant intoxication are similar to alcohol intoxication, with symptoms of euphoria, disinhibition and excitation (often associated with reckless behaviour), progressing to disorientation, slurred speech, diplopia and weakness, as central nervous system (CNS) depression worsens. Hallucinations and ataxia may occur at higher doses, and further CNS depression can result in seizures, coma and cardiopulmonary arrest.[3] However, despite reports of

1 Inhalants and their common chemical constituents[1-3]

Volatile solvents
- Correction fluids (1,1,1-trichloroethane)
- Dry-cleaning fluids (trichloroethylene, 1,1,1-trichloroethane)
- Glues (*n*-hexane, toluene, xylene)
- Nail polish remover (acetone, esters)
- Paint thinners and removers (dichloromethane, toluene, xylene)
- Petrol (benzene, *n*-hexane, toluene, xylene)

Aerosols (may contain chlorofluorocarbons and fluorocarbon propellants)
- Deodorants and hairsprays
- Fabric protector sprays
- Spray paints (toluene, methyl isobutyl ketone)
- Vegetable oil sprays

Gases
- Bottled gas (propane)
- Cigarette lighter fluid (butane)
- Medical anaesthetics (ether, chloroform, nitrous oxide)
- Whipped cream chargers (nitrous oxide)

Nitrites*
- Amyl nitrites

* Nitrites are often not considered under the umbrella of inhalant misuse due to differences in epidemiology, neurochemistry, direct effects and reasons for use (primarily used as sexual enhancers). ◆

inhalant-related deaths, Australian data on mortality rates from inhalant use are limited. While 121 inhalant-related deaths were reported between 1980 and 1987,[16] this number is likely to be a significant under-estimation of the actual total, especially as current Australian practice requires that the medical condition directly associated with death be documented, rather than any contributing substances. Thus, when inhalants play a critical but indirect role in an individual's death (eg, death by misadventure or suicide), this information is unlikely to be recorded, particularly given the inconsistencies in toxicology testing across Australia. In the United Kingdom, where data are collected on all deaths attributed to inhalants (regardless of the actual terminal event), 1857 deaths were reported between 1971 and 1999.[17] The majority of those dying were males (87%) under the age of 20 (66%; 55% of these were aged 14–18 years).

Indeed, deaths from inhalant use among young people are largely associated with "sudden sniffing death" (SSD) or accidental injury related to impulsive high-risk behaviour and impaired motor skills while intoxicated.[17] Those using inhalants are also at risk of suffocation or burns from exploding solvents, highlighting the importance of effective harm-reduction strategies. There is no apparent safe level of use, with even first-time experimental users being at risk of SSD as a result of cardiac arrhythmias (particularly after misuse of toluene, chlorofluorocarbons and butane).[18] Inhalants appear to sensitise the myocardium to endogenous catecholamines, which may result in fatal ventricular arrhythmias if the user is startled or agitated.[3] The practice of spraying inhalants directly into the mouth is also potentially fatal, as the cooling agents within aerosols can produce death by asphyxiation (via a frozen larynx) or pulmonary oedema.[10] Of the 73 people who died in 1999 from inhalant use in the UK, 43% had no previous history of inhalant use.[17]

Research examining the medical consequences of inhalant misuse has typically involved small and selective samples of adult patients — either young people referred for treatment after long-term inhalant use or those with occupational exposure. Nevertheless, such studies suggest that chronic inhalant exposure is associated with significant toxic effects, including renal, hepatic, bone marrow and pulmonary damage.[3] In adult samples, long-term inhalant exposure has also been associated with persistent neurological deficits.[19] While clinical features of neurological toxicity are generally non-specific, there appears to be a relationship between the frequency and duration of exposure and the extent of neurological abnormalities.[20] There is some evidence that the severity of these abnormalities reduces with abstinence, and may even normalise completely over time in some subjects.[20]

While chronic inhalant exposure is associated with significant toxic effects, the pathophysiological processes underpinning such damage remain unclear. This issue is further complicated by the fact that many products contain more than one type of inhalant, and also by the limited available data on the impact of inhalants on developmental age or gender. Thus, the incidence and nature of significant medical complications among young people using inhalants is unknown, as is the extent to which these effects are reversible following abstinence. The paucity of information on the physical health of young users is especially troubling as this (often disenfranchised) group are less likely to seek medical attention early.[3]

There is evidence that chronic inhalant misuse is also associated with gradual cognitive deterioration over time, sometimes resulting in permanent and irreversible damage in adult.[14,21] Structural brain abnormalities are also more common, particularly in subcortical and white matter regions,[22] and appear to correlate with the degree of cognitive impairment. However, few studies have comprehensively examined brain abnormalities or cognitive deficits in adolescents who are regular inhalant users, nor determined the extent to which improvement occurs with abstinence.

Finally, inhalant misuse has also been associated with high rates of major depression and behavioural problems (including antisocial and delinquent behaviour).[23] Rates of suicidal ideation and attempts are substantially elevated,[24] and cases of inhalant-induced manic and psychotic episodes have been reported.[25] Polydrug use is common among adolescents who regularly misuse

2 Use of over-the-counter and illicit substances by Australian secondary students, 2002[4]

Age	Lifetime use	Use in past week	Use on > 10 occasions
12 years			
Male	26%	11%	4%
Female	26%	8%	3%
15 years			
Male	19%	6%	3%
Female	20%	3%	2%
17 years			
Male	11%	2%	1%
Female	12%	2%	1%

Adapted from *Australian secondary students' use of over-the-counter and illicit substances in 2002*.[4] ◆

3 Risk factors for inhalant misuse among young people

- Socioeconomic disadvantage[10]
- Marginalisation[11]
- Severe family dysfunction[12]
- History of physical or sexual abuse[13]
- Mental health disorder and/or emotional problems[11,12]
- Peer influence (especially peer inhalant use and peer encouragement to use)[11]
- Poor school attendance and academic performance[11]
- Parental substance misuse[12]

inhalants, and those seeking treatment are likely to have additional substance use disorders.[26] However, while inhalant misuse has been associated with both psychiatric and drug use morbidity, it is unclear to what extent such psychopathology is premorbid.

Recent government responses

Over recent years, several states and territories have begun to comprehensibly examine the issue of inhalant misuse among disadvantaged youth, resulting in two published in-depth reports and a series of specific legislative changes.[2,6] In several states, police are now able to confiscate inhalant products, as well as temporarily detain affected young people to escort them to a "place of safety". Unfortunately, no substantive additional resources have been allocated to provide appropriate safe settings for intoxicated youth, nor to improve access to specialist treatment programs. This raises important issues relating to duty of care, and places both the police and youth drug services in a difficult position. Other legislative changes primarily focus on supply reduction (eg, instructing retailers that they should not sell inhalants to young people they suspect may misuse). However, in many instances, such products are not legitimately purchased but stolen, suggesting that inhalants should also be responsibly stored. Other deterrent strategies that have been identified include replacing petrol in regional areas with aviation fuel (causes severe headaches and stomach cramps if inhaled) or Opal fuel (BP Australia) (contains substantially fewer aromatic compounds than typical unleaded petrol), as well as assessing the feasibility of adding a bittering agent to inhalant products.[2]

However, direct funding for specific targeted interventions or comprehensive community responses has been lacking. While several programs for Indigenous communities have reported positive results, a recent review of both published and unpublished interventions to reduce the level of petrol sniffing within Aboriginal communities noted that very few initiatives have been rigorously evaluated.[5] Even fewer programs addressing inhalant misuse among non-Indigenous disadvantaged youth have been conducted, and it is unlikely that successful initiatives in Aboriginal young people would be wholly suitable for use in urban non-Indigenous settings.

What needs to be done?

To date, no research has comprehensively examined the biopsychosocial characteristics of those who regularly use inhalants, nor determined the long-term health effects or economic impact of inhalant misuse during adolescence. Australian data on actual rates of inhalant misuse and patterns of use are also lacking. This in part reflects the difficulties associated with engaging and retaining this disenfranchised population, as well as the political and cultural sensitivities associated with Indigenous populations or children in custody or care. The lack of a sufficient evidence base limits the ability of current services to meet the complex needs of people using inhalants and impedes the development of appropriate cost-effective early intervention and prevention programs. Indeed, given the early onset of inhalant misuse, and the difficulties associated with policing legal and readily accessible substances, a focus on prevention may provide the best avenue for effective intervention. However, this will require substantial public investment in interventions that address school failure and social disadvantage, as well as programs that specifically target family dysfunction.

A national research agenda is clearly a key priority, especially in terms of developing comprehensive evidence-based (and culturally sensitive) resources and interventions appropriate for the age range of individuals who misuse inhalants. In 2003, a National Inhalant Abuse Taskforce was established to develop a national approach to inhalant misuse. The taskforce is due to report soon, but, whatever its recommendations, there needs to be ongoing commitment and investment at federal, state and local levels to ensure the successful establishment of a national research framework, as well as the translation of relevant findings into comprehensive policies, programs and practices. In addition, more work needs to be conducted to ensure better coordination between local communities and relevant service systems (eg, primary care, drug and alcohol, mental health, juvenile justice, child protection, and education) to ensure that the complex biopsychosocial needs of young people misusing inhalants are appropriately identified and addressed.

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Competing interests

None identified.

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References

1 Ramsey J, Anderson HR, Bloor K, Flanagan RJ. An introduction to the practice, prevalence and chemical toxicology of volatile substance abuse. *Hum Toxicol* 1989; 8: 261-269.

2 Parliament of Victoria Drugs and Crime Prevention Committee. Inquiry into the inhalation of volatile substances: final report. Melbourne: Parliament of Victoria, 2002. http://www.parliament.vic.gov.au/dcpc/Reports%20in%20PDF/VSA%20Report_www.pdf (accessed Aug 2006).

3 Kurtzman TL, Otsuka KN, Wahl RA. Inhalant abuse by adolescents. *J Adolesc Health* 2001; 28: 170-180.

4 White V, Hayman J. Australian secondary students' use of over-the-counter and illicit substances in 2002. Canberra: Australian Government Department of Health and Ageing, 2004. (National Drug Strategy Monograph Series No. 56.)

5 MacLean SJ, D'Abbs PH. Petrol sniffing in Aboriginal communities: a review of interventions. *Drug Alcohol Rev* 2002; 21: 65-72.

6 Legislative Assembly of the Northern Territory. Select Committee on Substance Abuse in the Community. Petrol sniffing in remote Northern Territory communities. Darwin: Legislative Assembly of the Northern Territory, 2004. http://www.nt.gov.au/lant/parliament/committees/substance/Petrol%20Sniffing%20Report%20-%20FINAL.pdf (accessed Aug 2006).
7 Rintoul S. No hope, no cure. *The Australian* 2005; Oct 11: 11.
8 Toohey P. A generation stolen by the fumes. *The Weekend Australian* 2000; Aug 5: 1.
9 Burns CB, D'Abbs P, Currie BJ. Patterns of petrol sniffing and other drug use in young men from an Australian Aboriginal community in Arnhem Land, Northern Territory. *Drug Alcohol Rev* 1995; 14: 159-169.
10 Chalmers EM. Volatile substance abuse. *Med J Aust* 1991; 154: 269-274.
11 Oetting ER, Edwards RW, Beauvais F. Social and psychological factors underlying inhalant abuse. *NIDA Res Monogr* 1988; 85: 172-203.
12 Howard MO, Jenson JM. Inhalant use among antisocial youth: prevalence and correlates. *Addict Behav* 1999; 24: 59-74.
13 Fendrich M, Mackesy-Amiti ME, Wislar JS, Goldstein PJ. Childhood abuse and the use of inhalants: differences by degree of use. *Am J Public Health* 1997; 87: 765-769.
14 Cairney S, Maruff P, Burns C, Currie B. The neurobehavioural consequences of petrol (gasoline) sniffing. *Neurosci Biobehav Rev* 2002; 26: 81-89.
15 McGarvey EL, Clavet GJ, Mason W, Waite D. Adolescent inhalant abuse: environments of use. *Am J Drug Alcohol Abuse* 1999; 25: 731-741.
16 National Drug Abuse Information Centre. Deaths due to volatile substance abuse. Canberra: AGPS, 1998. (Statistical Update No. 8.)
17 Field-Smith ME, Taylor JC, Norman CL, et al. Trends in deaths associated with abuse of volatile substances 1971-1999. London: St George's Hospital Medical School, 2001.
18 Bass M. Sudden sniffing death. *JAMA* 1970; 212: 2075-2079.
19 Lolin Y. Chronic neurological toxicity associated with exposure to volatile substances. *Hum Toxicol* 1989; 8: 293-300.
20 Cairney S, Maruff P, Burns CB, et al. Neurological and cognitive recovery following abstinence from petrol sniffing. *Neuropsychopharmacology* 2005; 30: 1019-1027.
21 Chadwick OF, Anderson HR. Neuropsychological consequences of volatile substance abuse: a review. *Hum Toxicol* 1989; 8: 307-312.
22 Rosenberg NL, Grigsby J, Dreisbach J, et al. Neuropsychologic impairment and MRI abnormalities associated with chronic solvent abuse. *J Toxicol Clin Toxicol* 2002; 40: 21-34.
23 Zur J, Yule W. Chronic solvent abuse: 2. Relationship with depression. *Child Care Health Dev* 1990; 16: 21-34.
24 Dinwiddie SH, Reich T, Cloninger CR. Solvent use and psychiatric comorbidity. *Br J Addict* 1990; 85: 1647-1656.
25 Byrne A, Kirby B. Solvent abuse psychosis. *Br J Psychiatry* 1989; 155: 132.
26 Sakai JT, Hall SK, Mikulich-Gilbertson SK, Crowley TJ. Inhalant use, abuse, and dependence among adolescent patients: commonly comorbid problems. *J Am Acad Child Adolesc Psychiatry* 2004; 43: 1080-1088.

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