

Journal Pre-proof

The Dangerous use of Inhalants among Teens: a Case Report

Levari Ermelinda , Stefani Martina , Ferrucci Roberta ,
Negri Attilio , Corazza Ornella

PII: S2667-1182(21)00004-0
DOI: <https://doi.org/10.1016/j.ETDAH.2021.100006>
Reference: ETDAH 100006



To appear in: *Emerging Trends in Drugs, Addictions, and Health*

Received date: 5 February 2021
Revised date: 9 March 2021
Accepted date: 15 March 2021

Please cite this article as: Levari Ermelinda , Stefani Martina , Ferrucci Roberta , Negri Attilio , Corazza Ornella , The Dangerous use of Inhalants among Teens: a Case Report, *Emerging Trends in Drugs, Addictions, and Health* (2021), doi: <https://doi.org/10.1016/j.ETDAH.2021.100006>

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

© 2021 Published by Elsevier Ltd on behalf of International Society for the Study of Emerging Drugs. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

THE DANGEROUS USE OF INHALANTS AMONG TEENS: A CASE REPORT

Levari Ermelinda (a), Stefani Martina (a), Ferrucci Roberta (a), Negri Attilio (b, c), Corazza Ornella (c, d)

- a. Addiction Unit, Trento, Italy
- b. School of Clinical Pharmacology and Toxicology, University of Milan, Milan, Italy
- c. School of Life and Medical Sciences, University of Hertfordshire, Hatfield, United Kingdom
- d. Department of Psychology and Cognitive Science, University of Trento, Trento, Italy

ABSTRACT

The recreational use of inhalants among teenagers and other vulnerable individuals is a growing cause of concern for clinicians. Products, such as computer dusters and spray cleaners containing highly toxic compounds, such as difluoroethane, are being used to obtain immediate euphorizing effects with significant health risks. We provide an overview of this new drug trend in combination with a case report of a 14-year-old girl with a previous psychiatric history, who was admitted at the Addiction Treatment Unit (Ser.D) in Trento (Italy) after a period of inhalant abuse. The lack of literature in the field suggests the need for further investigations on such hazardous practices and more targeted prevention approaches aimed at informing adolescents, their parents and clinicians working with them.

Count word: 2391

Keywords:

Inhalants, difluoroethane, adolescents, case report

Corresponding author:

Dr Levari Ermelinda, Dirigente Medico, Specialista in Psichiatria, SerD Trento, via Gocciadoro 47/49, Trento, Italy
E-mail: ermelinda.levari@apss.tn.it

INTRODUCTION

Background

The abuse of a wide range of inhalants is an increasing drug trend particularly among teenagers (Willams & Storck, 2007). Such a behaviour consists in the voluntary inhalation of volatile substances to obtain a rapid and short-lasting euphoric effects (Willams & Storck, 2007; Kurniali et Al., 2012). Commonly used inhalants include easily available commercial products, such as nail polish remover, glue, spray paints and computer duster, spray, among others (Garland & Howard, 2012). These might contain a variety of chemicals (e.g., ethylacetate, benzene, propane, difluoroethane, ethyl chloride, acetone), which, when repeatedly inhaled, can cause serious outcomes such as Central Nervous System (CNS) depression, cardiac arrhythmias, hypoxia, metabolic acidosis, permanent neuro-cognitive damage (Willams & Storck, 2007; Kurniali et Al., 2012). Several fatalities related to volatile substance use have already been reported in literature. Ossiander (2014) identified 12 different chemicals associated with 56 deaths, with one of them, difluoroethane, a refrigerant gas contained in products generally used to remove dust from computers and keyboards, being related to 30 of these fatal outcomes (54%).

Diffusion and availability

In the United States (US), inhalants are among the most popular substances of abuse in the last decade (NIDA, 2017). It has been estimated that more than 1.8M million US citizens aged 12 years and older have used such products to obtain mood enhancing/euphoric effects (Lipari, 2017) About 684,000 of them were aged 12 to 17 with 4,9-8,9% reporting a lifetime use of inhalants (NIDA, 2017). Longitudinal data show a decrease with such risky behaviours among the older population who are more inclined to use other types of substances, suggesting that the use of inhalants may well anticipate the consumption of other legal or illegal drugs (NIDA, 2017; Lipari, 2017).

Inhalants are legal, cheap, easily available and provide rapid and short-term effects, making them an appealing alternative for traditional psychoactive substances not only for adolescents, but also for other vulnerable populations (e.g. homeless, polydrug users). Cases of intoxication have been reported in the US, United Kingdom and other European Union Member states (Garland & Howard, 2012; Vazan et A., 2011), with a lifetime prevalence of 7% in general European populations (ES-

PAD, 2016). The figure decreases to 3% in Italy (Dipartimento Politiche Antidroga, 2017) and they have rarely been used by our patients (0,1%) at Addiction Treatment Services (Ser.D) in Trento. However, their use is not normally detectable via the standard drug tests and their consumption may be more widespread than what is reported. This is due to the fact that they are legal compounds and laboratories do not have the sufficient tools to identify them.

Types of inhalers, neurobiological responses and side-effects

Several household products may be used to facilitate the intake (e.g. felt-tip pens and markers, glue, shoe polish, spray paints, and dusters), which can occur by (a) direct inhalation from a container or spray (“sniffing”), (b) inhalation through a fabric, generally a tissue, placed under the nose, on which the substance has been previously vaporized (“huffing”), (c) vaporization of the substance in a bag placed then under the nose (“bagging”) (Henretig, 1996; Espeland, 1995). Of particular concern is the inhalation of the highly toxic difluoroethane (Lipari, 2017), which is commonly found in inhalants such as computer cleaners/dusters. This refrigerant, used as a propellant in spray cans, is believed to exert its psychoactive effects by stimulating the GABA receptors and by inhibiting the NMDA receptors; other studies suggest that inhalants promote the release of dopamine in specific brain areas (Kurniali et Al.2012; Garland & Howard, 2012; Bass, 1970; Jevtovic-Todorovic, 1998) but neuropharmacological pathways and effects of acute and chronic difluoroethane inhalation are yet to be elucidated. The short-lasting effects may induce users to frequently redose. Difluoroethane has been related to traffic accidents (Hahn et Al., 2006) fatalities, mainly for cardiac arrhythmia (NIDA, 2017; Avella et Al., 2006) and serious threats to physical health, with cases of skeletal fluorosis and periostitis (Tucci et Al., 2017). It may also cause frostbite injury and angioedema. In 2012 Kurniali and colleagues (Kurniali et Al., 2012) reported the case of a 25-year-old man who was admitted in a Hospital Emergency Unit after a syncopal episode caused by prolong inhalation of a computer duster spray, which lasted for several months. The patient reported long QT interval, inspiratory stridor, reduced oxygen saturation and signs of angioedema of the labial and buccal mucosa, which required cardio-circulatory and respiratory support (Kurniali et Al, 2012). Few years after, in 2015 Winston and colleagues (Winston et Al., 2015) reported the case of a 40-year-old man presenting rapidly progressive airway compromise after four hours of consecutive recreational inhalation of dust removal spray. After being admitted to the Intensive Care Unit with hypertension, tachycardia, tachypnea, significant swelling of the lips and severe angioedema of the oropharyngeal mucosa, the patient, who had a diagnosis of major depression and a long psychiatric history, was

treated with anti-inflammatories, antihistamine and antibiotics and recovered in 5 days (Winston et Al., 2015).

In addition to both acute and chronic adverse consequences, early age exposure to inhalants seems to be correlated to a higher risk to develop an addiction as an adult (Crossin et Al., 2017) and cognitive impairment as the maturing brain may be more vulnerable to the acute effects of the drug (Yuncu et Al., 2015). The potential co-morbidity with psychiatric conditions such as Personality Disorders, mainly of Cluster B (for example such as Antisocial Personality Disorder, Borderline Personality Disorder or Histrionic Personality Disorder) and the correlation with delinquent and antisocial behaviours have also been questioned by researchers (Nakawaki & Crano, 2015; Perron et Al., 2008).

CASE REPORT

In early 2016, a 14-year-old girl, who we will refer to as “F.”, was accompanied to our Ser.D. by the mother and the stepfather, who were seriously concerned for her health. They described her recent behaviour as being characterized by the lack of acceptance of house rules, frequent runaways from home, together with suspecting use of psychoactive substances.

Earlier that year F. had left school, where she was attending an Intermediate Care Technician course.

After a short interaction with a nurse, the first psychiatric interview and assessment took place. This was at first carried out in presence of F.'s parents, but this turned out to be difficult to manage because of their conflictual relationship between F. and her mum. Parents were consequently asked to leave the room and rejoin at the end of the assessment with the purpose of establishing a therapeutic relationship with the teenager girl. During the conversation, F. showed cooperation and interest in answering to the questions, providing detailed information in her statements.

F. was born in Eastern Europe and arrived in Italy at the age of 4, when her mother decided to leave her homeland and her husband (F.'s biological father, who was never in contact with the girl and has no parental rights). F.'s mother married an Italian man who formally adopted her. In 2010, the couple had another daughter. During the clinical interview, F. confirmed the initial impression, describing a highly conflictual relationship with her mother. She told she ran away from home more than once because she could not tolerate her mother's behaviour.

When asked about her abuse of psychoactive substances F. admitted two experimental episodes of cannabis use. She also disclosed a recreational use of alcohol, which caused an access to the Emergency Unit during the previous summer, due to alcohol-induced coma. Such use had been

occasional in the previous year, mostly in the form of binge-drinking. She denied to have ever used any other psychoactive substance, but admitted having started to inhale spray cans, containing Difluoroethane, used to clean computer's screens and keyboards dust during the previous month and half: she revealed that this behaviour is very popular in her peers as the spray cans are easy to reach, legal and cheap. She used the spray more than 10 times, approximately one or two episode per week, in which she frequently re-dosed to obtain longer effects and greater positive feelings. The psychoactive effects she experienced were euphoria, relaxation feelings and vivid dreams. At the same time, she reported side-effects after the intake, mainly consisting in persistent headaches and in a syncopal episode which took place after a few repeated inhalations. The persistent headache episodes, lasting more than 24 hours, caused her concentration difficulties: due to this, and against the opinion of her parents, she decided to quit school few weeks before. She claimed she wanted to discontinue such use, as she is aware that this may "hurt her brain and lungs".

During the first interview, F. revealed a shy and introvert personality. She disclosed that about two years before she was victim of bullying due to her overweight and eating behaviour, characterized by binge-eating episodes, without purging activity. In order to overcome her eating disorder, she attended psychotherapy sessions at the local Paediatric Neuropsychiatry Unit. During a session, she reported that her binge-eating episodes were a way to fill her need of love and self acceptance and also to calm her feeling of emptiness. At the time of the clinical assessment, it was not possible to diagnose a Binge Eating Disorder as all the symptoms mostly belonged to the past. Also, even if F. experienced a very complicated relationship with her mother and it was very hard for her to follow the house rules, her case did not fulfil the criteria of a Conduct Disorder.

During the assessment it also emerged that local Prosecutor's Public Office previously required an investigation after an episode of binge drinking that led F. to hospital in a coma condition. The rapid escalation of her behaviours, social and family issues and the suspect of illegal substances use were very concerning to the Health and Social workers involved in her case that recommended a treatment in a social-educational therapeutic community.

A toxicology screen test on hair was also performed (3 cm segment): test results were negative to all the standard abuse substance searched (e.g., cannabis, cocaine, heroin, MDMA), confirming the information she reported in her medical and toxicological history.

A second psychiatric appointment was scheduled about two weeks after the first interview, but only the parents attended as F. was reported missing few days before and the police was investigating the case. No further psychological or medical treatment could be undertaken. After a few months, our

Ser.D was informed that F. was found and assigned by Court order to a social-educational therapeutic community for young people with substance related issues. Her persistent problematic behaviour, school drop-outs and the highly conflictual relationship with her mother, justified the need for an intensive rehabilitation and reintegration intervention.

In June 2016, the psychiatrist who carried out the first clinical interview attended a Multidisciplinary Evaluation Unit (UVM) meeting to discuss her case. Attendees included representatives from the Territorial Social Services, the Paediatric Neuropsychiatry Unit and F.'s parents. At the time the girl was still hosted by a social-educational therapeutic community. As a result of this, the UVM agreed that the current treatment was not appropriate because of her young age and the risk to develop a "drug user identity". F. was thus reassigned to our Ser.D. to consolidate the therapeutic in collaboration with a Paediatric Neuropsychiatry Unit.

The following assessment took place in August 2016. F. reported that she discontinued the use of cannabis and alcohol, and that she stopped the habit of inhaling spray cans. A second toxicology screen test on hair was performed, with negative results. Such test was performed in a public laboratory and had legal validity, in order to be used for a clinical report as requested by the local Court, due to the previous criminal proceedings regarding F. A subsequent Court Order in September 2016 required for the patient a course of treatment in another social educational therapeutic community with stricter rules and more frequent assessments by clinical staff. Due to the sensitivity and the complexity of the case, an appropriate therapeutic community was chosen together by all the medical and social services involved in the case (Addiction Unit, Territorial Social Services, Child Neuro-Psychiatry Unit). The current information about F.'s health describes her as more assertive, serene and respectful of the rules. She re-started school and she is gradually building a better relationship with her mother. There are not toxicology screens to confirm it, but it appears that the girl, now 16 years old, has interrupted every use of legal or illegal psychoactive substances.

DISCUSSION

Despite the increased recreational use of inhalants which occurred over the past decade in the US and across Europe (Garland & Howard, 2012; Crossin et Al., 2017) including Italy, their adverse consequences in the general and the adolescent population remain under-investigated, and often undetected and untreated. The phenomenon is further complicated by the fact that they are difficult to detected via standard drug tests. Among the wide range of inhalants, difluoroethane-based

computer duster, seems to have reached a wide popularity among teenagers causing serious consequences for users' physical health. The neurologic and psychological development may be severely affected by such a substance, whose acute and chronic effects are almost unstudied (Yuncu et Al., 2015). Related fatalities have also been reported (Ossiander, 2015). As we have seen in the case of F. highlights, inhalants misuse may also be related to the consumption of other substances, as well as related to underlying psychiatric conditions, such as eating disorders or mood disorders. Other factors, including emotional suffering, social distress and other risky behaviours, might also play a crucial role as also confirmed in previous case studies (Williams & Storck, 2007; Winston et Al., 2015). Inhalants may be consumed by some users to cope with such dysphoric mood states (Perron et Al., 2008) which may be even exacerbated by the consequences of the misuse itself, as in the case of F.'s school discontinuation. A multidisciplinary approach involving clinicians, psychologists and local social services, among others healthcare and social science professionals, is needed in order to prevent and mitigate the health risks associated with the spread of such a hazardous trend. Very little is also known about potential psychotherapeutic and psychopharmacologic forms of treatment (Kurniali et Al., 2012; Winston et Al., 2015; Beauvais et Al., 2002) and the current lack of guidelines may prevent clinicians to promptly address and treat such a condition. We hope our case report will encourage further discussion and debate about the suffering and the dysfunctional coping of adolescents in a changing scenario where drug consumption assumes always new and hazardous behaviours.

Author statement

Ermelinda Levari: Conceptualization; Writing- Original draft preparation;

Martina Stefani: Investigation

Roberta Ferrucci

Attilio Negri: Investigation; creation of the published work

Ornella Corazza: Supervision; Writing- Reviewing and Editing

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

AUTHORS CONTRIBUTION

EL carried out the literature review and wrote the first draft of the manuscript; MS supported the data analysis and the preparation of this manuscript; RF revised this manuscript at different stages; AN contributed to preparation and submission of this work; OC advised and supervised the preparation of this manuscript.

REFERENCES

- Avella J, Wilson JC, Lehrer M. Fatal cardiac arrhythmia after repeated exposure to 1,1 difluoroethane. *Am J Forensic Med Pathol* 2006; 27: 58-60;
- Bass M: Sudden sniffing death. *Jama* 1970 ; 2075:pp 212;
- Beauvais F, Jumper-Thurman P, Plested B, et al. A survey of attitudes among drug user treatment providers toward the treatment of inhalant users. *Subst Use Misuse*. 2002;37(11): 1391–410
- Crossin, R., Cairney, S., Lawrence, A. J., & Duncan, J. R. (2017). Adolescent inhalant abuse leads to other drug use and impaired growth; implications for diagnosis. *Australian and New Zealand Journal of Public Health*, 41(1), 99–104. <https://doi.org/10.1111/1753-6405.12595>
- Dipartimento Politiche Antidroga (2017) Relazione Annuale Al Parlamento 2017 Sullo Stato Delle Tossicodipendenze In Italia. Retrieved at http://www.politicheantidroga.gov.it/media/2153/relazione-al-parlamento_2017.pdf
- ESPAD Group (2016), ESPAD Report 2015: Results from the European School Survey Project on Alcohol and Other Drugs, Publications Office of the European Union, Luxembourg.
- Espeland K: Identifying the manifestations of inhalant abuse. *Nurse Pract* 1995; 20 : pp.49
- Garland, E. L., & Howard, M. O. (2012). Volatile substance misuse: Clinical considerations, neuro-psychopharmacology and potential role of pharmacotherapy in management. *CNS Drugs*, 26(11), 927–935. <https://doi.org/10.1007/s40263-012-0001-6>
- Hahn T, Avella J, Lehrer M. A motor vehicle accident fatality involving the inhalation of 1,1 difluoroethane. *J Anal Toxicol* 2006; 30: 638-42;
- Henretig F.. Inhalant abuse in children and adolescents. *Pediatr Ann* 1996; 25: pp.47
- Jevtovic-Todorovic V, Todorovic S.M., Mennerick S., et A: Nitrous oxide (laughing gas) is an NMDA antagonist, neuroprotectant and neurotoxic. *Nat Med* 1998; 4: pp 460
- Kurniali P.C., Henry L., Kurl R., Mehare JV: Inhalant abuse of computer cleaner manifested as angioedema. *Am J Emergency Med* 2012 Jan;30(1):265.e3-5. doi: 10.1016/j.ajem.2010.12.003. Epub 2011 Feb 3
- Lipari, R. N. (2017). Understanding Adolescent Inhalant Use. The CBHSQ Report. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/28722849>
- Nakawaki, B., & Crano, W. (2015). Patterns of substance use, delinquency, and risk factors among adolescent inhalant users. *Substance Use and Misuse*, 50(1), 114–122. <https://doi.org/10.3109/10826084.2014.961611>

National Institute on Drug Abuse (NIDA). (2017). Monitoring the Future Study: Trends in Prevalence of Inhalants for 8th Graders, 10th Graders, and 12th Graders. Retrieved from <https://www.drugabuse.gov/drugs-abuse/inhalants>

Ossiander, E. M. (2015). Volatile substance misuse deaths in Washington State, 2003-2012. *American Journal of Drug and Alcohol Abuse*, 41(1), 30–34. <https://doi.org/10.3109/00952990.2014.956110>

Perron BE, Vaughn MG, Howard MO. Reasons for using inhalants: evidence for discrete classes in a sample of incarcerated adolescents. *J Subst Abuse Treat*. 2008;34:450–5.

Tucci, J. R., Whitford, G. M., McAlister, W. H., Novack, D. V., Mumm, S., Keaveny, T. M., & Whyte, M. P. (2017). Skeletal Fluorosis Due To Inhalation Abuse of a Difluoroethane-Containing Computer Cleaner. *Journal of Bone and Mineral Research*, 32(1), 188–195. <https://doi.org/10.1002/jbmr.2923>

Vazan P, Khan MR, Poduska O, et al. Chronic toluene use among Roma youth in Eastern Slovakia. *Subst Use Misuse*. 2011;46(Suppl. 1):57–61.

Willams J.F., Storck M.: Inhalant abuse. *Pediatrics* 2007; 119: pp.1009-1017;

Winston A., Kanzy A., Bachuwa G: Air Duster abuse causing rapid airway compromise. *BMJ Case Rep* 2015; 2015: bcr2014207566. Published online 2015 Jan 7.;

Yuncu, Z., Zorlu, N., Saatcioglu, H., Basay, B., Basay, O., Zorlu, P. K., ... Gelal, F. (2015). Abnormal white matter integrity and impairment of cognitive abilities in adolescent inhalant abusers. *Neurotoxicology and Teratology*, 47, 89–95. <https://doi.org/10.1016/j.ntt.2014.11.009>