

# Cognitive, Imaging, and Psychiatric Changes Associated with Chronic Toluene Use

## Introduction

- More than 22 million Americans age 12 and older are reported to have misused inhalants.
- Toluene, the most commonly misused inhaled solvent worldwide, is an organic solvent found in ink, glue, paint, paint thinner, varnish, degreasers, and gasoline.
- Chronic toluene misuse has been shown to cause neuro-cognitive impairments in learning, memory, decision-making, processing speed, and concentration. Structural brain changes and severe psychiatric symptoms have also been reported.
- By better appreciating the broad range of impairments seen with chronic toluene abuse, clinicians can better identify and tailor treatment for this population.
- Here we performed an updated review to consolidate all data concerning cognitive, imaging, and psychiatric changes associated with chronic toluene use.

## Methods

- A systematic review was completed to evaluate the cognitive, imaging, and psychiatric changes associated with chronic toluene misuse. A PubMed-based search from inception through February 11, 2021, was conducted. Keywords were as follows: "inhalant abuse" OR "inhalant use disorder" OR "inhalant abuse" OR "inhalant abusers" OR "glue abuse" OR "toluene abuse" OR "sniffing" OR "huffing" AND "neurobehavioral manifestations" OR "neurocognitive disorders" OR "neuropathology" OR "neuropsychological tests" OR "neurobehavior\*" OR "neurocognit\*" OR "neuropatholog\*" OR "neuropsycholog\*" OR "cogniti\*" OR "memory."
- All studies that included cognitive assessments and imaging studies related to toluene use were included. All animal studies, literature reviews, commentaries, editorials, and non-English studies were excluded. Any case series with less than or equal to three cases was also excluded.

## Results

- The search resulted in a total of 68 studies. Of these, 17 studies met inclusion criteria, comprising a total of 697 cases.
- Imaging studies consistently showed toluene users to have cerebral/cerebellar atrophy, atrophic dilation of ventricles/sulci, loss of gray-white differentiation, corpus callosum thinning, and white matter changes. Studies also reported decreased gray matter volume in the right parietal lobe and the bilateral frontotemporal lobes; volume loss in these regions correlated with longer use.
- Markers of membrane metabolism were significantly higher in the left basal ganglia, a phenomenon seen in schizophrenia. EEG studies showed toluene use resulted in multiple abnormal EEG changes, including diffuse continuous slowing of background activity, and intermittent slowing. IMP-SPECT showed toluene use reduced regional cerebral blood flow (rCBF) in the bilateral prefrontal cortices and right temporal cortex.
- Cognitive assessments showed that toluene use resulted in the most pronounced impairment in attention, memory, visuospatial function, and complex cognition. Toluene misuse resulted in significantly lower Wechsler Intelligence Scale for Children (WISC) and Full-Scale IQ (FISQ) scores.
- Multiple assessment tools depicted slower reaction time in individuals with toluene misuse. Studies exploring visual deficits showed significantly lower scores in visual perceptual analysis, visual search, visual scanning, and ocular movements in individuals with toluene misuse. Several patients' memory impairment was so significant they were classified as "clinically demented."
- Several schizophrenia-like symptoms were linked with toluene misuse, including apathy, flat affect, auditory hallucinations, delusions, thought broadcasting, and bizarre behavior. Psychiatric symptoms, including anxiety, depression, insomnia, hostility, violent behavior, suicidality, and self-mutilation, were also associated with toluene misuse.

## Conclusion

- Toluene misuse is associated with adverse structural, cognitive, and neuropsychiatric changes.
- Imaging studies suggest toluene misuse is associated with white matter changes, gray volume loss, loss of gray-white matter differentiation, and cerebral atrophy.
- Neurocognitive testing showed that toluene misuse impairs attention, memory, visuospatial function, and complex cognition.
- Neuropsychiatric testing suggests that toluene misuse may cause schizophrenia-like symptoms, including visual and auditory hallucinations, delusions, flat affect, and bizarre behavior.
- By better understanding the effects and risks of chronic toluene misuse, clinicians may be more prepared to ask and educate their patients about chronic toluene misuse, tailoring treatment accordingly.
- Early identification and management of toluene misuse may mitigate effects seen with chronic use, aiding in improvement to the poor outcomes seen in this population.

## Authors and Disclosures

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## References and Tables

