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# Subacute Combined Degeneration of the Spinal Cord Secondary to Nitrous Oxide Balloons

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**Abstract**

*Presentation*
A 16-year old male presented to hospital with limb numbness and unsteady gait. He had a background of chronic nitrous oxide misuse, prompting a possible diagnosis of subacute combined degeneration of the spinal cord (SCDC), an increasingly prevalent cause of the neurological disorder.

*Diagnosis*
This diagnosis was confirmed with magnetic resonance imaging of the spine which demonstrated typical T2 hyperintensities in the posterior cervical and thoracic cord.

*Treatment*
As SCDC is caused by vitamin B12 deficiency, he was treated with intramuscular vitamin B12 injections. His gait and sensory symptoms improved within days.

*Discussion*
Nitrous oxide or "laughing gas" is cheap and accessible making it an increasingly popular recreational drug in Ireland, particularly among teenagers. It is not a controlled substance despite its severe side effects including significant neurological complications.

## Introduction

SCDC is characterised by demyelination of the dorsal column and lateral corticospinal tract. It occurs as a result of vitamin B12 (cobalamin) deficiency. This is typically caused by nutritional deficiency or gastrointestinal disease affecting B12 digestion and absorption[1]. However, nitrous oxide misuse is emerging as a cause of SCDC[2].

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**Case report**

A 16-year-old right handed male presented to hospital with a three week history of progressive lower limb numbness which had ascended from his toes to hips. This was associated with gait unsteadiness. He required crutches to mobilise. He was also experiencing fingertip numbness and intermittent shock like sensations throughout his body provoked by turning his head consistent with Lhermitte's sign.

The patient had been using nitrous oxide for four years. His usage had increased in recent months to approximately 12 bottles of nitrous oxide each weekend.

His medical history was significant only for delivery post term with a prolonged labour during which he sustained hypoxic ischaemic encephalopathy. He had no family history of neurological disorders.

His neurological examination revealed an ataxic gait which was worsened by elimination of visual input. He was Romberg's positive. Upper limb examination revealed normal tone and power but reduced reflexes. Vibration sense was reduced to the metacarpophalangeal joints and proprioception to the wrists bilaterally. Lower limb examination demonstrated increased tone bilaterally but no evidence of clonus and his plantars were downgoing. Power was preserved but reflexes were absent bilaterally. Vibration sense was reduced to the hip and proprioception to the ankles bilaterally. Cranial nerve examination was normal with no RAPD.

Biochemical tests demonstrated vitamin D and folate deficiencies but serum B12 levels were normal. His methylmalonic acid levels were significantly raised (2,316 nmol/L), however, indicative of a functional B12 deficiency (Fig. 1). He was not anaemic and there was no macrocytosis. Vasculitis and myositis screens were negative.

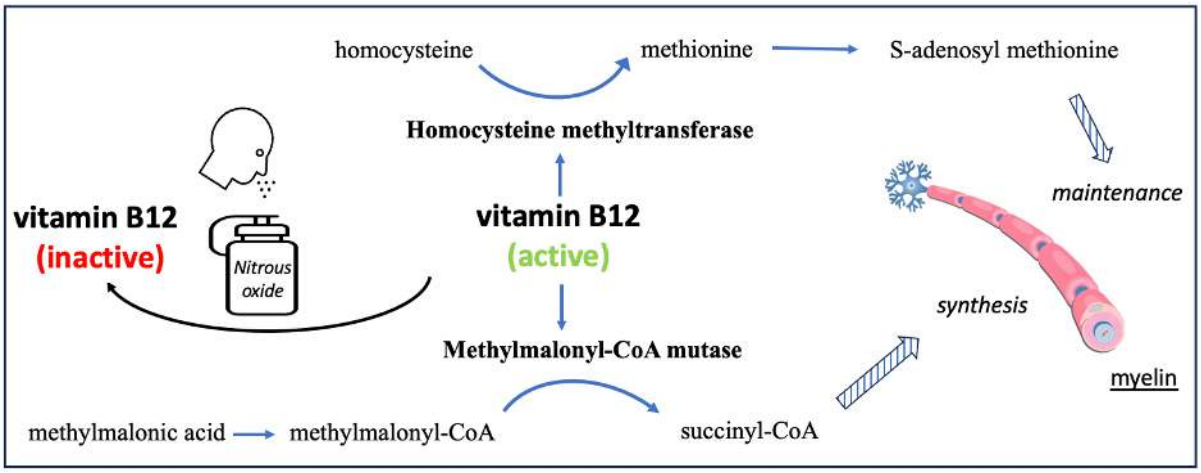

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Figure 1: Vitamin B12 is inactivated through nitrous oxide inhalation. Vitamin B12 is a coenzyme in metabolic pathways related to synthesis and maintenance of myelin sheath. Inhibition of methylmalonyl-CoA mutase causes build-up of methylmalonyl-CoA which is incorporated into myelin sheath in substitution for fatty acids resulting in an unstable, degradation prone sheath. As methylmalonic acid is a precursor of methylmalonyl-CoA, high levels are indicative of a relative B12 deficiency.

CSF analysis demonstrated a normal cell count and mildly increased protein levels. A CSF viral screen was negative.

Magnetic resonance imaging of his spine demonstrated increased T2 hyperintensity throughout the cervical and thoracic cord. The abnormality was central and extending into the posterior cord consistent with SCDC (Fig. 2). Brain imaging demonstrated findings consistent with previous imaging following hypoxic brain injury sustained at birth.

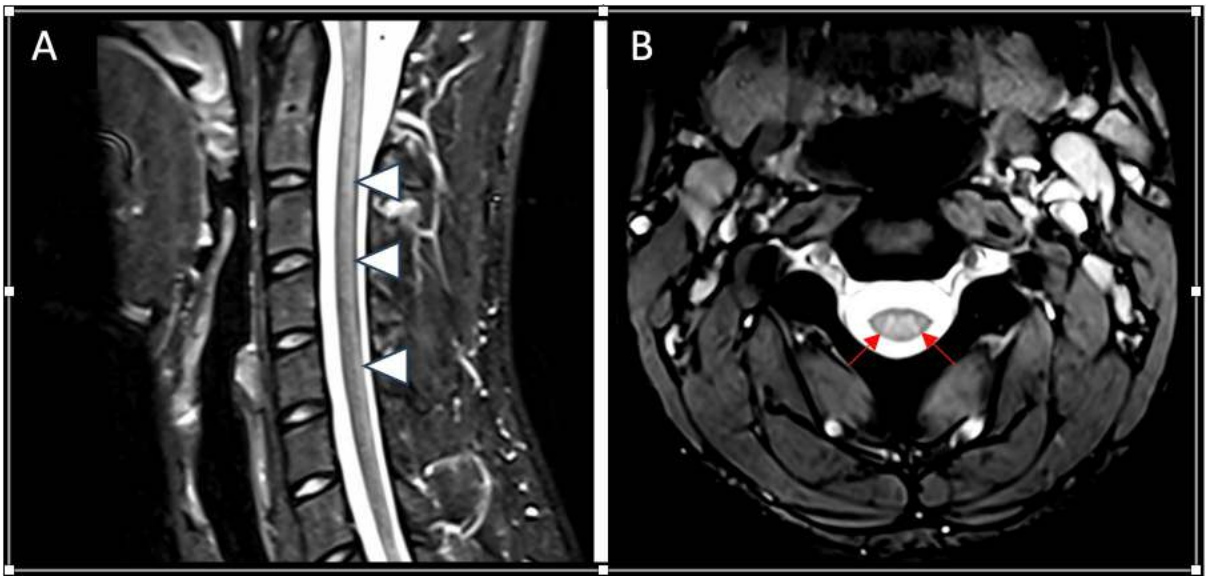


*Figure 2: [A] Sagittal view of MRI cervical spine demonstrating subtle diffuse T2 hyperintensity along posterior cord. [B] Axial T2 weighted image of cervical spine which shows symmetrical bilateral high signal along the dorsal columns, known as the "inverted V sign."*

The patient was treated with intramuscular vitamin B12 injections, Pabrinex® (vitamins B and C) and folic acid replacement. Clinical improvement was seen within days. He went from mobilising with crutches to independently. His sensory symptoms also began to improve.

**Discussion**

SCDC results from demyelination of the dorsal columns and lateral corticospinal tracts. Therefore, clinical features include changes in proprioception/vibration sense and upper motor neuron signs respectively. It is caused by vitamin B12 deficiency typically due to poor

nutrition or gastrointestinal disease affecting B12 digestion and absorption[1]. However, more recently, SCDC has been attributed to nitrous oxide inhalation. Nitrous oxide or "laughing gas" historically has been used as an anaesthetic, following which cases of SCDC were observed. More recently it has become a popular recreational drug as it causes a brief euphoric effect or high[2]. Nitrous oxide acts by converting B12 into an inactive form, hence the patient's normal B12 level. Vitamin B12 acts as an enzyme cofactor in macromolecular metabolism required for synthesis and maintenance of the myelin component of nerve sheaths, therefore deficiency compromises myelin integrity (Fig. 1)[3].

Nitrous oxide is cheap, accessible and it is not currently a controlled substance in Ireland. Furthermore, the prevalence of nitrous oxide "balloon" use is increasing. A survey of Irish adults (18 years and over) conducted in 2021 (n = 4,398) found that 23% of those who had used illicit drugs in the last year had used nitrous oxide previously. Another survey carried out in Dublin in 2021 (n = 2,384) found that 6% of males and 5% of females aged 15-17 years old had used nitrous oxide[4].

This case report stresses the importance of SDCD symptom recognition and the need for regulation of nitrous oxide given the likelihood of its incidence increasing in coming years.

**Declaration of Conflicts of Interest:**
None declared.

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