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**SOLVENT NEUROTOXICITY IN VEHICLE COLLISION
REPAIR WORKERS**

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Samuel John Keer

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Abstract

Previous studies have shown that vehicle collision repair workers may be at risk of solvent-induced symptoms of neurotoxicity. Changes in industry practices have likely resulted in reduced exposure, but little research has been conducted to assess whether this has reduced the risk of neurotoxicity. This thesis describes a series of studies, which aimed to assess: i) contemporary airborne solvent exposures in collision repair workers; ii) the determinants of airborne solvent exposures; iii) the prevalence of self-reported symptoms of neurotoxicity and objectively measured neuropsychological performance, compared to an unexposed reference group; iv) dose-response associations; and v) the effect of personal protective equipment (PPE) and good workplace hygiene on symptom prevalence.

In total, 370 vehicle collision repair and 211 construction workers (reference group) were recruited. Personal airborne solvent exposure was assessed in 85 collision repair workers, and information on demographics, work practices and symptoms was collected by questionnaire. A sub-group of 47 collision repair and 51 reference workers also completed a battery of neuropsychological tests.

Full-shift, airborne exposures were well below New Zealand and international occupational exposure limits (range, 0.04 – 16.5 ppm). Job title was the strongest predictor of exposure, and non-spraying tasks (e.g. mixing paint and cleaning equipment) were associated with higher exposures than spray painting itself.

Collision repair workers reported significantly more symptoms of neurotoxicity than the reference group, with odds ratios (ORs) of 2.0, 95% CI 1.3-3.3; 2.4, 1.2-4.8; and

6.4, 1.8-23.0, for reporting ≥ 5 , ≥ 10 and ≥ 15 symptoms, respectively. They also performed more poorly on neuropsychological tests, particularly those that measure attention/concentration and motor speed/dexterity (e.g. reference vs. collision repair group score on the RBANS total attention scale, -9.5, 95% CI, -15.9, -2.8).

Consistent use of PPE (particularly gloves) and good workplace hygiene practices were strongly protective against symptoms, with reductions in risk of up to 90% for those who most consistently wore PPE.

In conclusion, despite relatively low airborne exposure levels, collision repair workers continue to be at risk of solvent-induced neurotoxicity. These findings provide a strong evidence-base for the development and implementation of intervention programmes to reduce solvent exposures and associated morbidity in this population.

Authors Declaration

This thesis was produced according to Massey University's "thesis-by-paper" requirements i.e. it is based on research that is published. Each individual chapter is set out in the style of the journal in which it has been published. Consequently, some of the chapters are relatively succinct, there is some repetition (particularly in the methods sections) and there are small stylistic differences between chapters.

The published manuscripts include other authors who provided technical expertise and contributed to the writing of the papers, including my PhD supervisors and, in some cases, collaborators in different institutes in New Zealand and the U.K. However, for each chapter, my input was greatest, as reflected by being first author on the paper. I was the lead investigator for the studies described, involved in oversight of study design, recruitment, work co-ordination and data collection, data analysis and preparation of the manuscripts. I was also involved in preparation of the ethics application prior to the conduct of these studies.

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Abbreviations

NIOSH	National Institute of Occupational Safety and Health
CSN	Chronic Solvent-induced Neurotoxicity
CSE	Chronic Solvent-induced Encephalopathy
CTE	Chronic Toxic Encephalopathy
CNS	Central Nervous System
PNS	Peripheral Nervous System
PPE	Personal Protective Equipment
DNA	Deoxyribonucleic Acid
RNA	Ribonucleic Acid
IARC	International Agency for Research on Cancer
WHO	World Health Organisation
CAT	Computer Aided Topography
MRI	Magnetic Resonance Imaging
Q16	Neuropsychological Questionnaire 16
PNF	Psychologisch-Neurologischer Fragebogen (Questionnaire)
POMS	Profile of Mood States
NCTB	Neurobehavioral Core Test Battery
NES	Neurobehavioural Evaluation System
BARS	Behavioural Assessment and Research System
CANTAB	Cambridge Neuropsychological Performance Test Automated Battery
BEES	Behavioural Evaluation for Epidemiological Studies
RBANS	Repeatable Battery for the Assessment of Neurobehavioural Status
NART	National Adult Reading Test
JEM	Job-Exposure Matrix
TWA	Time-Weighted Average
TLV	Threshold Limit Values
WES	Workplace Exposure Standards
PEL	Permissible Exposure Limit
OEL	Occupational Exposure Limit
STEL	Short-Term Exposure Limit

ALV	Additive Limit Value
GCMS	Gas Chromatography Mass Spectroscopy
VEM	Video Exposure Monitoring
PIMEX	Picture Mixed Exposure
NSC-60	Neurobehavioural Symptom Checklist
LEV	Local Exhaust Ventilation
OR	Odds Ratio
CI	Confidence Interval
ER	Exposure Ratio
NZ	New Zealand
SIFT-MS	Selected-Ion flow-Tube Mass Spectroscopy
MEK	Methyl Ethyl Ketone
MIK	Methyl Isobutyl Ketone
GM	Geometric Mean
PPM	Parts Per Million
PPB	Parts Per Billion
PPT	Parts Per Trillion
W/W	Weight for Weight (Percentage Mass)
CRA	Collison Repair Association of New Zealand
HRC	Health Research Council of New Zealand
CR	Collision Repair
DASS	Depression, Anxiety and Stress Scale
SME	Small to Medium-sized Enterprise