

Commentary: Can isocyanate-induced occupational asthma in motor vehicle repair (MVR) be prevented? Learning from a successful UK project.

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Abstract: What's important about this Commentary?

1. It reviews the UK motor vehicle repair (MVR) industry size and make-up
2. It explains why paint sprayers, despite working in spray booths/rooms and wearing air-fed breathing apparatus were at relatively high risk of contracting occupational asthma (OA) from isocyanate inhalation
3. It itemises misperceptions about how exposure occurs and what the risks are from isocyanate exposure, and describes the HSE (Health and Safety Executive) Project to correct these misperceptions
4. It outlines the success of the Project in terms of reduced isocyanate exposure as measured with biological monitoring (BM) and reduced risk of OA amongst MVR workers
5. It discusses the use of air-fed breathing apparatus and the inappropriateness of recommending half-mask negative pressure respirators
6. It makes the point that in the circumstances of use, skin contact and absorption is insignificant
7. Recently BM exposure measurements have risen. The commentary suggests how this can be countered and ends by discussing how OA risk from isocyanate usage in MVR might be prevented in the UK and in other countries

MVR bodyshops and HSE Project background

With the introduction of 2-pack isocyanate paints and the dipping of bodywork in primers rusting of vehicle bodywork has more-or-less been prevented. The urethane coatings are tough, water resistant and colour stable. But they have a drawback, the isocyanate component can induce occupational asthma (OA). In the UK MVR paint sprayers in 2013 had ninety times the risk of contracting OA than the industrial average and one-in-ten people with OA, working in bodyshops, were not sprayers (HSE 2015)

In the late 1990s I interviewed 12 MVR paint sprayers with OA to find out what exposure control measures they used and why they had failed. Most worked in spray booths, some in spray rooms, and wore ori-nasal negative pressure half-mask respirators primarily to control exposure to the paint solvent. This was the respiratory protective equipment (RPE) recommended for the cellulous paints used before two-pack isocyanate paints were introduced. They and their employers assumed the level of respiratory protection provided was adequate when the new 2-pack paints

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were introduced. None of the sprayers interviewed knew that booths had a clearance time or that the new paint, which they liked because of its technical qualities, could cause OA. From 1984 HSE recommended that sprayers use air-fed breathing apparatus (HSE 1984) and from then on inspectors enforced against this standard.

Before the Project a hundred visits were made in Southeast England and sprayers were asked about the risks from 2-pack isocyanate paints 16% didn't know they were working with isocyanate paints and 50% didn't know that OA was the main health risk. When asked, people said that the paint contains cyanide (which it doesn't) and poisons you or gives you cancer. Ignorance was widespread.

In 2001 the Health and Safety Executive (HSE) started the Disease Reduction Programme (DRP) One DRP target was a 30% reduction in occupational asthma. A project team focused on MVR bodyshops was formed which I chaired. For more details see Jones et al (2013) and Piney et al (2015).

In 2005 there were approximately 21,000 spray painters in the UK of which MVR sprayers comprise about 60%, or about 12,000 workers. Over half worked in small

Figure 1 Fine invisible paint mist from spraying



and micro businesses (fewer than ten employees) and many only had one painter (Broughton et al, 2010). There were about 8000 MVR bodyshops in the UK (HSE 2007a). Initially it was not obvious why occupational asthma risk for MVR sprayers was still so high. Most worked in specialised enclosing spray booths and wore air-fed breathing apparatus. The earlier interviews, site visits, assessment of the hygiene literature and discussions with employers and industry suppliers showed:

1. That none of the stakeholders questioned, including the suppliers, realised that spraying created a fine invisible paint mist (Figure 1), or,

2. That airborne isocyanate concentrations created during spraying are high; in spray booths they are in the hundreds of micrograms per cubic metre of air ($\mu\text{g}/\text{m}^3$) and in spray rooms (generally home-constructed internal rooms with rudimentary extraction and filters) often in the thousands of $\mu\text{g}/\text{m}^3$ (Pronk et al 2006, White et al 2006, Fent et al 2008). (See Figures 2 and 2a and 2b).
3. That many employer and supplier stakeholders did not realise that spray booths and rooms had a “clearance time”, and needed to be kept under slight negative pressure to prevent paint mist leakage (HSE 2008a)
4. Many sprayers did not understand that lifting visors to examine the paint film quality, or removing their respiratory protective equipment (RPE) before the booth/room has cleared could expose them to isocyanates (Williams et al, 1999).
5. Appreciation of the health risk was misperceived, as was the main exposure route. When sprayers were asked what was the main risk from using 2-pack isocyanate paints they invariably, and wrongly, replied “cancer”. And when asked ‘how does the isocyanate get into your body’, many said that it went through the skin, some adding ‘especially the thin skin around the eyes’.

To improve understanding and awareness and give advice on controlling exposure in ways accessible to small businesses, HSE developed the MVR Bodyshop Project (started in 2004, HSE, 2007). The overall aim was to improve isocyanate exposure control by 2008 in at least 20% of premises (approximately 1600 MVR bodyshops) via three interlinked strands of work comprising:

- i. A programme of Safety and Health Awareness Days (SHADs),
- ii. On-site visits by HSE Inspectors or Health & Safety Awareness Officers, and,
- iii. Engagement with third party stakeholders (spray booth and equipment manufacturers, local suppliers, trade associations, occupational health providers, training providers such as colleges).” (Jones et al 2013)

“A mixed-media format was developed and structured based on previous HSE research into engaging with small and micro-businesses (Strutt et al, 2004). Part of the effective communication strategy included repeating key messages in a variety of different and engaging ways. The SHADs were piloted and amended to have maximum impact on bodyshop audiences, using before and after evaluation forms as simple measuring tools (O’Hara et al, 2006a).”

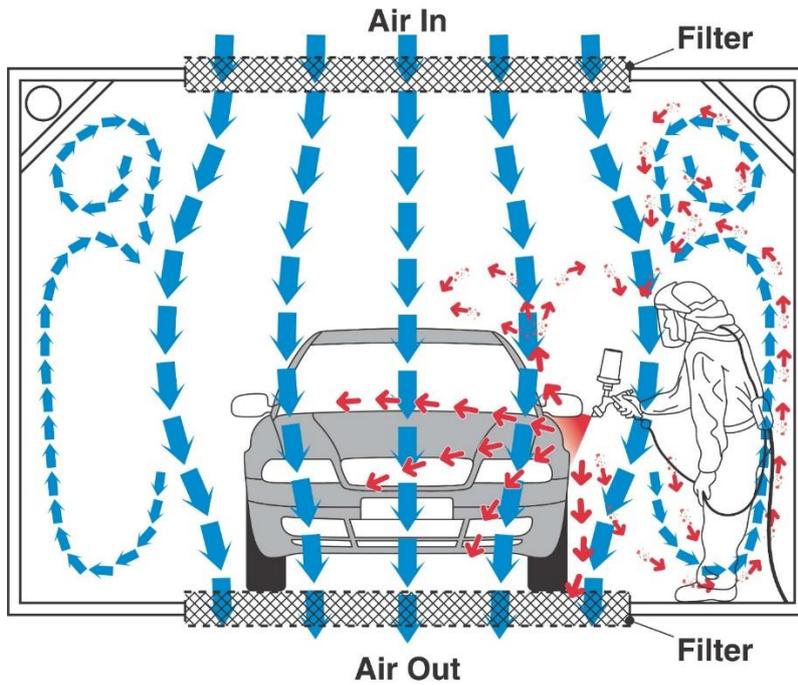


Figure 2 Downdraught spray booth showing air movement including recirculating eddies

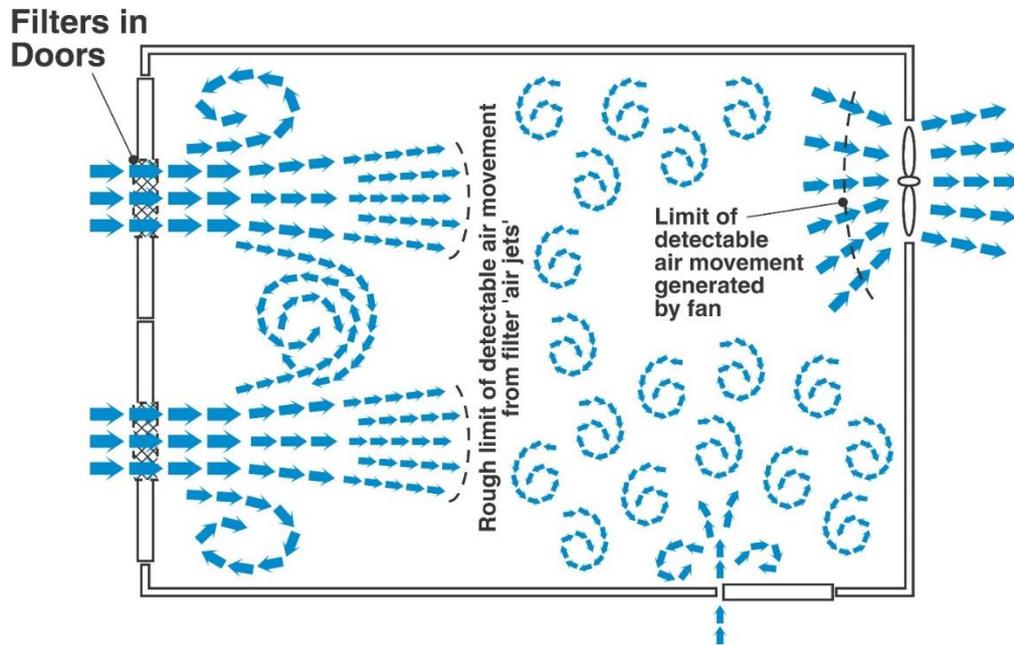


Figure 2a showing air movement in a spray room

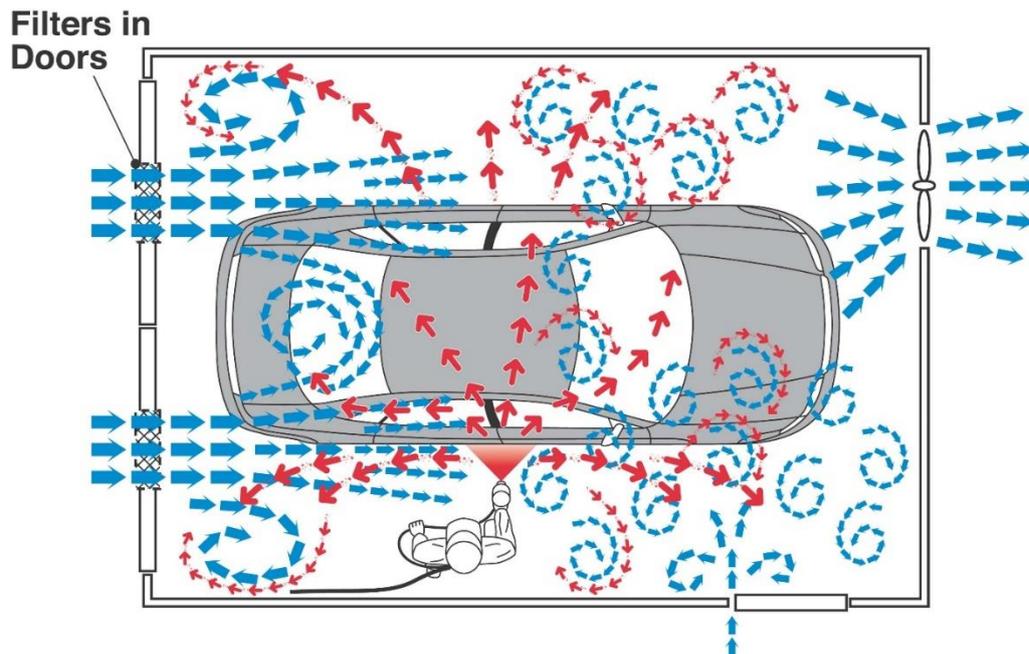


Figure 2b showing air movement in spray room and spread of fine paint mist

Spray booth and room clearance time can be measured using a smoke generator and following simple instructions Saunders et al (2006). Companies performing the annual thorough examination and test of spray booths/rooms under the Control of Substances Hazardous to Health (COSHH) Regulations could do such work

HSE MVR Project impact

We consciously followed the marketing acronym AIDA (Awareness, Interest, Desire and Action). The SHADs took the audiences through all stages of AIDA. To encourage action the 4000 attendees representing 1400 bodyshops (14% of the total) were offered free isocyanate biological monitoring kits with instructions, a consent form and a questionnaire. A high proportion of the post-SHAD BM samples were non-detectable (83%). No exposure differences were found between people using visor and half-mask breathing apparatus and between people working in booths and rooms. People recording raised exposure levels greater than the UK BM Guidance Value BMGV of 1 $\mu\text{mol/mol}$ creatinine were offered free repeat sampling. Eighty five percent of repeat samples were below the limit of quantification and the results were significantly lower than the initial results.

The exposure control measures in this, as in many cases, are a mixture of having the correct equipment and understanding and adopting the correct methods of working (Figure 3). At each SHAD the HSE speaker made clear that the risk of occupational asthma was preventable, and the bulk of each event focused on simple, practical control measures. Post event questionnaires showed the SHADs were very well received by the audience and substantially improved their knowledge of the hazards of isocyanates, the means of controlling exposure and how to check control measures were working. Eighteen percent of UK body shops attended a SHAD and 90% of attendees intended to take some action to improve their control of exposure to isocyanates (O'Hara, 2006a). A follow-up survey, after one of the pilot

events, found that over 50% of MVR bodyshops had actually improved exposure control measures (O’Hara et al, 2006b). A subsequent independent evaluation of the project impact (Broughton et al, 2010) showed that some of the key messages, for instance, concerning spray booth clearance time, had been adopted in the large majority of UK bodyshops” Jones et al (2013)

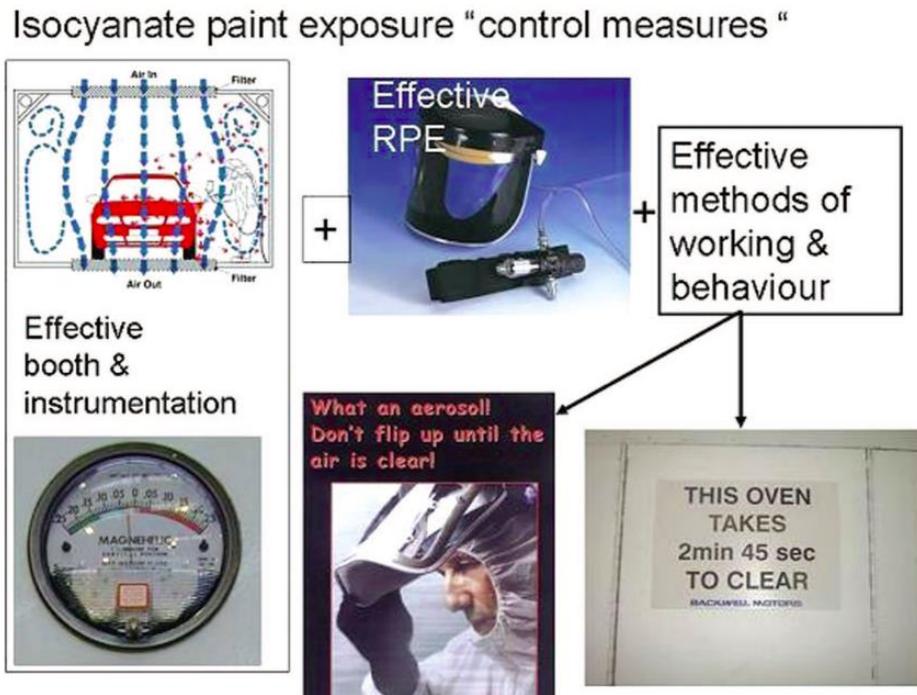


Figure 3 MVR Bodyshop Isocyanate exposure control measures

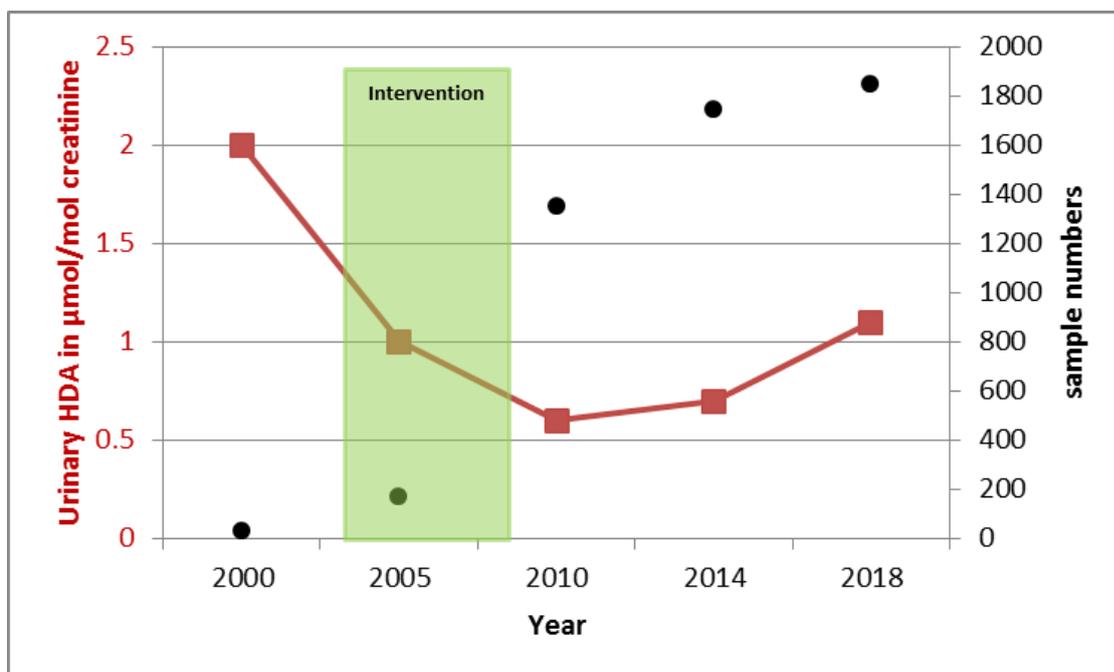


Figure 4 Urinary HDA (1,6-Hexamethylene Diamine) and sample numbers

For some years after the project BM levels were mainly below the UK BMGV but an increase in BM results 2012 - 2018 suggest that some of the key project messages need reinforcing Figure 4, Jones (2024)

What impact did the Project have on OA incidence in the MVR industry?

The question can be answered in two ways. Stocks et al (2015) compared the BM values recorded for MVR bodyshops from Health and Safety Laboratory (HSL) samples with Surveillance of Work-related and Occupational Respiratory Disease (SWORD) cases. Incidence ratios for OA fell from 1.0 in 2002-2005 to 0.3 2012-2014 (a fall of 70%) after the MVR Project. And asthma cases, after the Project had finished fell from approximately 24 cases per hundred thousand workers in 2003-2005 (before the Project) to 10 per 100,000 in 2009-2011 to 1 per 100,000 in 2014-2016 (a fall of ~96%) Jones (2024)

The evidence suggests that the MVR Project reduced isocyanate exposure and OA risk by more than 30% the DRP target.

Discussion

Respiratory protection and the need for air-fed breathing apparatus

1. Both half mask and visor devices provide high levels of protection. Judging from the spray rooms BM results protection factors in practice are greater than 40, the assigned protection factors (APF) for these devices. HSE HS 53 (2013). Clayton and Baxter (2015) measured protection factors in the thousands.
2. Sprayers using visors are tempted to flip up the visor at the end of a spraying session to check on the wet paint film applied and spray some more in the 10 or so seconds while the film is 'wet'. Solutions to this problem could be to supply tear-off transparent sheets as used by F1 racing drivers – these might supply a good-enough field of view. Or visors which are scratched could be replaced. Or, if this doesn't work, the sprayer could use an air-fed half-mask device
3. Both half-mask and visor air-fed devices can provide respiratory protection for more than one hour HSE 2013 HSE HS 53 (2013)
4. Half-mask negative pressure respirators have a maximum APF of 20. They cannot provide sufficient respiratory protection for sprayers working in for either spray booths (hundreds of micrograms of isocyanate per cubic metre of air $\mu\text{g}/\text{m}^3$) and certainly not for spray rooms (thousands of $\mu\text{g}/\text{m}^3$ isocyanate per cubic metre of air $\mu\text{g}/\text{m}^3$). A similar conclusion was reached by Reeb-Whitaker et al (2012)
5. According to HSG53 (HSE 2013) such devices should not be worn for more than one hour)

6. If an HSE inspector comes across an MVR workplace where the sprayers use such devices he or she will normally issue a Prohibition Notice and require the employer to provide air-fed breathing apparatus, Figure 5.
7. Half-mask negative pressure respirators are recommended in the USA, Australia and possibly other countries. It's strongly suggest that only air-fed breathing apparatus can provide sufficient protection and RPE standards in these countries should be updated and improved.



Figure 5 Inadequate half mask negative pressure respirator used to spray 2-pack isocyanate paint

How are people exposed in MVR bodyshops?

Some have implied that exposure in MVR bodyshops can occur via the skin as well as the lungs (see Pronk et al (2006) & Fent et al (2008)). In the circumstances of use I think that this is incorrect. Sprayers in the UK wear Tyvek type boiler suits, nitrile gloves and their faces are often protected by visors. The fine paint mist hardly settles at all surfaces in the booth/room. The last thing a sprayer wants to do is to come into skin contact with the wet paint film he (or she) has just so carefully applied.

How are the 1 in 10 with isocyanate OA, who are not paint sprayers, exposed?

In at least four ways:

1. The person enter the spray booth or room during the clearance time and/or during paint spraying (Figure 6)

2. The booth is under positive pressure and leaks into the bodyshop workplace
3. Exhaust air from the booth or room is not filtered correctly and recirculates back into the Bodyshop
4. Spraying takes place in the open workshop i.e. not in a spray booth/room

All of these sources of exposure can be managed and controlled

Figure 6 Person without any respiratory protection enters spray booth during spraying and during the booth clearance time



Can occupational asthma (OA) in MVR bodyshops be prevented?

1. In the UK the recent BM results suggest that the impact of the MVR project on exposure control measures has waned and there is a need to reinforce the original messages. I suggest, because they have maximum impact, using videos on the HSE YouTube site using SHAD audiovisual material. The Cardiff SHAD was filmed and edited videos and Powerpoint presentations are available from the HSE Health and Safety Laboratory. And perhaps mailing all UK bodyshops about the further information. As well as putting articles in the trade magazines. HSE inspectors could reinforce the key messages during their visits.
2. If the paint sprayer wear air-fed breathing apparatus, allows for the clearance time and knows how to exit the booth/room safely then more-or-less no isocyanate exposure occurs. Similarly, if others who have to enter the booth/space know not to do so during the clearance time then they will not be exposed. If the booth/room runs at negative pressure then no paint mist escapes and others are not put at risk. Running a bodyshop correctly means

that no-one is exposed and therefore cannot contract isocyanate induced OA. On the face of it, as long as bodyshop personnel are knowledgeable, follow the practical rules then no-one should get OA from isocyanate usage. While this is a counsel of perfection I see no reason why, with the right communication and influencing strategy, the time will come when paint sprayers and others in MVR bodyshops should not be put at risk of occupational asthma from isocyanate exposure in the UK.

Other countries need to learn the lessons from UK experience

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