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## ABSTRACT

**Objective**-Workers who are working-at-heights, in a harness, are susceptible to suspension after a fall-arrest; causing concerns about so called: “suspension trauma\*.” The purpose of this project was threefold: *i*) to consult with Working at Heights (WAH) training providers in Ontario to compare their training with regard to harness suspension management; *ii*) to assess whether harness suspension events were occurring within the industrial sector; and *iii*) to ask about harness equipment in regards to prevention of suspension syncope and compliance by workers.

**Methods**-Review of current literature databases, pertaining to harness suspension, was conducted along with consultation of 190 WAH training providers across Ontario via email, phone, or both.

**Results**-Despite clear agreement in the literature on best practice for the management and treatment of harness suspension, inconsistencies persist among WAH training providers with regards to content and recommendations surrounding management. No documented, confirmed cases of the so called “suspension trauma,” in the industrial sector, were confirmed; either through literature review or consultation with WAH training providers. Harness equipment, in particular design and fit, is considered a factor in worker compliance.

**Conclusions**-Although no confirmed industrial cases of ‘suspension trauma’ have been reported, the risk of ‘suspension trauma’ is a concern for workers and working at height trainers. The Ministry of Labour, Training and Skills Development should adopt and communicate clear guidelines on the management of harness suspension, including the proper positioning of the rescued worker after fall. Further research is merited for consideration of the impact of harness design and fit on worker compliance, as well as the impact of anthropometrics on proper harness fit.

## INTRODUCTION

In April 2015, the Ministry of Labour, Training and Skills Development (MLTSD) imposed mandatory Working at Heights (WAH) training for all workers that access working at heights.<sup>1</sup> Accordingly, workers using harnesses, as a form of personal protective equipment (PPE), increased. Despite an increased

worker/workplace awareness about the risks of falls from height and enhanced use of PPE<sup>2</sup>, falls from height fatalities continue to occur, at a rate consistent to prior WAH mandatory training.<sup>3</sup> In 2018, the MLTSD completed a *Fall from Heights Fatalities Analysis* reviewing 92 fatalities caused by falling from heights during a span from 2009 to 2016. Improper use of PPE or not wearing PPE were contributing factors in 63 of the fatality cases.<sup>3</sup> Annually, more than 40,000 Canadians are injured due to fall accidents<sup>4</sup>, and falls from heights significantly contribute to lost time work claims.<sup>5</sup> However, when a worker experiences a fall, the injury data collected and reported, does not provide detailed reporting about the injury; most commonly, only the cause of the injury, the job type, and the height of the fall. As such little is known about the incidence of harness suspension, as a source of injury or occurrence rates, in saving lives/preventing injury. Given the rise in the use of harnesses in Ontario, it would be meaningful to know whether there is an increase in harness suspension occurrences, injuries or fatalities due to suspension; however, this data is not reported.

Anecdotally, and as part of the regular WAH training programs, workers are educated about the risk of so called “suspension trauma,” in the case of a fall, when the worker is wearing a harness. Despite the protective benefits a harness provides during a fall, a physiological phenomenon is known to occur when a worker is suspended motionless and vertically in a harness for even a short period of time (<10 min). This phenomenon causes the development of pre-syncopal symptoms and/or loss of consciousness and can lead to death.<sup>6</sup> This physiological phenomenon is called orthostatic hypotension, but it has been erroneously termed “suspension trauma\*” in the broader

community; and has also been referred to as: harness hang syndrome, suspension syncope, suspension syndrome, harness-induced pathology, and orthostatic shock while suspended.<sup>6, 7</sup>

\* The naming of suspension trauma has come into question with some researchers suggesting that the term trauma be removed and be replaced by syncope (loss of consciousness) as there is no evidence of the clinical presentation of suspension trauma.<sup>7, 8</sup> Others prefer the term suspension shock to more accurately describe the physiological response of being suspended motionless.<sup>18</sup> For the purpose of this paper the term harness suspension will be used, as this describes the condition, whether or not syncope occurs.

A clear problem is revealed when reviewing the available literature on harness suspension. Specifically, despite consensus on the management of a harness suspension; by a review panel comprised of clinical professionals in the field<sup>10</sup>, key regulatory bodies in the United States and Canada have retained outdated messaging regarding this topic. As such, communication about harness suspension to the larger community is inaccurate. This discrepancy may contribute to the lack of documented incidences of harness suspension in the industrial sector.

The present situation seems to have arisen due to the widespread citation of a non-medical report on harness suspension. This research report, was commissioned by the Health and Safety Executive (HSE), an independent regulator in Britain and was written by Paul Seddon (2002) to evaluate and report on the literature dealing with the effects of being suspended in a harness. In this report, Seddon described the literature, at the time, on a condition called “suspension trauma.” Of significance to today: emphasis was placed on the aspect of positioning a person after rescue. Specifically, in the rescue and treatment recommendations it stated:

***“Important! The casualty must never be laid down after being rescued from the suspended position, not***

***even in the recovery position. The casualty should be positioned with the upper body raised, i.e. in a seated, or possibly squatting or crouched posture [6], [19], [22], and [33].”***  
***[page 42, HSE CRR 451/2002, 2002]***

In brief, it was implied that the casualty must never be placed in a horizontal position after a harness suspension because the suspension causes the blood to pool in the pelvis and lower limbs, which then becomes acidic (due to build-up of lactic acid and other toxic wastes). Once the harness is released, that pooled blood rushes back to the heart causing heart failure, due to damage and overstrain. This concept was first proposed in 1972, at the Second Annual Conference of Rescue Mountain Doctors, in Innsbruck, Austria. At the time the term Rescue Death was introduced to describe this overload of acidic blood, re-entering the circulation back to the heart, in overwhelming concentrations and causing death, essentially from rescue. Since then, the term Reflow Syndrome has been also been used. The consensus was: to prevent Rescue Death, casualties should be placed in a sitting or at least a crouching position to allow the pooled blood to return more slowly back to heart; to reduce overstrain.<sup>9</sup> Unfortunately this discredited report is a highly cited reference regarding harness suspension and it continues to guide WAH training programs.

Due to concerns raised by first responders about the inconsistency of this positioning with standard First-responder best practice; the Health and Safety Executive commissioned a follow-up review by clinicians and other regulatory bodies. They concluded: “The correct positioning of a casualty who is suspended or who has been suspended and may be suffering from suspension trauma needs to be clarified, for the benefit of both rescuer and rescued casualty. The standard practice of

prioritization, i.e. airway, breathing, circulation (A, B, C), might be correct.”<sup>10</sup>

Publications by Adisesh et al (2009) and Thomassen et al (2009) found no evidence to support the hypothesis that a flood of toxins were responsible for any Rescue Death.<sup>7, 13</sup> A review by Roger Mortimer (2011) also questioned the ability of Reflow Syndrome to induce rapid death.<sup>8</sup> Significantly, the Health and Safety Executive updated it’s advice on the management of harness suspension and published a revised report in 2009, recognizing that medical guidance was needed for first responders and in the workplace.<sup>10</sup> They stated that their originally published report:

*“was not intended to be a review of the medical advice for rescue from suspension, it has been frequently cited in such a context and in support of measures that differ from standard UK first aid practice.”*

It was then recommended that all post-suspension patients should be treated in the same manner as any other patient suffering from syncope, that is: in a fully supine and horizontal position.<sup>10</sup> Australia followed suit in 2009, and provided guidelines on first aid and management for suspension trauma through the Australian Resuscitation Council (ARC).<sup>11</sup> In these reports it discusses positioning of casualty post-fall and concludes: there is no evidence to support placing the casualty in any position other than the horizontal (supine) position. Numerous papers since have supported this recommendation about positioning post-fall.<sup>12-19</sup> This includes recommendations that using the horizontal (supine) position should be used regardless of level of consciousness of the casualty.<sup>11, 15, 18-19</sup>

The MLTSD clearly states, under the Purpose of Working at Heights (WAH) Standard:

*“1. Ensure that workers who are exposed to the hazard of falling from heights receive high quality and consistent training”.<sup>1</sup>*

Despite this, and the fact that clear guidelines from regulatory bodies exists; there remains confusion and inconsistencies in training programs for harness suspension management in Ontario. The MLTSD has not provided a clear guideline, stating:

*“(4) Before any use of a fall arrest system or a safety net by a worker at a project, the worker’s employer shall develop written procedures for rescuing the worker after his or her fall has been arrested.” (Government of Ontario, 2019, O. Reg. 145/00, s. 12)*

However, given that no “suspension traumas” have been reported, this is concordant with current literature; which may partially explain why inconsistencies persist.

Given that Suspension Syncope and death, can happen, time is of critical importance when a worker is suspended after fall-arrest; with a recommended rescue time of six minutes or less. As such consistent training amongst all workers on site is important: everyone assisting with the rescue should be clear and consistent in their objectives. The fact that different workers may be receiving different training is therefore problematic. Although the rescue management of a fallen worker is ultimately the employer’s responsibility; inconsistent information could impact the rescue plan, and worse cause potential harm to the fallen worker.

Therefore, the purpose of this project was threefold:

1) to consult with WAH training providers across Ontario to compare their harness

suspension management training, noting which management plan they used and why; 2) to ask whether they had ever personally managed a harness suspension rescue, or whether they were aware that such a rescue has occurred in a workplace; and 3) to ask about harness equipment for the prevention of suspension syncope and compliance by workers.

## **METHODS**

An extensive review of the current literature surrounding the topic of suspension trauma was conducted via internet databases using key terms such as: “suspension trauma”, “orthostatic intolerance”, “harness hang syndrome”, and “harness induced pathology”. In total, 64 papers were reviewed, with 30 papers meeting the criteria addressing incidence and occurrence, treatment and management of suspension trauma, and harness impact and design.

A list of WAH training providers was accessed through the MLTSD database with 190 organizations identified and subsequently contacted either via email, telephone, or both (Response Rate: 22%; n=42). Organizations were invited to have a dialogue about suspension trauma incidence and occurrence, the treatment and management of suspension trauma, and questions pertaining to harness design and fit. A table was formulated to capture dialogue and tabulate data that would be analyzed and represented for the purpose of this project.

WAH training providers could be characterized into three broad categories: 1) training and consulting; 2) training; and 3) construction companies offering training. Training and consulting organizations had

the highest response rate n=20, followed by strictly training organizations n=14, and construction companies offering training n=2. Within the “Training and Consulting” category, organizations have a diverse background and delivery of services, which includes rescue management plans for working from heights. Within the broad “Training” category, both small and large organizations provide strictly training programs, including WAH.

## **RESULTS**

### **Suspension Trauma Incidence**

WAH training providers reported zero confirmed cases of suspension trauma events. A small number of providers indicated that they have heard, third hand, of a suspension trauma; but not directly. Management of these supposed suspension trauma cases was not available for reporting. Despite the lack of confirmed cases of suspension trauma, WAH training providers unanimously reported that suspension trauma is a real hazard for workers working at heights and not merely a myth.

### **WAH Reported Management Approaches**

WAH training providers reported that forty-five percent of providers do not offer treatment and management of suspension trauma in their training, while fifty-five percent of providers do discuss treatment and management of suspension trauma in various degrees.

WAH training providers who offer treatment and management of suspension trauma in their training programs discuss positioning of the worker post-fall. Ninety-three percent of those providers provided recommendations of positioning ‘other than’

horizontal (supine). Fifty-six percent reported recommending the sitting or semi-sitting position post-fall. The “W” position was the second highest reported recommendation (19%). Figure 1 details the different positioning recommendations for rescued workers from the responding trainers:

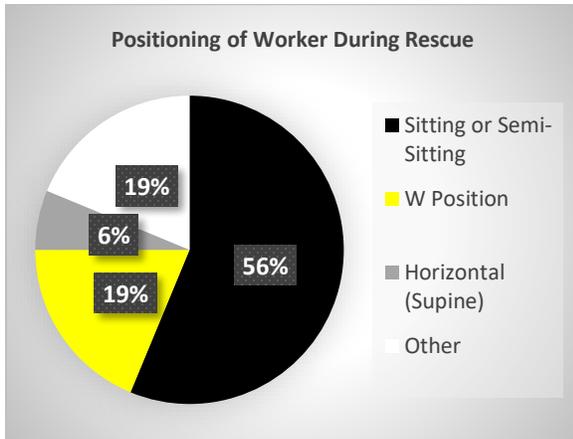


Figure 1: Percentage of WAH providers and their training recommendations for positioning of workers post-suspension rescue

### Guidelines for Treatment and Management of Suspension Trauma

Ninety-five percent of WAH providers said that there was a need for clear guidelines on this topic to support knowledge transfer to workers.

### Harness Fit and Design

Ninety-five percent of WAH training providers reported that harness fit, and design was an issue, with workers’ size playing a significant factor in proper fit. The quality of harness: economy compared to more expensive models; also played a significant role in harness fit reported by WAH training providers with economical models fitting poorly.

### Compliance with Harness Usage

WAH training providers cited multiple reasons why they thought workers did not comply with harness use while working at heights. These reasons are summarized in Table I. The most reported reason for non-compliance was that the worker was uneducated or lacked understanding about the risk of falls without a harness (and therefore a poor perception of personal risk) (30%). Other cited factors were uncomfortable fit, lack of experience in how to use a harness, inconvenience to the worker in the time and effort required, and a belief that sometimes workers were just lazy and did not want to bother with suiting up.



Table I: WAH training providers opinions on why workers do not wear harnesses while working

### DISCUSSION

No cases of confirmed suspension trauma in the industrial sector could be found, in the literature or through interviews. This reaffirms a similar search performed in 2010 by Adishes et al. who also could not find any documented industrial cases of syncope in fall protection,<sup>7</sup> and despite an increased usage of harnesses in Ontario.<sup>3</sup> If harnesses are saving lives and preventing injury, it would be valuable for workplaces to track any falls that then had a suspension occur. Tracking these near misses would be valuable in

promoting the use of harnesses and reinforcing the need to replace any harness after a fall.

Despite the clinical consensus around suspension syncope in the industrial sector there is agreement amongst first aid responders and trainers that “suspension trauma” does in fact pose a risk to workers working from heights. This was confirmed in consultation with WAH training providers, though a relatively small sample size. Purposeful modifications in the data collection process about falls, should occur, such that documentation include: *i*) occurrence of a suspension, and *ii*) whether there were any clinical outcomes, related to the suspension. It would be meaningful to know whether near misses are happening, i.e. are workers being suspended, but rescued without incidence? It would also be beneficial to share real examples of harness suspension and the outcomes in training programs and safety shares.

Current treatment and management practices for harness suspension among WAH providers is a cause for concern. Although each individual WAH provider had their training approved by MLTSD’s Chief Prevention Officer, there is a large discrepancy amongst trainers in knowledge transfer. Fifty-five percent of the responding WAH providers indicated some form of treatment and management plan in their training programs; but only 6% were recommending management that aligns with current, international best-practice. It was clear that the lack of consistency was due to both the mixed messaging on internet resources, many still incorrectly citing the 2002 Seddon report, and no clear direction from the MLTSD.

A key focus area for communication is: with regards to the positioning of the worker post-rescue. Due to the discrepancies

in online resources, surrounding treatment and management of harness suspension, training recommendations for positioning of a worker post-fall is inconsistent. Of the papers reviewed for this project, there was no indication that evidence exists to support the positioning of a suspended worker other than in the horizontal (supine) position, whether conscious or unconscious and that best practice should be to follow the standard first aid management plan; including the ABCs (Airway, Breathing, and Circulation).<sup>6-8, 10-19</sup> Adisesh et al. indicate there have been, to date, no studies reviewing the effects of sitting rescued casualties in a semi-recumbent position.<sup>10</sup> Even though no scientific evidence exists to support the positioning of rescued worker in the sitting or semi-recumbent position, organizations continue to offer this advice when discussing treatment and management of harness suspension. This is concerning and may explain why ninety-five percent of organizations that participated in this project felt a need for clear guidelines around the treatment and management of harness suspension.

A secondary factor, explored in this project, was the impact of harnesses as both a factor in so called “suspension trauma” and a reason for workers to not wear harnesses while working from heights. A paper (written without medical input) entitled: “*Can Your Safety Harness Kill You?*” has received much traction in the safety community, and has been widely cited as a cautionary tale of the risks of harness-use after a fall-arrest.<sup>20</sup> Unfortunately, an article like this may send the wrong message to the industry, and may encourage non-compliance with harness use. Again, data indicating the incidence of harness suspension might counter this belief. Further research to determine correlation of compliance with harness wearing between

workers who receive WAH training with treatment and management of harness suspension and those who do not is warranted.

Anthropometrics play a critical role in a properly fitting harness, as does cost. Workplaces and workers themselves may be reluctant to purchase more expensive harnesses without clear justification. However, good fit and comfort appear to be key indicators of regular use, which will contribute to attaining a higher level of safety for everyone in a fall-arrest scenario.

The clinical evidence warrants a change in terminology and consistent use by all parties (government, workers, safe work associations, and WAH trainers). This would align people about what the injury is and how it should be managed. As noted, there is no evidence of suspension trauma, thus the terms harness suspension and suspension syncope, to describe the act of a person hanging vertically by a harness and the act of person hanging vertically and motionless, respectively; would be more appropriate.<sup>7-8, 18</sup>

Lastly, we would emphasize the importance of harness use and compliance for workers working from heights. The take home messaging should be that harnesses save lives and the dialogue needs to shift from punitive communication for non-compliance to positive reinforcement for compliance and the importance of proper harness usage.

## RECOMMENDATIONS

1. The MLTSD should adopt and communicate clear guidelines around the treatment and management of harness suspension to WAH training groups, that reflect the current scientific evidence about

first aid measures, including positioning of the worker post-rescue.

2. The MLTSD should only approve WAH training providers that are applying the agreed-upon content for WAH training.

3. The WSIB and workplaces should collect data specific to the occurrence of any harness suspension event during any fall whether or not it causes an injury; and in the case of an injury from a suspension, follow-up clinical information should be gathered to better understand this phenomenon in the industrial setting.

4. Further research is merited, in the industrial sector, regarding harness fit/design and perceptions to better understand the challenges and concerns of workers and harness use.

5. Consideration should be given to officially change the terminology using harness suspension (the act) and suspension syncope (if a person faints) to better align with the physiological response of the body to hanging vertically and motionless, respectively, after a fall-arrest rather than the outdated “suspension trauma”.

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