Improving the Safe Transportation of Liquid Nitrogen at Academia

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Introduction:

Liquid nitrogen is commonly used in the healthcare industry - both diagnostic and research laboratories may use the chemical routinely. However, liquid nitrogen is a highly hazardous substances to transport and use. The liquid itself causes severe skin burns and the nitrogen gas generated from the liquid can cause asphyxiation. Accidents involving liquid nitrogen and its gas are not common, but its impact can be very severe. The liquid nitrogen spillage incident from a toppled liquid nitrogen vessel in Academia present itself that the existing risk control measures were inadequate and more can be done.

Objective:

The aim is to work with all relevant stakeholders to identify the shortfalls in transportation of liquid nitrogen vessels and to improve on the work conditions and emergency response measures.

Methodology:

The liquid nitrogen spillage incident at Academia in Sep 2014 was analyzed in detail by the SingHealth safety team to identify the gaps in the safety of liquid nitrogen vessel storage and transportation. The following stages were planned out:-

- **Incident investigation:** Interview with the victim to understand the situation and finding the root cause.
- **Review of vessels and transportation route:** Survey of the vessels (Dewar tanks) in used and the designated transportation route to identify hazards
- **Review of emergency response measures:** Identify areas where such measures need to be beefed up.
- **Review of risk assessments:** Risk assessments with associated activities were reviewed and revised.
- **Communication:** Engage the staff using safety alerts (newsletter) and safety talks


SAFETY & HEALTH ALERT

Brought to you by SingHealth IBC and Research Lab Safety office — 15 October 2014, Ref: SHAS1-2014

Researcher Severely Injured due to Toppled Liquid Nitrogen Vessel

Brief Description

In September 2014, some researchers were on duty to transport liquid nitrogen vessels down to Basement 1 of The Academia for refilling. While transporting the liquid nitrogen vessels back to the laboratory, the wheels of the transport cart get caught by the elevated floor at the loading / unloading bay and the vessel toppled. As the lid of the vessel was not locked, liquid nitrogen spilled out and onto the shoes of one of the researchers. The researcher suffered cold burns and was given over two weeks of medical leave for his injuries.

Recommendations

Risk Assessment

- Conduct a thorough Risk Assessment (RA) before starting any work involving liquid nitrogen vessel transportation. Site-specific hazards are to be identified and control measures put in place to reduce all risks associated with the work activity. In this case, the risk of toppling of liquid nitrogen vessel must be identified and preventive safety measures established and implemented prior to work commencement.

Safe Work Procedure

- Include inspection on the wheels of the liquid nitrogen vessels before transporting. Staff should report any faults immediately to their Supervisor and to transport the vessels only when all faults have been rectified.
- Ensure sufficient manpower for the transportation of the vessels.
- Push the vessels in a stable manner and do not rush.
- Put on appropriate PPE derived from risk assessments (Cryo gloves, safety shoes, lab coat/cryo aprons).

Reporting

- Report all cases of near misses or incidents.

*The issue of **Safety & Health Alert** on the safe transportation of liquid nitrogen vessels*

Results:

Transportation Route

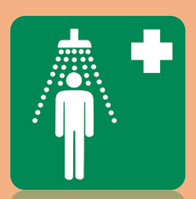
It was discovered that although the designated route by-pass the common human traffic, it was so heavily utilized that damages in the form of cracks and holes on the cement floor had developed. This had caused the wheels of the vessel to get stuck and toppled when maneuvered. Therefore, it is crucial to inspect the transportation route frequently and any damages to the flooring should be reported for repair as soon as possible. The imperfections on the floor of the transportation route was identified and repaired.:

Before: Cracks and holes of flooring that can caught the wheels and cause vessels to topple.

After: Damaged flooring repaired. Yellow lines drawn to mark elevated grounds.

Emergency Response Measures

The liquid nitrogen spillage incident at Academia prompted the safety team to look into the emergency response features available along the transportation route. It was discovered that the designated topping up area – the loading / unloading bay, was not equipped with flushing facilities. The area also serves as the main entrance point where chemicals will be delivered by vendors. The flushing facility would facilitate the flushing off of chemical spillages on the body. Working with SGH Facility Department, an emergency shower was installed at the loading unloading bay.

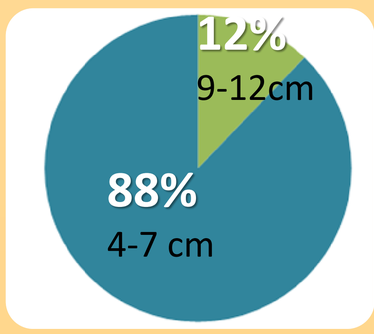


Emergency shower installed at site near where refilling of liquid nitrogen will be carried out.

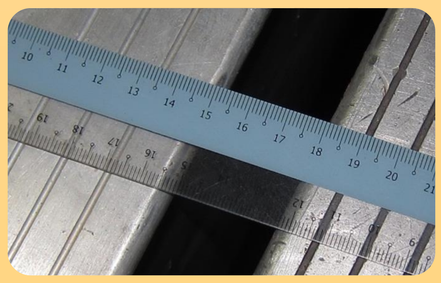
Liquid Nitrogen Vessels

The wheel size (diameter) of the liquid nitrogen vessel's transport cart was analyzed as it had played a crucial role in getting the vessel to topple when the wheels struck obstacles or run over holes on the floor. When inspected, it was discovered that the transport cart involved in the incident was about 7cm in diameter. When tested, the smaller wheels of the transport cart (≤ 7cm) were found to be prone to get trapped in gaps formed between the lift car and lift lobby. The small wheel size was also prone to get caught at the holes formed on the damaged flooring. A larger wheel may allow the vessel to ride over lift gaps and any floor damages or holes more efficiently.

The wheels of 41 liquid nitrogen vessels (Dewar tanks) were measured, and 36 of the tanks had diameter of less than or equals 7cm:



Of the 41 wheel size measured, 88% of the wheels were ≤ 7cm



Lift gaps were measured to be 3cm. When tested, wheels size of less than 7cm were prone to getting trapped and had to be lifted to bypass the gap.

Solutions:

- To acquire transport carts with larger wheel size, preferably larger than 10cm. Transport cart with smaller wheel size for movement within the room only.
- Check the wheels regularly, carts with damaged or loose wheels should not be used.
- Engage liquid nitrogen suppliers to transport the refilling tanks to top up the Dewar tanks on site. This eliminate the need to transport vessels for refilling.

Site Specific Risk Assessment

The vessels and transportation route taken for transporting liquid nitrogen vessels differ with sites and begets different hazards and risks. Therefore, the risk assessments for liquid nitrogen vessel transportation was conducted with this in mind and will include the evaluation of the equipment and the designated route.

Conclusion:

The size of the transport cart wheels and the condition of the transportation route flooring are two important factors to ensure the safe transportation of liquid nitrogen vessels. Should accident occurs, proper flushing facility must be available to ensure the spillages on body can be flushed away to reduce the extent of injury.

To create awareness on the safe transportation of liquid nitrogen vessel, staffs had been actively engaged through safety and health alert newsletter, safety talks and meetings. The importance of site-specific work activity risk assessments was emphasized through sharing of this incident with other SingHealth institutions.